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2006-05-16	2.0	AUTOSAR Administration	Initial release

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Note on XML examples

This specification includes examples in XML based on the AUTOSAR metamodel available at the time of writing. These examples are included as illustrations of configurations and their expected outcome but should not be considered part of the specification.

1 Introduction

This document contains the software specification of the AUTOSAR Run-Time Environment (*RTE*) and the *Basic Software Scheduler*. Basically, the RTE together with the OS, AUTOSAR COM and other Basic Software Modules is the implementation of the Virtual Functional Bus concepts (*VFB*, [1]). The RTE implements the AUTOSAR Virtual Functional Bus interfaces and thereby realizes the communication between AUTOSAR software-components.

This document describes how these concepts are realized within the RTE. Furthermore, the Application Programming Interface (*API*) of the RTE and the interaction of the RTE with other basic software modules is specified.

The *Basic Software Scheduler* offers concepts and services to integrate Basic Software Modules Hence, the *Basic Software Scheduler*

- embed *Basic Software Module* implementations into the AUTOSAR OS context
- trigger main processing functions of the *Basic Software Modules*
- apply data consistency mechanisms for the *Basic Software Modules*
- to communicate modes between *Basic Software Modules*

1.1 Scope

This document is intended to be the main reference for developers of an RTE generator tool or of a concrete RTE implementation respectively. The document is also the reference for developers of AUTOSAR software-components and basic software modules that interact with the RTE, since it specifies the application programming interface of the RTE and therefore the mechanisms for accessing the RTE functionality. Furthermore, this specification should be read by the AUTOSAR working groups that are closely related to the RTE (see Section 1.2 below), since it describes the interfaces of the RTE to these modules as well as the behavior / functionality the RTE expects from them.

This document is structured as follows. After this general introduction, Chapter 2 gives a more detailed introduction of the concepts of the RTE. Chapter 3 describes how an RTE is generated in the context of the overall AUTOSAR methodology. Chapter 4 is

the central part of this document. It specifies the RTE functionality in detail. The RTE API is described in Chapter 5.

The appendix of this document consists of five parts: Appendix A lists the restrictions to the AUTOSAR metamodel that this version of the RTE specification relies on. Appendix B explicitly lists all external requirements, i.e. all requirements that are not about the RTE itself but specify the assumptions on the environment and the input of an RTE generator. In Appendix C some MISRA-C rules are listed that are likely to be violated by RTE code, and the rationale why these violations may occur.

Note that Chapters 1 and 2, as well as Appendix C do not contain any requirements and are thus intended for information only.

Chapters 4 and 5 are probably of most interest for developers of an RTE Generator. Chapters 2, 3, 5 are important for developers of AUTOSAR software-components and basic software modules. The most important chapters for related AUTOSAR work packages would be Chapters 4, 5, as well as Appendix B.

The specifications in this document do not define details of the implementation of a concrete RTE or RTE generator respectively. Furthermore, aspects of the ECU- and system-generation process (like e.g. the mapping of SW-Cs to ECUs, or schedulability analysis) are also not in the scope of this specification. Nevertheless, it is specified what input the RTE generator expects from these configuration phases.

1.2 Dependency to other AUTOSAR specifications

The main documents that served as input for the specification of the RTE are the specification of the Virtual Functional Bus [1] and the specification of the Software Component Template [2]. Also of primary importance are the specifications of those Basic Software modules that closely interact with the RTE (or vice versa). These are especially the communication module [3] and the operating system [4]. The main input of an RTE generator is described (among others) in the ECU Configuration Description. Therefore, the corresponding specification [5] is also important for the RTE specification. Furthermore, as the process of RTE generation is an important part of the overall AUTOSAR Methodology, the corresponding document [6] is also considered.

The following list shows the specifications that are closely interdependent to the specification of the RTE:

- Specification of the Virtual Functional Bus [1]
- Specification of the Software Component Template [2]
- Specification of AUTOSAR COM [3]
- Specification of AUTOSAR OS [4]
- Specification of ECU State Manager and Communication Manager [7]
- Specification of ECU Configuration [5]

- Specification of System Description / Generation [8]
- AUTOSAR Methodology [6]
- Specification of BSW Module Description Template [9]
- AUTOSAR Generic Structure Template [10]

1.3 Acronyms and Abbreviations

All abbreviations used throughout this document – except the ones listed here – can be found in the official AUTOSAR glossary [11].

1.4 Technical Terms

All technical terms used throughout this document – except the ones listed here – can be found in the official AUTOSAR glossary [11] or the Software Component Template Specification [2].

Term	Description
application mode manager	An <i>application mode manager</i> is an <i>AUTOSAR software-component</i> that provides the service of switching modes. The modes of an <i>application mode manager</i> do not have to be standardized.
ASCR runnable	A <i>Runnable Entity</i> that is triggered by at least one <i>AsynchronousServerCallReturnsEvent</i> .
associated Local Software Cluster Communication Plug-In	The <i>Local Software Cluster Communication Plug-In</i> which is assigned to a communication graph, <i>ExclusiveArea</i> , <i>mode machine instance</i> or distributed shared mode group and therefore handles all accesses via RTE APIs, SchM APIs or RTE internal code.
associated Cross Software Cluster Communication Plug-In	The <i>Cross Software Cluster Communication Plug-In</i> which is assigned to a communication graph, <i>mode machine instance</i> and therefore handles all accesses via RTE APIs or RTE internal code.
<i>AutosarDataPrototype</i> implementation	Definitions and declarations for non automatic ¹ memory objects which are allocated by the RTE and implementing <i>AutosarDataPrototypes</i> or their belonging status handling.
<i>BswSchedulableEntity</i> activation	The activation of a <i>BswSchedulableEntity</i> is defined as the activation of the task/ISR2 that contains the <i>BswSchedulableEntity</i> and eventually includes setting a flag that tells the glue code in the task/ISR2 which <i>BswSchedulableEntity</i> is to be executed.

¹declaration with no static or external specifier defines an automatic variable

BswSchedulableEntity start	A <code>BswSchedulableEntity</code> is started by the calling the C-function that implements the <code>BswSchedulableEntity</code> from within a started task/ISR2.
'C' typed <code>PerInstanceMemory</code>	'C' typed <code>PerInstanceMemory</code> is defined with the class <code>PerInstanceMemory</code> . The type of the memory is defined with a 'C' typedef in the attribute <code>typeDefinition</code> .
client	A client is defined as one <code>ClientServerOperation</code> in one <code>RPortPrototype</code> of one Software Component instance. For the definition of the client neither the number of <code>ServerCallPoints</code> nor <code>RunnableEntity</code> accesses to the <code>ServerCallPoint</code> are relevant. A Software Component instance can appear as several clients to the same server if it defines <code>ServerCallPoints</code> for several <code>PortPrototypes</code> of the same <code>PortInterface</code> 's <code>ClientServerOperation</code> .
CodeGenerationTime variability	Variability defined with an <code>VariationPoint</code> or <code>AttributeValueVariationPoint</code> with latest <code>bindingTime</code> <code>CodeGenerationTime</code> .
coherency group	<p>A set of <code>implicit read accesses</code> and <code>implicit write accesses</code> for which the RTE cares for data coherency. Please note that in the context of this specification the definition of coherency includes that</p> <ul style="list-style-type: none"> • read data values of different <code>VariableDataPrototypes</code> have to be from the same age, except the values are changed by <code>implicit write accesses</code> belonging to the coherency group • written data values of different <code>VariableDataPrototypes</code> are communicated to readers NOT belonging to the coherency group after the last <code>implicit write access</code> belonging to the coherency group.
coherent implicit data access	An <code>implicit read access</code> or an <code>implicit write access</code> which belongs to <code>coherency group</code> . Therefore it is referenced by a <code>RteVariableReadAccessRef</code> or <code>RteVariableWriteAccessRef</code> belonging to a <code>RteImplicitCommunication</code> container which <code>RteCoherentAccess</code> parameter is set to true.
coherent implicit read access	An <code>implicit read access</code> which belongs to <code>coherency group</code> . Therefore it is referenced by a <code>RteVariableReadAccessRef</code> belonging to a <code>RteImplicitCommunication</code> container which <code>RteCoherentAccess</code> parameter is set to true.
coherent implicit write access	An <code>implicit write access</code> which belongs to <code>coherency group</code> . Therefore it is referenced by a <code>RteVariableReadAccessRef</code> or <code>RteVariableWriteAccessRef</code> belonging to a <code>RteImplicitCommunication</code> container which <code>RteCoherentAccess</code> parameter is set to true.

common mode machine instance	<p>A 'common mode machine instance' is a special 'mode machine instance' shared by BSW Modules and SW-Cs:</p> <p>The RTE Generator creates only one <code>mode machine instance</code> if a <code>ModeDeclarationGroupPrototype</code> instantiated in a port of a software-component is synchronized (<i>synchronized-ModeGroup</i> of a <i>SwcBswMapping</i>) with a <i>providedModeGroup</i> <code>ModeDeclarationGroupPrototype</code> of a Basic Software Module instance. The related <code>mode machine instance</code> is called <code>common mode machine instance</code>.</p>
Communication Graph	<p>The sum of all <code>AbstractAccessPoints</code> to elements of <code>PortInterfaces</code> instantiated in <code>PortPrototypes</code> which are connected to each other, or the sum of all accesses from <code>BswModuleEntitys</code> to interface elements in a <code>BswModuleDescriptions</code> connected to each other.</p>
Data Communication Graph	<p>The sum of all <code>VariableAccesses</code> to <code>VariableDataPrototypes</code> instantiated in <code>PortPrototypes</code> which are connected to each other, or the sum of all <code>VariableAccesses</code> to <code>VariableDataPrototypes</code> in the <code>InternalBehavior</code>, or the sum of all <code>BswVariableAccesses</code> to <code>VariableDataPrototypes</code> in <code>BswModuleDescriptions</code> connected to each other.</p>
Parameter Communication Graph	<p>The sum of all <code>ParameterAccesses</code> to <code>ParameterDataPrototypes</code> instantiated in <code>PortPrototypes</code> which are connected to each other, or the sum of all <code>ParameterAccesses</code> to <code>ParameterDataPrototypes</code> in the <code>InternalBehavior</code>.</p>
Client Server Communication Graph	<p>The sum of all <code>ServerCallPoints</code> to <code>operations</code> instantiated in <code>PortPrototypes</code> which are connected to each other inclusive the belonging <code>server runnable</code>.</p>
Trigger Communication Graph	<p>The sum of all <code>ExternalTriggeringPoints</code> for <code>triggers</code> instantiated in <code>PortPrototypes</code> which are connected to each other inclusive the belonging <code>triggered runnable</code>.</p>
Mode Communication Graph	<p>The sum of all <code>ModeAccessPoints</code> and <code>ModeSwitchPoints</code> to <code>ModeDeclarationGroupPrototypes</code> instantiated in <code>PortPrototypes</code> which are connected to each other, or the sum of all <code>managedModeGroups</code> and <code>accessedModeGroups</code> to <code>ModeDeclarationGroupPrototypes</code> in <code>BswModuleDescriptions</code> connected to each other.</p>
copy semantic	<p>Copy semantic means, that the accessing entities are able to read or write the "copied" data from their execution context in a non concurrent and non preempting manner. If all accessing entities are in the same <code>preemption area</code> this might not require a real physical data copy.</p>

core local mode user group	<p>In the case that mode users belong to different partitions which in turn are scheduled on different micro controller cores the overall mode machine instance needs to be distributed cross core. Thereby some restrictions are only applicable between the mode users executed on the same micro controller core.</p> <p>All mode users of the same mode manager which belong to EcucPartition which in turn belong to OsApplications referring to the same EcucCoreDefinition are belonging to the same core local mode user group.</p>
data semantic	<p>When data is distributed, the last received value is of interest (last-is-best semantics). Therefore the software implementation policy, stated in the swImplPolicy attribute of the SwDataDefProps, shouldn't be 'queued'.</p>
event semantic	<p>When events are distributed the whole history of received events is of interest, hence they must be queued on receiver side. Therefore the software implementation policy, stated in the swImplPolicy attribute of the SwDataDefProps, will have the value 'queued' (corresponding to event distribution with a queue).</p>
execution-instance	<p>An execution-instance of an ExecutableEntity is one instance or call context of an ExecutableEntity with respect to concurrent execution, see section 4.2.3.</p>
hard error runnable	<p>A <i>Runnable Entity</i> that is triggered by at least by one TransformerHardErrorEvent.</p>
implicit read access	<p>VariableAccess aggregated in the role dataReadAccess to a VariableDataPrototype</p>
implicit write access	<p>VariableAccess aggregated in the role dataWriteAccess to a VariableDataPrototype</p>
incoherent implicit data access	<p>An implicit read access or an implicit write access which does not belong to a coherency group. Therefore it is NOT referenced by any RteVariableReadAccessRef or RteVariableWriteAccessRef belonging to a RteImplicitCommunication container which RteCoherentAccess parameter is set to true.</p>
incoherent implicit read access	<p>An implicit read access which does not belong to a coherency group. Therefore it is NOT referenced by any RteVariableReadAccessRef belonging to a RteImplicitCommunication container which RteCoherentAccess parameter is set to true.</p>
incoherent implicit write access	<p>An implicit write access which does not belong to a coherency group. Therefore it is NOT referenced by any RteVariableWriteAccessRef belonging to a RteImplicitCommunication container which RteCoherentAccess parameter is set to true.</p>
inter-ECU communication	<p>The communication between ECUs, typically using COM is called inter-ECU communication in this document.</p>
inter-partition communication	<p>The communication within one ECU but between different partitions, represented by different OS applications, is called inter-partition communication in this document. It may involve the use of OS mechanisms like IOC or trusted function calls. The partitions can be located on different cores or use different memory sections of the ECU.</p>
intra-ECU communication	<p>The communication within one ECU is called intra-ECU communication in this document. It is a super set of inter-partition communication and intra-partition communication.</p>

intra-partition communication	The communication within one partition of one ECU is called <i>intra-partition</i> communication. In this case, RTE can make use of internal buffers and queues for communication.
invalidateable	Invalidateable <i>VariableDataPrototypes</i> are <i>VariableDataPrototypes</i> that have an <i>invalidValue</i> .
ISR body	The definition of the task function using the macro <i>ISR</i> .
ISR2	An interrupt service routine of category 2.
LinkTime variability	Variability defined with an <i>VariationPoint</i> or <i>AttributeValue-VariationPoint</i> with latest <i>bindingTime</i> <i>LinkTime</i> .
mode disabling	When a 'mode disabling' is active, RTE and <i>Basic Software Scheduler</i> disables the activation of <i>mode disabling dependent ExecutableEntities</i> . The 'mode disabling' is active during the mode that is referenced in the mode disabling dependency and during the transitions that enter and leave this mode. See also section 4.4.1.
mode disabling dependency	A <i>RTEEvent</i> (respectively a <i>BswEvent</i>) that starts a <i>RunnableEntity</i> (respectively a <i>BswSchedulableEntity</i>) can contain a <i>disabledMode</i> (respectively <i>disabledInMode</i>) association which <i>references</i> a <i>ModeDeclaration</i> . This association is called <i>mode disabling dependency</i> in this document.
mode disabling dependent ExecutableEntity	A mode disabling dependent <i>RunnableEntity</i> or a <i>BswSchedulableEntity</i> is triggered by an <i>RTEEvent</i> respectively a <i>BswEvent</i> with a <i>mode disabling dependency</i> . RTE and <i>Basic Software Scheduler</i> prevent the activation of those <i>RunnableEntity</i> or <i>BswSchedulableEntity</i> by the <i>RTEEvent</i> / <i>BswEvent</i> , when the corresponding <i>mode disabling</i> is active. See also section 4.4.1.
mode machine instance	The instances of mode machines or <i>ModeDeclarationGroups</i> are defined by the <i>ModeDeclarationGroupPrototypes</i> of the <i>mode managers</i> . Since a mode switch is not executed instantaneously, The RTE or <i>Basic Software Scheduler</i> has to maintain it's own states. For each <i>mode manager</i> 's <i>ModeDeclarationGroupPrototype</i> , RTE or <i>Basic Software Scheduler</i> has one state machine. This state machine is called <i>mode machine instance</i> . For all <i>mode users</i> of the same <i>mode manager</i> 's <i>ModeDeclarationGroupPrototype</i> , RTE and <i>Basic Software Scheduler</i> uses the same <i>mode machine instance</i> . See also section 4.4.2.
mode manager	Entering and leaving modes is initiated by a <i>mode manager</i> . A <i>mode manager</i> is either a software component that provides a p-port typed by a <i>ModeSwitchInterface</i> or a BSW module which defines in its <i>BswModuleDescription</i> a <i>ModeDeclarationGroupPrototype</i> in the role <i>providedModeGroup</i> . See also section 4.4.2.
ModeSwitchAck ExecutableEntity	A <i>RunnableEntity</i> or a <i>BswSchedulableEntity</i> that is triggered by a <i>ModeSwitchedAckEvent</i> respectively a <i>BswModeSwitchedAckEvent</i> connected to the <i>mode manager</i> 's <i>ModeDeclarationGroupPrototype</i> . It is called <i>ModeSwitchAck ExecutableEntity</i> . See also section 4.4.1.
mode switch notification	The communication of a mode switch from the <i>mode manager</i> to the <i>mode user</i> using either the <i>ModeSwitchInterface</i> or <i>providedModeGroup</i> and <i>requiredModeGroup</i> <i>ModeDeclarationGroupPrototypes</i> is called <i>mode switch notification</i> .

mode switch port	The port for receiving (or sending) a mode switch notification. For this purpose, a <i>mode switch port</i> is typed by a ModeSwitchInterface .
mode user	An <i>AUTOSAR SW-C</i> or <i>AUTOSAR Basic Software Module</i> that depends on modes is called a mode user. The dependency can occur through a SwcModeSwitchEvent/BswModeSwitchEvent , a ModeAccessPoint for a provided/required mode switch port , or a accessedModeGroup for a providedModeGroup/requiredModeGroup ModeDeclarationGroupPrototype . See also section 4.4.1.
NvBlockSwComponent	<i>NvBlockSwComponent</i> is a SwComponentPrototype typed an NvBlockSwComponentType .
on-entry ExecutableEntity	A RunnableEntity or a BswSchedulableEntity that is triggered by a SwcModeSwitchEvent respectively a BswModeSwitchEvent with <i>ModeActivationKind</i> 'entry' is triggered on entering the mode. It is called <i>on-entry ExecutableEntity</i> . See also section 4.4.1.
on-exit ExecutableEntity	A RunnableEntity or a BswSchedulableEntity that is triggered by a SwcModeSwitchEvent respectively a BswModeSwitchEvent with <i>ModeActivationKind</i> 'exit' is triggered on exiting the mode. It is called <i>on-exit ExecutableEntity</i> . See also section 4.4.1.
on-transition ExecutableEntity	A RunnableEntity or a BswSchedulableEntity that is triggered by a SwcModeSwitchEvent respectively a BswModeSwitchEvent with <i>ModeActivationKind</i> 'transition' is triggered on a transition between the two specified modes. It is called <i>on-transition ExecutableEntity</i> . See also section 4.4.1.
post-build variability	Variability defined with an VariationPoint having an post-BuildVariantCriterion
pre-build variability	Variability defined with an VariationPoint or AttributeValueVariationPoint with latest bindingTime SystemDesignTime , CodeGenerationTime , PreCompileTime or LinkTime .
PreCompileTime variability	Variability defined with an VariationPoint or AttributeValueVariationPoint with latest bindingTime PreCompileTime .
preemption area	A preemption area defines a set of tasks which are scheduled cooperatively. Therefore tasks of one preemption area are preempting each other only at dedicated schedule points. A schedule point is not allowed to occur during the execution of a RunnableEntity .
primitive data type	Primitive data types are the types implemented by a boolean, integer (up to 32 bits), floating point, or opaque type (up to 32 bits).
RIPS FlatInstanceDescriptor	FlatInstanceDescriptor with rtePluginProps referencing a Communication Graph .
RP enabler flag	A Boolean flag to permit run-time enabling/disabling bypass.
RP event id	Identifier for bypassed event; passed as parameter to RP service function .
RP global buffer	A buffer read/written by RP. The RP global buffer is conceptually separated from the RTE managed buffer holding the variable data prototype value.
RP global measurement buffer	A buffer used by RP to store the original variable data prototype value for subsequent measurement purposes before replacement by the RP generated value.

RP runnable disabler flag	A Boolean flag to permit conditional RunnableEntity execution. When conditional execution is configured the runnable is executed if the flag is <code>FALSE</code> .
RP service component	An AUTOSAR or vendor specific BSW module providing an RP service, e.g. “XCP on CAN” or “XCP on Ethernet”.
RP service profile	A definition of a service combining the symbol of the function providing the service and the permitted range of RP service point ids .
RP service function	An invocation of a function provided by a RP service component where data is sampled and/or stimulated.
RP service point	A location where one or more RP service functions provided by a RP service component are invoked.
RP service point id	Integer identifier for RP service point .
RP service invocation wrapper	A “wrapper” function created by the RTE that is responsible for invoking the RP RP service function (s). The indirection thus introduced enables a post-build tool to replace the invocation of the RTE generated function with arbitrary functionality.
RP stimulation enabler flag	A Boolean flag to permit conditional RP stimulation.
RTE event identifier	Integer identifier used by RP to identify RTE event associated with an RP service point .
Applicative Software Cluster	The Software Cluster which mainly contains software components and only selected BSW modules (e.g. a Service module, transformers, etc.)
Host Software Cluster	The Software Cluster which contains major part of the BSW and especially the micro controller dependent lower layer BSW Modules, e.g. OS and MCAL.
RTE Implementation Plug-In	A RTE Implementation Plug-In is a part of the overall RTE implementation which is not provided by the RTE Generator but from an additional source (e.g. a Plug-In Generator or a manually implemented source code).
RTE Implementation Plug-In Service	A RTE Implementation Plug-In Service is a single entry point into the RTE Implementation Plug-In implementing a low level service for the RTE. For instance access to a specific buffer.
Local Software Cluster Communication Plug-In	A Local Software Cluster Communication Plug-In is an RTE Implementation Plug-In which handles the communication locally inside a Software Cluster. This includes the Transformer handling if a DataMapping exist for the according Communication Graph
Cross Software Cluster Communication Plug-In	A Cross Software Cluster Communication Plug-In is an RTE Implementation Plug-In which handles the communication towards other Software Cluster. This includes the Transformer handling if intra ECU transformation is configured.
RIPS	The acronym RIPS stands for RTE Implementation Plug-In Service and the related API infix Rips is derived from this.

RIPS FlatInstanceDescriptor	A FlatInstanceDescriptor which assigns the communication graph with an RTE Implementation Plug-In
runnable activation	The activation of a runnable is linked to the RTEEvent that leads to the execution of the runnable. It is defined as the incident that is referred to by the RTEEvent . E. g., for a timing event, the corresponding runnable is activated, when the timer expires, and for a data received event, the runnable is activated when the data is received by the RTE.
runnable start	A runnable is started by the calling the C-function that implements the runnable from within a started task/ISR2.
server	A server is defined as one RunnableEntity which is the target of an OperationInvokedEvent . Call serialization is on activation of RunnableEntity .
server ExecutableEntity	A server that is triggered either by an OperationInvokedEvent or by an BswOperationInvokedEvent . In certain situations, RTE can implement the client server communication as a simple function call.
server runnable	A server that is triggered by an OperationInvokedEvent . It has a mixed behavior between a runnable and a function call. In certain situations, RTE can implement the client server communication as a simple function call.
SystemDesignTime variability	Variability defined with an VariationPoint or AttributeValueVariationPoint with latest bindingTime SystemDesignTime.
Task body	The definition of the task function using the macro TASK.
trigger emitter	A <i>trigger emitter</i> has the ability to release triggers which in turn are activating triggered ExecutableEntities . <i>trigger emitter</i> are described by the meta model with provide trigger ports , Trigger in role releasedTrigger , InternalTriggeringPoints and BswInternalTriggeringPoints .
trigger port	A PortPrototype which is typed by an TriggerInterface
trigger sink	A <i>trigger sink</i> relies on the activation of <i>Runnable Entities</i> or <i>Basic Software Schedulable Entities</i> if a particular <i>Trigger</i> is raised. A <i>trigger sink</i> has a dedicated require trigger port (s) or / and requiredTrigger Trigger (s) to communicate to the trigger source (s).
trigger source	A <i>trigger source</i> administrate the particular <i>Trigger</i> and informs the RTE or <i>Basic Software Scheduler</i> if the <i>Trigger</i> is raised. A <i>trigger source</i> has dedicated provide trigger port (s) or / and releasedTrigger Trigger (s) to communicate to the trigger sink (s).
triggered BswSchedulableEntity	A BswSchedulableEntity that is triggered at least by one BswExternalTriggerOccurredEvent or BswInternalTriggerOccurredEvent . In particular cases, the <i>Trigger Event Communication</i> or the <i>Inter Basic Software Schedulable Entity Triggering</i> is implemented by <i>Basic Software Scheduler</i> as a direct or trusted function call of the <i>triggered ExecutableEntity</i> by the triggering <i>ExecutableEntity</i> .

triggered ExecutableEntity	A <i>Runnable Entity</i> or a <i>Basic Software Schedulable Entity</i> that is triggered at least by one ExternalTriggerOccurredEvent / BswExternalTriggerOccurredEvent or InternalTriggerOccurredEvent / BswInternalTriggerOccurredEvent . In particular cases, the Trigger Event Communication or the <i>Inter Runnable Triggering</i> is implemented by RTE or <i>Basic Software Scheduler</i> as a direct or trusted function call of the <i>triggered ExecutableEntity</i> by the triggering ExecutableEntity .
triggered runnable	A <i>Runnable Entity</i> that is triggered at least by one ExternalTriggerOccurredEvent or InternalTriggerOccurredEvent . In particular cases, the Trigger Event Communication or the <i>Inter Runnable Triggering</i> is implemented by RTE as a direct or trusted function call of the <i>triggered runnable</i> by the triggering runnable.
unconnected port	An <i>unconnected port</i> is a RPortPrototype or PPortPrototype referenced by no AssemblySwConnectors and/or DelegationSwConnectors , or with at least no DataMapping of any of the elements in the port interface. Hint: PRPortPrototypes are always treated as connected ports. (See [SWS_Rte_06030])
direct function call	A <i>direct function call</i> is a function call that is not performed via other means than pure RTE code. Typically, this is a C function call in an OsTask , OsIsr or RTE API (see 5.6).
trusted function call	A <i>trusted function call</i> is a function call that is performed via the CallTrustedFunction() API of the OS. This is usually necessary to achieve a direct function call like behavior when crossing partition boundaries.

Table 1.1: Technical Terms

1.5 Document Conventions

Requirements in the SRS are referenced using [[SRS_Rte_<n>](#)] where <n> is the requirement id. For example, [[SRS_Rte_00098](#)].

Requirements in the SWS are marked with [[SWS_Rte_<nnnnn>](#)] as the first text in a paragraph. The scope of the requirement is marked with the half brackets.

Constraints on the input of the RTE are marked with [[SWS_Rte_CONSTR_<XXXXX>](#)].

Technical terms are typeset in monospace font, e.g. [Warp Core](#).

AUTOSAR Meta Class Names and Attributes are typeset in monospace font, e.g. [ApplicationSwComponentType](#). As a general rule, plural forms of AUTOSAR Meta Class Names and Attributes are created by adding "s" to the singular form, e.g. [PortPrototypes](#). By this means the document resembles terminology used in the AUTOSAR XML Schema.

AUTOSAR ECU Configuration Parameters are typeset in monospace font, e.g. [RteCodeVendorId](#). As a general rule, plural forms of ECU Configuration Parameters are created by adding "s" to the singular form, e.g. [RteEventToTaskMappings](#). By

this means the document resembles terminology used in the ARXML file of AUTOSAR ECU Configuration Parameter Definition.

API function calls are also marked with monospace font, like `Rte_EjectWarpCore`.

1.6 Requirements Tracing

The following table references the requirements specified in [12] as well as [13] and links to the fulfillment of these. Please note that if column “Satisfied by” is empty for a specific requirement this means that this requirement is not fulfilled by this document.

Requirement	Description	Satisfied by
[SRS_00235]	No description	[SWS_Rte_70124]
[SRS_BSW_00004]	All Basic SW Modules shall perform a pre-processor check of the versions of all imported include files	[SWS_Rte_07692]
[SRS_BSW_00007]	All Basic SW Modules written in C language shall conform to the MISRA C 2012 Standard.	[SWS_Rte_01168] [SWS_Rte_03715] [SWS_Rte_06804] [SWS_Rte_06805] [SWS_Rte_06806] [SWS_Rte_06807] [SWS_Rte_06808] [SWS_Rte_06809] [SWS_Rte_06810] [SWS_Rte_07086] [SWS_Rte_07300] [SWS_Rte_08900]
[SRS_BSW_00101]	The Basic Software Module shall be able to initialize variables and hardware in a separate initialization function	[SWS_Rte_04546] [SWS_Rte_04547] [SWS_Rte_04548] [SWS_Rte_04549] [SWS_Rte_04550] [SWS_Rte_04551] [SWS_Rte_07270] [SWS_Rte_07271] [SWS_Rte_07273] [SWS_Rte_70047] [SWS_Rte_80051] [SWS_Rte_80052] [SWS_Rte_80055]
[SRS_BSW_00161]	The AUTOSAR Basic Software shall provide a microcontroller abstraction layer which provides a standardized interface to higher software layers	[SWS_Rte_02734]
[SRS_BSW_00300]	All AUTOSAR Basic Software Modules shall be identified by an unambiguous name	[SWS_Rte_01003] [SWS_Rte_01157] [SWS_Rte_01158] [SWS_Rte_01161] [SWS_Rte_01169] [SWS_Rte_01171] [SWS_Rte_07122] [SWS_Rte_07139] [SWS_Rte_07284] [SWS_Rte_07288] [SWS_Rte_07295] [SWS_Rte_07504] [SWS_Rte_07922]
[SRS_BSW_00305]	Data types naming convention	[SWS_Rte_01055] [SWS_Rte_01150] [SWS_Rte_02301] [SWS_Rte_02310] [SWS_Rte_02311] [SWS_Rte_03731] [SWS_Rte_03733]
[SRS_BSW_00307]	Global variables naming convention	[SWS_Rte_01171] [SWS_Rte_03712] [SWS_Rte_07284]

[SRS_BSW_00308]	AUTOSAR Basic Software Modules shall not define global data in their header files, but in the C file	[SWS_Rte_03786] [SWS_Rte_07121] [SWS_Rte_07502] [SWS_Rte_07921]
[SRS_BSW_00310]	API naming convention	[SWS_Rte_01071] [SWS_Rte_01072] [SWS_Rte_01083] [SWS_Rte_01091] [SWS_Rte_01092] [SWS_Rte_01102] [SWS_Rte_01111] [SWS_Rte_01118] [SWS_Rte_01120] [SWS_Rte_01123] [SWS_Rte_01206] [SWS_Rte_01252] [SWS_Rte_02569] [SWS_Rte_02631] [SWS_Rte_02725] [SWS_Rte_03550] [SWS_Rte_03553] [SWS_Rte_03560] [SWS_Rte_03565] [SWS_Rte_03741] [SWS_Rte_03744] [SWS_Rte_03800] [SWS_Rte_03928] [SWS_Rte_03929] [SWS_Rte_04577] [SWS_Rte_04579] [SWS_Rte_05509] [SWS_Rte_06207] [SWS_Rte_07367] [SWS_Rte_07390] [SWS_Rte_07394] [SWS_Rte_07556] [SWS_Rte_89020] [SWS_Rte_89021] [SWS_Rte_89022] [SWS_Rte_89023] [SWS_Rte_91000] [SWS_Rte_91113] [SWS_Rte_91114] [SWS_Rte_91115] [SWS_Rte_91117] [SWS_Rte_91119] [SWS_Rte_91121] [SWS_Rte_91122]
[SRS_BSW_00312]	Shared code shall be reentrant	[SWS_Rte_01012]
[SRS_BSW_00327]	Error values naming convention	[SWS_Rte_01058] [SWS_Rte_01060] [SWS_Rte_01061] [SWS_Rte_01064] [SWS_Rte_01065] [SWS_Rte_01317] [SWS_Rte_02312] [SWS_Rte_02571] [SWS_Rte_02594] [SWS_Rte_02702] [SWS_Rte_02739] [SWS_Rte_02747] [SWS_Rte_02757] [SWS_Rte_04582] [SWS_Rte_07054] [SWS_Rte_07289] [SWS_Rte_07290] [SWS_Rte_07384] [SWS_Rte_07562] [SWS_Rte_07563] [SWS_Rte_07655] [SWS_Rte_08065] [SWS_Rte_08551] [SWS_Rte_08725] [SWS_Rte_08726]
[SRS_BSW_00330]	It shall be allowed to use macros instead of functions where source code is used and runtime is critical	[SWS_Rte_01274]
[SRS_BSW_00336]	Basic SW module shall be able to shutdown	[SWS_Rte_07274] [SWS_Rte_07275] [SWS_Rte_07277] [SWS_Rte_70047] [SWS_Rte_80053] [SWS_Rte_80054] [SWS_Rte_80055]
[SRS_BSW_00337]	Classification of development errors	[SWS_Rte_06631] [SWS_Rte_06632] [SWS_Rte_06633] [SWS_Rte_06634] [SWS_Rte_06635] [SWS_Rte_06637] [SWS_Rte_07675] [SWS_Rte_07682] [SWS_Rte_07683] [SWS_Rte_07684] [SWS_Rte_07685]

[SRS_BSW_00342]	It shall be possible to create an AUTOSAR ECU out of modules provided as source code and modules provided as object code, even mixed	[SWS_Rte_07511]
[SRS_BSW_00346]	All AUTOSAR Basic Software Modules shall provide at least a basic set of module files	[SWS_Rte_06638]
[SRS_BSW_00347]	A Naming separation of different instances of BSW drivers shall be in place	[SWS_Rte_06203] [SWS_Rte_06532] [SWS_Rte_06535] [SWS_Rte_06536] [SWS_Rte_07093] [SWS_Rte_07250] [SWS_Rte_07253] [SWS_Rte_07255] [SWS_Rte_07260] [SWS_Rte_07263] [SWS_Rte_07266] [SWS_Rte_07282] [SWS_Rte_07295] [SWS_Rte_07504] [SWS_Rte_07528] [SWS_Rte_07694] [SWS_Rte_08765] [SWS_Rte_08789] [SWS_Rte_08790]
[SRS_BSW_00351]	Encapsulation of compiler specific methods to map objects	[SWS_Rte_04557] [SWS_Rte_04562]
[SRS_BSW_00353]	All integer type definitions of target and compiler specific scope shall be placed and organized in a single type header	[SWS_Rte_01163] [SWS_Rte_01164] [SWS_Rte_07104] [SWS_Rte_07641]
[SRS_BSW_00384]	The Basic Software Module specifications shall specify at least in the description which other modules they require	[SWS_Rte_01412]
[SRS_BSW_00407]	Each BSW module shall provide a function to read out the version information of a dedicated module implementation	[SWS_Rte_07278] [SWS_Rte_07279] [SWS_Rte_07280] [SWS_Rte_07281]
[SRS_BSW_00415]	Interfaces which are provided exclusively for one module shall be separated into a dedicated header file	[SWS_Rte_07295] [SWS_Rte_07500] [SWS_Rte_07501] [SWS_Rte_07503] [SWS_Rte_07504] [SWS_Rte_07505] [SWS_Rte_07506] [SWS_Rte_07510]
[SRS_BSW_00447]	Standardizing Include file structure of BSW Modules Implementing Autosar Service	[SWS_Rte_07120]
[SRS_Com_02044]	AUTOSAR COM and LargeData COM shall provide a transmit confirmation function	[SWS_Rte_01407] [SWS_Rte_01411]
[SRS_Rte_00003]	Tracing of sender-receiver communication	[SWS_Rte_01238] [SWS_Rte_01240] [SWS_Rte_01241] [SWS_Rte_01242] [SWS_Rte_03814] [SWS_Rte_04531] [SWS_Rte_04532] [SWS_Rte_07639] [SWS_Rte_08901]
[SRS_Rte_00004]	Tracing of client-server communication	[SWS_Rte_01238] [SWS_Rte_01240] [SWS_Rte_01241] [SWS_Rte_01242] [SWS_Rte_03814] [SWS_Rte_04531] [SWS_Rte_04532] [SWS_Rte_07639] [SWS_Rte_08901]

[SRS_Rte_00005]	The RTE generator shall support "trace" builds	[SWS_Rte_01327] [SWS_Rte_01328] [SWS_Rte_04592] [SWS_Rte_04593] [SWS_Rte_04594] [SWS_Rte_04595] [SWS_Rte_04596] [SWS_Rte_04597] [SWS_Rte_04598] [SWS_Rte_04599] [SWS_Rte_04600] [SWS_Rte_04601] [SWS_Rte_04602] [SWS_Rte_04603] [SWS_Rte_04604] [SWS_Rte_04605] [SWS_Rte_04606] [SWS_Rte_04607] [SWS_Rte_04608] [SWS_Rte_04609] [SWS_Rte_04610] [SWS_Rte_04611] [SWS_Rte_04612] [SWS_Rte_04613] [SWS_Rte_04614] [SWS_Rte_05091] [SWS_Rte_05092] [SWS_Rte_05093] [SWS_Rte_05106] [SWS_Rte_06031] [SWS_Rte_08000] [SWS_Rte_CONSTR_09065] [SWS_Rte_CONSTR_09066]
[SRS_Rte_00008]	VFB tracing configuration	[SWS_Rte_01236] [SWS_Rte_01321] [SWS_Rte_04592] [SWS_Rte_05091] [SWS_Rte_05092] [SWS_Rte_05093] [SWS_Rte_08000] [SWS_Rte_08901] [SWS_Rte_CONSTR_09065] [SWS_Rte_CONSTR_09066]
[SRS_Rte_00011]	Support for multiple Application Software Component instances.	[SWS_Rte_01012] [SWS_Rte_01013] [SWS_Rte_01016] [SWS_Rte_01126] [SWS_Rte_01148] [SWS_Rte_01349] [SWS_Rte_02001] [SWS_Rte_02002] [SWS_Rte_02008] [SWS_Rte_02009] [SWS_Rte_02015] [SWS_Rte_02310] [SWS_Rte_02311] [SWS_Rte_03015] [SWS_Rte_03711] [SWS_Rte_03716] [SWS_Rte_03717] [SWS_Rte_03718] [SWS_Rte_03719] [SWS_Rte_03720] [SWS_Rte_03721] [SWS_Rte_03722] [SWS_Rte_03793] [SWS_Rte_03806] [SWS_Rte_06031] [SWS_Rte_07194] [SWS_Rte_07225] [SWS_Rte_07837] [SWS_Rte_07838] [SWS_Rte_07839] [SWS_Rte_08091]
[SRS_Rte_00012]	Multiple instantiated AUTOSAR software components delivered as binary code shall share code	[SWS_Rte_01007] [SWS_Rte_02015] [SWS_Rte_03015]
[SRS_Rte_00013]	Per-instance memory	[SWS_Rte_02301] [SWS_Rte_02302] [SWS_Rte_02303] [SWS_Rte_02304] [SWS_Rte_02305] [SWS_Rte_03782] [SWS_Rte_05062] [SWS_Rte_07045] [SWS_Rte_07133] [SWS_Rte_07134] [SWS_Rte_07135] [SWS_Rte_07161] [SWS_Rte_07182] [SWS_Rte_07183] [SWS_Rte_07184] [SWS_Rte_08303] [SWS_Rte_08304]
[SRS_Rte_00017]	Rejection of inconsistent component implementations	[SWS_Rte_01004] [SWS_Rte_02751] [SWS_Rte_07510]

[SRS_Rte_00018]	Rejection of invalid configurations	[SWS_Rte_01287] [SWS_Rte_01313] [SWS_Rte_01358] [SWS_Rte_01373] [SWS_Rte_02009] [SWS_Rte_02051] [SWS_Rte_02204] [SWS_Rte_02254] [SWS_Rte_02316] [SWS_Rte_02500] [SWS_Rte_02526] [SWS_Rte_02529] [SWS_Rte_02662] [SWS_Rte_02663] [SWS_Rte_02664] [SWS_Rte_02670] [SWS_Rte_02706] [SWS_Rte_02723] [SWS_Rte_02730] [SWS_Rte_02733] [SWS_Rte_02738] [SWS_Rte_02750] [SWS_Rte_03010] [SWS_Rte_03014] [SWS_Rte_03018] [SWS_Rte_03019] [SWS_Rte_03526] [SWS_Rte_03527] [SWS_Rte_03594] [SWS_Rte_03605] [SWS_Rte_03755] [SWS_Rte_03764] [SWS_Rte_03813] [SWS_Rte_03817] [SWS_Rte_03820] [SWS_Rte_03823] [SWS_Rte_03826] [SWS_Rte_03831] [SWS_Rte_03851] [SWS_Rte_03862] [SWS_Rte_03866] [SWS_Rte_03869] [SWS_Rte_03875] [SWS_Rte_03876] [SWS_Rte_03877] [SWS_Rte_03885] [SWS_Rte_03886] [SWS_Rte_03950] [SWS_Rte_03951] [SWS_Rte_03970] [SWS_Rte_03986] [SWS_Rte_03987] [SWS_Rte_03988] [SWS_Rte_03989] [SWS_Rte_04591] [SWS_Rte_05149] [SWS_Rte_06502] [SWS_Rte_06503] [SWS_Rte_06504] [SWS_Rte_06505] [SWS_Rte_06508] [SWS_Rte_06509] [SWS_Rte_06511] [SWS_Rte_06547] [SWS_Rte_06548] [SWS_Rte_06610] [SWS_Rte_06613] [SWS_Rte_06719] [SWS_Rte_06724] [SWS_Rte_06732] [SWS_Rte_06768] [SWS_Rte_06769] [SWS_Rte_06770] [SWS_Rte_06801] [SWS_Rte_06802] [SWS_Rte_06803] [SWS_Rte_06814] [SWS_Rte_06839] [SWS_Rte_07005] [SWS_Rte_07006] [SWS_Rte_07007] [SWS_Rte_07026] [SWS_Rte_07028] [SWS_Rte_07039] [SWS_Rte_07044] [SWS_Rte_07057] [SWS_Rte_07075] [SWS_Rte_07101] [SWS_Rte_07135] [SWS_Rte_07157] [SWS_Rte_07170] [SWS_Rte_07175] [SWS_Rte_07181] [SWS_Rte_07190] [SWS_Rte_07191] [SWS_Rte_07192]
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		[SWS_Rte_07343] [SWS_Rte_07347] [SWS_Rte_07353] [SWS_Rte_07356] [SWS_Rte_07402] [SWS_Rte_07403] [SWS_Rte_07516] [SWS_Rte_07524] [SWS_Rte_07545] [SWS_Rte_07548] [SWS_Rte_07549] [SWS_Rte_07564] [SWS_Rte_07588] [SWS_Rte_07610] [SWS_Rte_07621] [SWS_Rte_07638] [SWS_Rte_07640] [SWS_Rte_07642] [SWS_Rte_07654] [SWS_Rte_07662] [SWS_Rte_07667] [SWS_Rte_07670] [SWS_Rte_07681] [SWS_Rte_07686] [SWS_Rte_07803] [SWS_Rte_07808] [SWS_Rte_07809] [SWS_Rte_07810] [SWS_Rte_07811] [SWS_Rte_07812] [SWS_Rte_07842] [SWS_Rte_07845] [SWS_Rte_07927] [SWS_Rte_08072] [SWS_Rte_08076] [SWS_Rte_08311] [SWS_Rte_08417] [SWS_Rte_08423] [SWS_Rte_08603] [SWS_Rte_08604] [SWS_Rte_08605] [SWS_Rte_08700] [SWS_Rte_08767] [SWS_Rte_08768] [SWS_Rte_08788] [SWS_Rte_08800] [SWS_Rte_08903] [SWS_Rte_08908] [SWS_Rte_08909] [SWS_Rte_72023] [SWS_Rte_82004] [SWS_Rte_82012] [SWS_Rte_CONSTR_80200] [SWS_Rte_CONSTR_80206]
[SRS_Rte_00019]	RTE is the communication infrastructure	[SWS_Rte_01264] [SWS_Rte_02527] [SWS_Rte_02528] [SWS_Rte_02610] [SWS_Rte_02611] [SWS_Rte_02612] [SWS_Rte_03000] [SWS_Rte_03001] [SWS_Rte_03002] [SWS_Rte_03004] [SWS_Rte_03005] [SWS_Rte_03007] [SWS_Rte_03008] [SWS_Rte_03760] [SWS_Rte_03761] [SWS_Rte_03762] [SWS_Rte_03769] [SWS_Rte_03775] [SWS_Rte_03776] [SWS_Rte_03795] [SWS_Rte_03796] [SWS_Rte_04515] [SWS_Rte_04516] [SWS_Rte_04520] [SWS_Rte_04522] [SWS_Rte_04526] [SWS_Rte_04527] [SWS_Rte_04585] [SWS_Rte_04586] [SWS_Rte_04587] [SWS_Rte_04588] [SWS_Rte_05065] [SWS_Rte_05084] [SWS_Rte_05085] [SWS_Rte_05500] [SWS_Rte_06000] [SWS_Rte_06011] [SWS_Rte_06023] [SWS_Rte_06024] [SWS_Rte_07662] [SWS_Rte_08001] [SWS_Rte_08002] [SWS_Rte_08586] [SWS_Rte_08587] [SWS_Rte_08907] [SWS_Rte_CONSTR_03873] [SWS_Rte_CONSTR_03874]
[SRS_Rte_00020]	Access to OS	[SWS_Rte_02250]
[SRS_Rte_00021]	Per-ECU RTE customization	[SWS_Rte_01316] [SWS_Rte_05000]

[SRS_Rte_00022]	Interaction with call-backs	[SWS_Rte_01165]
[SRS_Rte_00023]	RTE Overheads	[SWS_Rte_05053]
[SRS_Rte_00024]	Source-code AUTOSAR software components	[SWS_Rte_01000] [SWS_Rte_01195] [SWS_Rte_01315] [SWS_Rte_07120]
[SRS_Rte_00025]	Static communication	[SWS_Rte_06026]
[SRS_Rte_00027]	VFB to RTE mapping shall be semantic preserving	[SWS_Rte_01274] [SWS_Rte_02200] [SWS_Rte_02201] [SWS_Rte_02649] [SWS_Rte_02651] [SWS_Rte_02653] [SWS_Rte_02654] [SWS_Rte_02657] [SWS_Rte_07346] [SWS_Rte_08700] [SWS_Rte_08703] [SWS_Rte_08705] [SWS_Rte_08707] [SWS_Rte_08709]
[SRS_Rte_00028]	"1:n" Sender-receiver communication	[SWS_Rte_01071] [SWS_Rte_01072] [SWS_Rte_01082] [SWS_Rte_01091] [SWS_Rte_01092] [SWS_Rte_01135] [SWS_Rte_02631] [SWS_Rte_02633] [SWS_Rte_02635] [SWS_Rte_04526] [SWS_Rte_04585] [SWS_Rte_04586] [SWS_Rte_04587] [SWS_Rte_04588] [SWS_Rte_06023] [SWS_Rte_06024] [SWS_Rte_07394] [SWS_Rte_07824] [SWS_Rte_07825] [SWS_Rte_07826] [SWS_Rte_07827] [SWS_Rte_08413] [SWS_Rte_08414] [SWS_Rte_08415] [SWS_Rte_08586] [SWS_Rte_08587] [SWS_Rte_08592] [SWS_Rte_08593] [SWS_Rte_08594] [SWS_Rte_08595] [SWS_Rte_70126] [SWS_Rte_70138]
[SRS_Rte_00029]	"n:1" Client-server communication	[SWS_Rte_01102] [SWS_Rte_01109] [SWS_Rte_01133] [SWS_Rte_01166] [SWS_Rte_01359] [SWS_Rte_03763] [SWS_Rte_03767] [SWS_Rte_03768] [SWS_Rte_03769] [SWS_Rte_03770] [SWS_Rte_04517] [SWS_Rte_04519] [SWS_Rte_06019] [SWS_Rte_07023] [SWS_Rte_07024] [SWS_Rte_07026] [SWS_Rte_07027] [SWS_Rte_07845] [SWS_Rte_08310] [SWS_Rte_72023]
[SRS_Rte_00031]	Multiple Runnable Entities	[SWS_Rte_01016] [SWS_Rte_01126] [SWS_Rte_01130] [SWS_Rte_01132] [SWS_Rte_02202] [SWS_Rte_06713]
[SRS_Rte_00032]	Data consistency mechanisms	[SWS_Rte_01122] [SWS_Rte_02740] [SWS_Rte_02741] [SWS_Rte_02743] [SWS_Rte_02744] [SWS_Rte_02745] [SWS_Rte_02746] [SWS_Rte_03500] [SWS_Rte_03504] [SWS_Rte_03514] [SWS_Rte_03516] [SWS_Rte_03517] [SWS_Rte_03519] [SWS_Rte_03595] [SWS_Rte_03739] [SWS_Rte_03740] [SWS_Rte_03812] [SWS_Rte_03999] [SWS_Rte_04545] [SWS_Rte_05164] [SWS_Rte_07005] [SWS_Rte_08318] [SWS_Rte_08319] [SWS_Rte_08320]

		[SWS_Rte_08321] [SWS_Rte_08322] [SWS_Rte_08419]
[SRS_Rte_00033]	Serialized execution of Server Runnable Entities	[SWS_Rte_02527] [SWS_Rte_02528] [SWS_Rte_02529] [SWS_Rte_02530] [SWS_Rte_04515] [SWS_Rte_04518] [SWS_Rte_04522] [SWS_Rte_07008] [SWS_Rte_08001] [SWS_Rte_08002] [SWS_Rte_CONSTR_03873] [SWS_Rte_CONSTR_03874]
[SRS_Rte_00036]	Assignment to OS Applications	[SWS_Rte_07347] [SWS_Rte_08903]
[SRS_Rte_00045]	Standardized VFB tracing interface	[SWS_Rte_01238] [SWS_Rte_01239] [SWS_Rte_01240] [SWS_Rte_01241] [SWS_Rte_01242] [SWS_Rte_01243] [SWS_Rte_01244] [SWS_Rte_01245] [SWS_Rte_01246] [SWS_Rte_01247] [SWS_Rte_01248] [SWS_Rte_01249] [SWS_Rte_01250] [SWS_Rte_01319] [SWS_Rte_01321] [SWS_Rte_01326] [SWS_Rte_03814] [SWS_Rte_04531] [SWS_Rte_04532] [SWS_Rte_04533] [SWS_Rte_04534] [SWS_Rte_06032] [SWS_Rte_06113] [SWS_Rte_06114] [SWS_Rte_07639] [SWS_Rte_08901]
[SRS_Rte_00046]	Support for "Executable Entity runs inside" Exclusive Areas	[SWS_Rte_01120] [SWS_Rte_01122] [SWS_Rte_01123] [SWS_Rte_02740] [SWS_Rte_02741] [SWS_Rte_02743] [SWS_Rte_02744] [SWS_Rte_02745] [SWS_Rte_02746] [SWS_Rte_03500] [SWS_Rte_03515] [SWS_Rte_07250] [SWS_Rte_07251] [SWS_Rte_07252] [SWS_Rte_07253] [SWS_Rte_07254] [SWS_Rte_07522] [SWS_Rte_07523] [SWS_Rte_07524] [SWS_Rte_07578] [SWS_Rte_07579] [SWS_Rte_08318] [SWS_Rte_08319] [SWS_Rte_08320] [SWS_Rte_08321] [SWS_Rte_08322]
[SRS_Rte_00048]	RTE Generator input	[SWS_Rte_08769] [SWS_Rte_08770] [SWS_Rte_08771] [SWS_Rte_08772] [SWS_Rte_08773] [SWS_Rte_08774] [SWS_Rte_08775] [SWS_Rte_08776]
[SRS_Rte_00049]	Construction of task bodies	[SWS_Rte_02204] [SWS_Rte_02254] [SWS_Rte_04557] [SWS_Rte_04558] [SWS_Rte_04559] [SWS_Rte_04560] [SWS_Rte_04561] [SWS_Rte_04562] [SWS_Rte_06200] [SWS_Rte_06201] [SWS_Rte_07516] [SWS_Rte_08417] [SWS_Rte_82005] [SWS_Rte_CONSTR_04558] [SWS_Rte_CONSTR_04559]

[SRS_Rte_00051]	RTE API mapping	[SWS_Rte_01053] [SWS_Rte_01055] [SWS_Rte_01119] [SWS_Rte_01123] [SWS_Rte_01132] [SWS_Rte_01146] [SWS_Rte_01148] [SWS_Rte_01153] [SWS_Rte_01156] [SWS_Rte_01159] [SWS_Rte_01197] [SWS_Rte_01266] [SWS_Rte_01268] [SWS_Rte_01269] [SWS_Rte_01274] [SWS_Rte_01280] [SWS_Rte_01281] [SWS_Rte_01282] [SWS_Rte_01283] [SWS_Rte_01284] [SWS_Rte_01285] [SWS_Rte_01286] [SWS_Rte_01287] [SWS_Rte_01288] [SWS_Rte_01289] [SWS_Rte_01290] [SWS_Rte_01293] [SWS_Rte_01294] [SWS_Rte_01296] [SWS_Rte_01297] [SWS_Rte_01298] [SWS_Rte_01299] [SWS_Rte_01300] [SWS_Rte_01301] [SWS_Rte_01302] [SWS_Rte_01303] [SWS_Rte_01304] [SWS_Rte_01305] [SWS_Rte_01306] [SWS_Rte_01307] [SWS_Rte_01308] [SWS_Rte_01309] [SWS_Rte_01310] [SWS_Rte_01312] [SWS_Rte_01313] [SWS_Rte_01342] [SWS_Rte_01343] [SWS_Rte_01349] [SWS_Rte_01354] [SWS_Rte_01355] [SWS_Rte_01363] [SWS_Rte_01364] [SWS_Rte_01365] [SWS_Rte_01366] [SWS_Rte_02301] [SWS_Rte_02302] [SWS_Rte_02588] [SWS_Rte_02589] [SWS_Rte_02607] [SWS_Rte_02608] [SWS_Rte_02613] [SWS_Rte_02614] [SWS_Rte_02615] [SWS_Rte_02616] [SWS_Rte_02617] [SWS_Rte_02618] [SWS_Rte_02619] [SWS_Rte_02620] [SWS_Rte_02621] [SWS_Rte_02623] [SWS_Rte_02632] [SWS_Rte_02666] [SWS_Rte_02676] [SWS_Rte_02677] [SWS_Rte_02678] [SWS_Rte_02679] [SWS_Rte_02730] [SWS_Rte_03014] [SWS_Rte_03562] [SWS_Rte_03567] [SWS_Rte_03602] [SWS_Rte_03603] [SWS_Rte_03605] [SWS_Rte_03706] [SWS_Rte_03707] [SWS_Rte_03716] [SWS_Rte_03717] [SWS_Rte_03718] [SWS_Rte_03719] [SWS_Rte_03720] [SWS_Rte_03721] [SWS_Rte_03723] [SWS_Rte_03725] [SWS_Rte_03726] [SWS_Rte_03730] [SWS_Rte_03731]
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		[SWS_Rte_03733] [SWS_Rte_03734] [SWS_Rte_03739] [SWS_Rte_03740] [SWS_Rte_03746] [SWS_Rte_03752] [SWS_Rte_03799] [SWS_Rte_03801] [SWS_Rte_03812] [SWS_Rte_03835] [SWS_Rte_03837] [SWS_Rte_03872] [SWS_Rte_03879] [SWS_Rte_03880] [SWS_Rte_03881] [SWS_Rte_03927] [SWS_Rte_03930] [SWS_Rte_03949] [SWS_Rte_03952] [SWS_Rte_04545] [SWS_Rte_04578] [SWS_Rte_04580] [SWS_Rte_05510] [SWS_Rte_05511] [SWS_Rte_06205] [SWS_Rte_06208] [SWS_Rte_06209] [SWS_Rte_06639] [SWS_Rte_06713] [SWS_Rte_06817] [SWS_Rte_06818] [SWS_Rte_06819] [SWS_Rte_06820] [SWS_Rte_06821] [SWS_Rte_06823] [SWS_Rte_06827] [SWS_Rte_06831] [SWS_Rte_07137] [SWS_Rte_07138] [SWS_Rte_07170] [SWS_Rte_07225] [SWS_Rte_07226] [SWS_Rte_07227] [SWS_Rte_07228] [SWS_Rte_07291] [SWS_Rte_07395] [SWS_Rte_07396] [SWS_Rte_07416] [SWS_Rte_07677] [SWS_Rte_07837] [SWS_Rte_07838] [SWS_Rte_07839] [SWS_Rte_07850] [SWS_Rte_07851] [SWS_Rte_08073] [SWS_Rte_08091] [SWS_Rte_08092] [SWS_Rte_08093] [SWS_Rte_08094] [SWS_Rte_08309] [SWS_Rte_08312] [SWS_Rte_08777] [SWS_Rte_08778] [SWS_Rte_08779] [SWS_Rte_08780] [SWS_Rte_08782] [SWS_Rte_08783] [SWS_Rte_08784] [SWS_Rte_08785] [SWS_Rte_08786]
[SRS_Rte_00052]	Initialization and finalization of components	[SWS_Rte_02503] [SWS_Rte_02562] [SWS_Rte_02564] [SWS_Rte_02707] [SWS_Rte_03852] [SWS_Rte_07046] [SWS_Rte_08911] [SWS_Rte_08912] [SWS_Rte_70116] [SWS_Rte_70117]
[SRS_Rte_00055]	RTE use of global namespace	[SWS_Rte_01171] [SWS_Rte_02317] [SWS_Rte_02318] [SWS_Rte_02319] [SWS_Rte_02320] [SWS_Rte_03609] [SWS_Rte_03610] [SWS_Rte_06706] [SWS_Rte_06707] [SWS_Rte_06708] [SWS_Rte_06812] [SWS_Rte_06813] [SWS_Rte_07036] [SWS_Rte_07037] [SWS_Rte_07104] [SWS_Rte_07109] [SWS_Rte_07110] [SWS_Rte_07111] [SWS_Rte_07114] [SWS_Rte_07115] [SWS_Rte_07116] [SWS_Rte_07117] [SWS_Rte_07118] [SWS_Rte_07119]

		[SWS_Rte_07144] [SWS_Rte_07145] [SWS_Rte_07146] [SWS_Rte_07148] [SWS_Rte_07149] [SWS_Rte_07162] [SWS_Rte_07163] [SWS_Rte_07166] [SWS_Rte_07284]
[SRS_Rte_00059]	RTE API shall pass "in" primitive data types by value	[SWS_Rte_01017] [SWS_Rte_01020] [SWS_Rte_06805] [SWS_Rte_06807] [SWS_Rte_07069] [SWS_Rte_07070] [SWS_Rte_07071] [SWS_Rte_07072] [SWS_Rte_07073] [SWS_Rte_07074] [SWS_Rte_07076] [SWS_Rte_07077] [SWS_Rte_07078] [SWS_Rte_07079] [SWS_Rte_07080] [SWS_Rte_07081] [SWS_Rte_07083] [SWS_Rte_07084] [SWS_Rte_07661] [SWS_Rte_08300]
[SRS_Rte_00060]	RTE API shall pass "in" composite data types by reference	[SWS_Rte_01018] [SWS_Rte_05107] [SWS_Rte_05108] [SWS_Rte_06804] [SWS_Rte_06807] [SWS_Rte_07082] [SWS_Rte_07084] [SWS_Rte_07086]
[SRS_Rte_00061]	"in/out" and "out" parameters	[SWS_Rte_01017] [SWS_Rte_01018] [SWS_Rte_01019] [SWS_Rte_01020] [SWS_Rte_05107] [SWS_Rte_05108] [SWS_Rte_05109] [SWS_Rte_06806] [SWS_Rte_07082] [SWS_Rte_07083] [SWS_Rte_07084] [SWS_Rte_07661]
[SRS_Rte_00062]	Local access to basic software components	[SWS_Rte_02051]
[SRS_Rte_00065]	Deterministic generation	[SWS_Rte_02514] [SWS_Rte_05150]
[SRS_Rte_00068]	Signal initial values	[SWS_Rte_02517] [SWS_Rte_03852] [SWS_Rte_05078] [SWS_Rte_07046] [SWS_Rte_07642] [SWS_Rte_07668] [SWS_Rte_08311] [SWS_Rte_08911] [SWS_Rte_08912] [SWS_Rte_70116] [SWS_Rte_70117]
[SRS_Rte_00069]	Communication timeouts	[SWS_Rte_01064] [SWS_Rte_01095] [SWS_Rte_01107] [SWS_Rte_01114] [SWS_Rte_03754] [SWS_Rte_03758] [SWS_Rte_03759] [SWS_Rte_03763] [SWS_Rte_03767] [SWS_Rte_03768] [SWS_Rte_03770] [SWS_Rte_03771] [SWS_Rte_03772] [SWS_Rte_06002] [SWS_Rte_06013] [SWS_Rte_07056] [SWS_Rte_07059] [SWS_Rte_07060] [SWS_Rte_08310]
[SRS_Rte_00070]	Invocation order of Runnable Entities	[SWS_Rte_02207]

[SRS_Rte_00072]	Activation of Runnable Entities	[SWS_Rte_01131] [SWS_Rte_01133] [SWS_Rte_01135] [SWS_Rte_01137] [SWS_Rte_01166] [SWS_Rte_01292] [SWS_Rte_01359] [SWS_Rte_02203] [SWS_Rte_02512] [SWS_Rte_02697] [SWS_Rte_02758] [SWS_Rte_03520] [SWS_Rte_03523] [SWS_Rte_03524] [SWS_Rte_03526] [SWS_Rte_03527] [SWS_Rte_03530] [SWS_Rte_03531] [SWS_Rte_03532] [SWS_Rte_06748] [SWS_Rte_06759] [SWS_Rte_06760] [SWS_Rte_06771] [SWS_Rte_07023] [SWS_Rte_07024] [SWS_Rte_07026] [SWS_Rte_07027] [SWS_Rte_07061] [SWS_Rte_07177] [SWS_Rte_07178] [SWS_Rte_07207] [SWS_Rte_07208] [SWS_Rte_07379] [SWS_Rte_07403] [SWS_Rte_07515] [SWS_Rte_07575] [SWS_Rte_08791] [SWS_Rte_82008]
[SRS_Rte_00073]	Atomic transport of Data Elements	[SWS_Rte_04527]
[SRS_Rte_00075]	API for accessing per-instance memory	[SWS_Rte_01118] [SWS_Rte_01119] [SWS_Rte_06203] [SWS_Rte_06204] [SWS_Rte_06205]
[SRS_Rte_00077]	Instantiation of per-instance memory	[SWS_Rte_02303] [SWS_Rte_02304] [SWS_Rte_02305] [SWS_Rte_03782] [SWS_Rte_05062] [SWS_Rte_07045] [SWS_Rte_07133] [SWS_Rte_07161] [SWS_Rte_07182] [SWS_Rte_07183] [SWS_Rte_07184] [SWS_Rte_08303] [SWS_Rte_08304]
[SRS_Rte_00078]	Support for Data Element Invalidation	[SWS_Rte_01206] [SWS_Rte_01282] [SWS_Rte_02309] [SWS_Rte_02589] [SWS_Rte_02590] [SWS_Rte_02594] [SWS_Rte_02599] [SWS_Rte_02600] [SWS_Rte_02603] [SWS_Rte_02607] [SWS_Rte_02609] [SWS_Rte_02626] [SWS_Rte_02629] [SWS_Rte_02666] [SWS_Rte_02702] [SWS_Rte_03778] [SWS_Rte_03800] [SWS_Rte_03801] [SWS_Rte_03802] [SWS_Rte_05024] [SWS_Rte_05025] [SWS_Rte_05026] [SWS_Rte_05030] [SWS_Rte_05032] [SWS_Rte_05048] [SWS_Rte_05049] [SWS_Rte_05064] [SWS_Rte_06727] [SWS_Rte_06820] [SWS_Rte_06821] [SWS_Rte_06822] [SWS_Rte_06823] [SWS_Rte_06824] [SWS_Rte_06825] [SWS_Rte_06829] [SWS_Rte_07031] [SWS_Rte_07032] [SWS_Rte_08004] [SWS_Rte_08005] [SWS_Rte_08007] [SWS_Rte_08008] [SWS_Rte_08009] [SWS_Rte_08046] [SWS_Rte_08047] [SWS_Rte_08048] [SWS_Rte_08049] [SWS_Rte_08050] [SWS_Rte_08096]

		[SWS_Rte_08097] [SWS_Rte_08098] [SWS_Rte_08099] [SWS_Rte_08100] [SWS_Rte_08101] [SWS_Rte_08102] [SWS_Rte_08405] [SWS_Rte_08406] [SWS_Rte_08407] [SWS_Rte_08501]
[SRS_Rte_00079]	Single asynchronous client-server interaction	[SWS_Rte_01105] [SWS_Rte_01109] [SWS_Rte_01133] [SWS_Rte_01166] [SWS_Rte_01359] [SWS_Rte_02658] [SWS_Rte_03765] [SWS_Rte_03766] [SWS_Rte_03771] [SWS_Rte_03772] [SWS_Rte_07023] [SWS_Rte_07024] [SWS_Rte_07026] [SWS_Rte_07027] [SWS_Rte_08800]
[SRS_Rte_00080]	Multiple requests of servers	[SWS_Rte_03769] [SWS_Rte_04516] [SWS_Rte_04520]
[SRS_Rte_00082]	Standardized communication protocol	[SWS_Rte_02649] [SWS_Rte_02651] [SWS_Rte_02653] [SWS_Rte_02654] [SWS_Rte_02655] [SWS_Rte_02656] [SWS_Rte_02657] [SWS_Rte_07346] [SWS_Rte_07413] [SWS_Rte_08700] [SWS_Rte_08703] [SWS_Rte_08705] [SWS_Rte_08707] [SWS_Rte_08709] [SWS_Rte_08711] [SWS_Rte_08712]
[SRS_Rte_00083]	Optimization for source-code components	[SWS_Rte_01152] [SWS_Rte_01274]
[SRS_Rte_00084]	Support infrastructural errors	[SWS_Rte_01318] [SWS_Rte_02593]
[SRS_Rte_00087]	Software Module Header File generation	[SWS_Rte_01000] [SWS_Rte_01004] [SWS_Rte_01006] [SWS_Rte_01132] [SWS_Rte_01274] [SWS_Rte_03786] [SWS_Rte_05078] [SWS_Rte_06703] [SWS_Rte_06704] [SWS_Rte_06705] [SWS_Rte_06713] [SWS_Rte_07127] [SWS_Rte_07131] [SWS_Rte_07924]
[SRS_Rte_00089]	Independent access to interface elements	[SWS_Rte_06008]
[SRS_Rte_00091]	Inter-ECU Marshalling	[SWS_Rte_02557] [SWS_Rte_03863] [SWS_Rte_03864] [SWS_Rte_03865] [SWS_Rte_04504] [SWS_Rte_04505] [SWS_Rte_04508] [SWS_Rte_04527] [SWS_Rte_05081] [SWS_Rte_05173] [SWS_Rte_07413] [SWS_Rte_08546] [SWS_Rte_08547] [SWS_Rte_08548] [SWS_Rte_08549] [SWS_Rte_08551] [SWS_Rte_08552] [SWS_Rte_08553] [SWS_Rte_08554] [SWS_Rte_08555] [SWS_Rte_08556] [SWS_Rte_08557] [SWS_Rte_08572] [SWS_Rte_08573]

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[SRS_Rte_00092]	Implementation of VFB model "waitpoints"	[SWS_Rte_01358] [SWS_Rte_02740] [SWS_Rte_02741] [SWS_Rte_02743] [SWS_Rte_02744] [SWS_Rte_02745] [SWS_Rte_02746] [SWS_Rte_03010] [SWS_Rte_03018] [SWS_Rte_07402] [SWS_Rte_07846] [SWS_Rte_07847] [SWS_Rte_08318] [SWS_Rte_08319] [SWS_Rte_08320] [SWS_Rte_08321] [SWS_Rte_08322] [SWS_Rte_CONSTR_80206]
[SRS_Rte_00094]	Communication and Resource Errors	[SWS_Rte_01034] [SWS_Rte_01084] [SWS_Rte_01086] [SWS_Rte_01093] [SWS_Rte_01094] [SWS_Rte_01095] [SWS_Rte_01103] [SWS_Rte_01104] [SWS_Rte_01105] [SWS_Rte_01106] [SWS_Rte_01107] [SWS_Rte_01112] [SWS_Rte_01113] [SWS_Rte_01114] [SWS_Rte_01207] [SWS_Rte_01259] [SWS_Rte_01260] [SWS_Rte_01261] [SWS_Rte_01262] [SWS_Rte_01318] [SWS_Rte_01330] [SWS_Rte_01331] [SWS_Rte_01333] [SWS_Rte_01334] [SWS_Rte_01339] [SWS_Rte_01344] [SWS_Rte_02312] [SWS_Rte_02313] [SWS_Rte_02524] [SWS_Rte_02525] [SWS_Rte_02571] [SWS_Rte_02572] [SWS_Rte_02578] [SWS_Rte_02598] [SWS_Rte_02602] [SWS_Rte_02674] [SWS_Rte_02721] [SWS_Rte_02727] [SWS_Rte_02728] [SWS_Rte_02729] [SWS_Rte_03606] [SWS_Rte_03774] [SWS_Rte_03785] [SWS_Rte_03853] [SWS_Rte_04530] [SWS_Rte_06210] [SWS_Rte_06828] [SWS_Rte_06830]

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[SRS_Rte_00098]	Explicit Sending	[SWS_Rte_01071] [SWS_Rte_06011] [SWS_Rte_06016]
[SRS_Rte_00099]	Decoupling of interrupts	[SWS_Rte_03530] [SWS_Rte_03531] [SWS_Rte_03532] [SWS_Rte_03594] [SWS_Rte_03600]
[SRS_Rte_00100]	Compiler independent API	[SWS_Rte_01314]

[SRS_Rte_00107]	Support for INFORMATION_TYPE attribute	[SWS_Rte_01135] [SWS_Rte_01137] [SWS_Rte_01331] [SWS_Rte_02312] [SWS_Rte_02313] [SWS_Rte_02516] [SWS_Rte_02518] [SWS_Rte_02520] [SWS_Rte_02521] [SWS_Rte_02522] [SWS_Rte_02523] [SWS_Rte_02524] [SWS_Rte_02525] [SWS_Rte_02571] [SWS_Rte_02572] [SWS_Rte_02718] [SWS_Rte_02719] [SWS_Rte_02720] [SWS_Rte_02721] [SWS_Rte_02758] [SWS_Rte_04500] [SWS_Rte_06010] [SWS_Rte_06771] [SWS_Rte_70101]
[SRS_Rte_00108]	Support for INIT_VALUE attribute	[SWS_Rte_01268] [SWS_Rte_02517] [SWS_Rte_04501] [SWS_Rte_04502] [SWS_Rte_05078] [SWS_Rte_06009] [SWS_Rte_07642] [SWS_Rte_07668] [SWS_Rte_07680] [SWS_Rte_07681] [SWS_Rte_08311]
[SRS_Rte_00109]	Support for RECEIVE_MODE attribute	[SWS_Rte_02519] [SWS_Rte_03018] [SWS_Rte_06002] [SWS_Rte_06012]
[SRS_Rte_00110]	Support for BUFFERING attribute	[SWS_Rte_01331] [SWS_Rte_02312] [SWS_Rte_02313] [SWS_Rte_02515] [SWS_Rte_02522] [SWS_Rte_02523] [SWS_Rte_02524] [SWS_Rte_02525] [SWS_Rte_02526] [SWS_Rte_02527] [SWS_Rte_02529] [SWS_Rte_02530] [SWS_Rte_02571] [SWS_Rte_02572] [SWS_Rte_02719] [SWS_Rte_02720] [SWS_Rte_02721] [SWS_Rte_02723] [SWS_Rte_07008] [SWS_Rte_70101]
[SRS_Rte_00111]	Support for CLIENT_MODE attribute	[SWS_Rte_01293] [SWS_Rte_01294] [SWS_Rte_06639]
[SRS_Rte_00115]	API for data consistency mechanism	[SWS_Rte_01120] [SWS_Rte_01122] [SWS_Rte_01307] [SWS_Rte_01308]
[SRS_Rte_00116]	RTE Initialization and finalization	[SWS_Rte_02535] [SWS_Rte_02536] [SWS_Rte_02538] [SWS_Rte_02544] [SWS_Rte_02569] [SWS_Rte_02570] [SWS_Rte_02584] [SWS_Rte_02585] [SWS_Rte_03852] [SWS_Rte_04552] [SWS_Rte_06766] [SWS_Rte_06767] [SWS_Rte_07046] [SWS_Rte_07270] [SWS_Rte_07586] [SWS_Rte_08911] [SWS_Rte_08912] [SWS_Rte_70116] [SWS_Rte_70117]
[SRS_Rte_00121]	Support for FILTER attribute	[SWS_Rte_04581] [SWS_Rte_05500] [SWS_Rte_05501] [SWS_Rte_05503] [SWS_Rte_08077] [SWS_Rte_08079]

[SRS_Rte_00122]	Support for Transmission Acknowledgement	[SWS_Rte_01080] [SWS_Rte_01083] [SWS_Rte_01084] [SWS_Rte_01086] [SWS_Rte_01137] [SWS_Rte_01283] [SWS_Rte_01284] [SWS_Rte_01285] [SWS_Rte_01286] [SWS_Rte_01287] [SWS_Rte_01344] [SWS_Rte_02612] [SWS_Rte_02676] [SWS_Rte_02677] [SWS_Rte_02678] [SWS_Rte_02725] [SWS_Rte_02727] [SWS_Rte_02729] [SWS_Rte_02758] [SWS_Rte_03002] [SWS_Rte_03005] [SWS_Rte_03604] [SWS_Rte_03754] [SWS_Rte_03756] [SWS_Rte_03757] [SWS_Rte_03758] [SWS_Rte_03774] [SWS_Rte_03775] [SWS_Rte_03776] [SWS_Rte_05065] [SWS_Rte_05084] [SWS_Rte_05085] [SWS_Rte_05504] [SWS_Rte_06771] [SWS_Rte_07055] [SWS_Rte_07286] [SWS_Rte_07367] [SWS_Rte_07374] [SWS_Rte_07375] [SWS_Rte_07376] [SWS_Rte_07379] [SWS_Rte_07557] [SWS_Rte_07558] [SWS_Rte_07560] [SWS_Rte_07561] [SWS_Rte_07634] [SWS_Rte_07635] [SWS_Rte_07636] [SWS_Rte_07637] [SWS_Rte_07646] [SWS_Rte_07647] [SWS_Rte_07648] [SWS_Rte_07650] [SWS_Rte_07651] [SWS_Rte_07652] [SWS_Rte_07659] [SWS_Rte_07660] [SWS_Rte_07846] [SWS_Rte_07847] [SWS_Rte_07848] [SWS_Rte_07849] [SWS_Rte_07850] [SWS_Rte_07851] [SWS_Rte_07927] [SWS_Rte_08017] [SWS_Rte_08018] [SWS_Rte_08020] [SWS_Rte_08021] [SWS_Rte_08022] [SWS_Rte_08023] [SWS_Rte_08043] [SWS_Rte_08044] [SWS_Rte_08045] [SWS_Rte_08074] [SWS_Rte_08075] [SWS_Rte_08076] [SWS_Rte_08583] [SWS_Rte_72011] [SWS_Rte_72012] [SWS_Rte_72013] [SWS_Rte_72014] [SWS_Rte_72015] [SWS_Rte_72016] [SWS_Rte_72019] [SWS_Rte_72020]
[SRS_Rte_00123]	The RTE shall forward application level errors from server to client	[SWS_Rte_01103] [SWS_Rte_02576] [SWS_Rte_02577] [SWS_Rte_02578] [SWS_Rte_02593] [SWS_Rte_07925] [SWS_Rte_07926] [SWS_Rte_08705] [SWS_Rte_08709]
[SRS_Rte_00124]	API for application level errors during Client Server communication	[SWS_Rte_01103] [SWS_Rte_01130] [SWS_Rte_02573] [SWS_Rte_02575]

[SRS_Rte_00126]	C language support	[SWS_Rte_01005] [SWS_Rte_01162] [SWS_Rte_01167] [SWS_Rte_01169] [SWS_Rte_03709] [SWS_Rte_03710] [SWS_Rte_03724] [SWS_Rte_07124] [SWS_Rte_07125] [SWS_Rte_07126] [SWS_Rte_07297] [SWS_Rte_07298] [SWS_Rte_07299] [SWS_Rte_07507] [SWS_Rte_07508] [SWS_Rte_07509] [SWS_Rte_07678] [SWS_Rte_07923]
[SRS_Rte_00128]	Implicit Reception	[SWS_Rte_01268] [SWS_Rte_03598] [SWS_Rte_03599] [SWS_Rte_03741] [SWS_Rte_03878] [SWS_Rte_03954] [SWS_Rte_03955] [SWS_Rte_03956] [SWS_Rte_04577] [SWS_Rte_06000] [SWS_Rte_06001] [SWS_Rte_06004] [SWS_Rte_06011] [SWS_Rte_07007] [SWS_Rte_07020] [SWS_Rte_07062] [SWS_Rte_07063] [SWS_Rte_07064] [SWS_Rte_07652] [SWS_Rte_08408] [SWS_Rte_72019]
[SRS_Rte_00129]	Implicit Sending	[SWS_Rte_03570] [SWS_Rte_03571] [SWS_Rte_03572] [SWS_Rte_03573] [SWS_Rte_03574] [SWS_Rte_03598] [SWS_Rte_03744] [SWS_Rte_03746] [SWS_Rte_03878] [SWS_Rte_03953] [SWS_Rte_03954] [SWS_Rte_03955] [SWS_Rte_03957] [SWS_Rte_05509] [SWS_Rte_06011] [SWS_Rte_07007] [SWS_Rte_07021] [SWS_Rte_07041] [SWS_Rte_07062] [SWS_Rte_07065] [SWS_Rte_07066] [SWS_Rte_07067] [SWS_Rte_07068] [SWS_Rte_07367] [SWS_Rte_07374] [SWS_Rte_07375] [SWS_Rte_07376] [SWS_Rte_07646] [SWS_Rte_07647] [SWS_Rte_07648] [SWS_Rte_07650] [SWS_Rte_07651] [SWS_Rte_07660] [SWS_Rte_08408] [SWS_Rte_08418]
[SRS_Rte_00131]	"n:1" Sender-receiver communication	[SWS_Rte_01071] [SWS_Rte_01072] [SWS_Rte_01091] [SWS_Rte_01092] [SWS_Rte_01135] [SWS_Rte_02631] [SWS_Rte_02633] [SWS_Rte_02635] [SWS_Rte_02670] [SWS_Rte_03760] [SWS_Rte_03761] [SWS_Rte_03762] [SWS_Rte_07394] [SWS_Rte_07824] [SWS_Rte_07825] [SWS_Rte_07826] [SWS_Rte_07827] [SWS_Rte_08788]
[SRS_Rte_00133]	Concurrent invocation of Runnable Entities	[SWS_Rte_02697] [SWS_Rte_03523] [SWS_Rte_07007]
[SRS_Rte_00134]	Runnable Entity categories supported by the RTE	[SWS_Rte_03574] [SWS_Rte_03954] [SWS_Rte_06003] [SWS_Rte_06007] [SWS_Rte_07062]
[SRS_Rte_00137]	API for mismatched ports	[SWS_Rte_01368] [SWS_Rte_01369] [SWS_Rte_01370]

[SRS_Rte_00138]	C++ language support	[SWS_Rte_01005] [SWS_Rte_01011] [SWS_Rte_03709] [SWS_Rte_03710] [SWS_Rte_07124] [SWS_Rte_07125] [SWS_Rte_07126] [SWS_Rte_07297] [SWS_Rte_07298] [SWS_Rte_07299] [SWS_Rte_07507] [SWS_Rte_07508] [SWS_Rte_07509]
[SRS_Rte_00139]	Support for unconnected ports	[SWS_Rte_01329] [SWS_Rte_01330] [SWS_Rte_01331] [SWS_Rte_01332] [SWS_Rte_01333] [SWS_Rte_01334] [SWS_Rte_01344] [SWS_Rte_01346] [SWS_Rte_01347] [SWS_Rte_01375] [SWS_Rte_02316] [SWS_Rte_02638] [SWS_Rte_02639] [SWS_Rte_02640] [SWS_Rte_02641] [SWS_Rte_02642] [SWS_Rte_02749] [SWS_Rte_02750] [SWS_Rte_03019] [SWS_Rte_03783] [SWS_Rte_03784] [SWS_Rte_03785] [SWS_Rte_03978] [SWS_Rte_03980] [SWS_Rte_04530] [SWS_Rte_05099] [SWS_Rte_05101] [SWS_Rte_05102] [SWS_Rte_05170] [SWS_Rte_06030] [SWS_Rte_06210] [SWS_Rte_07378] [SWS_Rte_07655] [SWS_Rte_07659] [SWS_Rte_07660] [SWS_Rte_07663] [SWS_Rte_07667] [SWS_Rte_07668] [SWS_Rte_07669] [SWS_Rte_07847] [SWS_Rte_72016] [SWS_Rte_82004]
[SRS_Rte_00140]	Binary-code AUTOSAR software components	[SWS_Rte_01000] [SWS_Rte_01195] [SWS_Rte_01315] [SWS_Rte_07120]
[SRS_Rte_00141]	Explicit Reception	[SWS_Rte_01072] [SWS_Rte_01091] [SWS_Rte_01092] [SWS_Rte_06011] [SWS_Rte_07394] [SWS_Rte_07673]
[SRS_Rte_00142]	Support for InterRunnable Variables	[SWS_Rte_01303] [SWS_Rte_01304] [SWS_Rte_01305] [SWS_Rte_01306] [SWS_Rte_01350] [SWS_Rte_01351] [SWS_Rte_02636] [SWS_Rte_03516] [SWS_Rte_03517] [SWS_Rte_03519] [SWS_Rte_03550] [SWS_Rte_03553] [SWS_Rte_03560] [SWS_Rte_03562] [SWS_Rte_03565] [SWS_Rte_03567] [SWS_Rte_03580] [SWS_Rte_03582] [SWS_Rte_03583] [SWS_Rte_03584] [SWS_Rte_03589] [SWS_Rte_04579] [SWS_Rte_04580] [SWS_Rte_06207] [SWS_Rte_06208] [SWS_Rte_07007] [SWS_Rte_07022] [SWS_Rte_07187]

[SRS_Rte_00143]	Mode Switches	[SWS_Rte_02500] [SWS_Rte_02503] [SWS_Rte_02504] [SWS_Rte_02512] [SWS_Rte_02544] [SWS_Rte_02546] [SWS_Rte_02562] [SWS_Rte_02563] [SWS_Rte_02564] [SWS_Rte_02587] [SWS_Rte_02630] [SWS_Rte_02631] [SWS_Rte_02634] [SWS_Rte_02661] [SWS_Rte_02662] [SWS_Rte_02663] [SWS_Rte_02664] [SWS_Rte_02665] [SWS_Rte_02667] [SWS_Rte_02668] [SWS_Rte_02669] [SWS_Rte_02675] [SWS_Rte_02679] [SWS_Rte_02706] [SWS_Rte_02707] [SWS_Rte_02708] [SWS_Rte_02730] [SWS_Rte_03869] [SWS_Rte_06766] [SWS_Rte_06767] [SWS_Rte_06768] [SWS_Rte_06769] [SWS_Rte_06770] [SWS_Rte_06772] [SWS_Rte_06773] [SWS_Rte_06774] [SWS_Rte_06775] [SWS_Rte_06776] [SWS_Rte_06777] [SWS_Rte_06778] [SWS_Rte_06779] [SWS_Rte_06780] [SWS_Rte_06785] [SWS_Rte_06786] [SWS_Rte_06787] [SWS_Rte_06788] [SWS_Rte_06789] [SWS_Rte_06790] [SWS_Rte_06791] [SWS_Rte_06792] [SWS_Rte_06793] [SWS_Rte_06794] [SWS_Rte_06795] [SWS_Rte_06796] [SWS_Rte_06797] [SWS_Rte_06832] [SWS_Rte_06833] [SWS_Rte_06834] [SWS_Rte_06835] [SWS_Rte_06836] [SWS_Rte_06837] [SWS_Rte_06838] [SWS_Rte_06839] [SWS_Rte_06840] [SWS_Rte_07056] [SWS_Rte_07057] [SWS_Rte_07058] [SWS_Rte_07059] [SWS_Rte_07060] [SWS_Rte_07150] [SWS_Rte_07151] [SWS_Rte_07152] [SWS_Rte_07153] [SWS_Rte_07154] [SWS_Rte_07155] [SWS_Rte_07157] [SWS_Rte_07173] [SWS_Rte_07259] [SWS_Rte_07533] [SWS_Rte_07535] [SWS_Rte_07559] [SWS_Rte_07564] [SWS_Rte_08905] [SWS_Rte_08908] [SWS_Rte_70102]
[SRS_Rte_00144]	RTE shall support the notification of mode switches via AUTOSAR interfaces	[SWS_Rte_02508] [SWS_Rte_02544] [SWS_Rte_02546] [SWS_Rte_02549] [SWS_Rte_02566] [SWS_Rte_02567] [SWS_Rte_02568] [SWS_Rte_02624] [SWS_Rte_02628] [SWS_Rte_02659] [SWS_Rte_02660] [SWS_Rte_02732] [SWS_Rte_02738] [SWS_Rte_03858] [SWS_Rte_03859] [SWS_Rte_06742] [SWS_Rte_06743] [SWS_Rte_06744] [SWS_Rte_06745] [SWS_Rte_06746] [SWS_Rte_06747] [SWS_Rte_06766] [SWS_Rte_06767] [SWS_Rte_06772]

		[SWS_Rte_06773] [SWS_Rte_06774] [SWS_Rte_06775] [SWS_Rte_06776] [SWS_Rte_06777] [SWS_Rte_06778] [SWS_Rte_06779] [SWS_Rte_06780] [SWS_Rte_06781] [SWS_Rte_06782] [SWS_Rte_06783] [SWS_Rte_06784] [SWS_Rte_06785] [SWS_Rte_06786] [SWS_Rte_06787] [SWS_Rte_06788] [SWS_Rte_06789] [SWS_Rte_06790] [SWS_Rte_06791] [SWS_Rte_06792] [SWS_Rte_06793] [SWS_Rte_06794] [SWS_Rte_06795] [SWS_Rte_06796] [SWS_Rte_06797] [SWS_Rte_07155] [SWS_Rte_07262] [SWS_Rte_07540] [SWS_Rte_07640] [SWS_Rte_07666] [SWS_Rte_08500] [SWS_Rte_08504] [SWS_Rte_08505] [SWS_Rte_08506] [SWS_Rte_08509] [SWS_Rte_08510] [SWS_Rte_08908]
[SRS_Rte_00145]	Compatibility mode	[SWS_Rte_01151] [SWS_Rte_01216] [SWS_Rte_01234] [SWS_Rte_01257] [SWS_Rte_01277] [SWS_Rte_01279] [SWS_Rte_01326] [SWS_Rte_03794] [SWS_Rte_03871]
[SRS_Rte_00146]	Vendor mode	[SWS_Rte_01234]
[SRS_Rte_00147]	Support for communication infrastructure time-out notification	[SWS_Rte_02589] [SWS_Rte_02590] [SWS_Rte_02599] [SWS_Rte_02600] [SWS_Rte_02604] [SWS_Rte_02607] [SWS_Rte_02609] [SWS_Rte_02610] [SWS_Rte_02611] [SWS_Rte_02629] [SWS_Rte_02666] [SWS_Rte_02703] [SWS_Rte_02710] [SWS_Rte_03759] [SWS_Rte_05021] [SWS_Rte_06820] [SWS_Rte_06821] [SWS_Rte_06822] [SWS_Rte_06823] [SWS_Rte_06824] [SWS_Rte_06825] [SWS_Rte_06829] [SWS_Rte_08004] [SWS_Rte_08061] [SWS_Rte_08062] [SWS_Rte_08103] [SWS_Rte_08104] [SWS_Rte_08501]
[SRS_Rte_00148]	Support "Specification of Memory Mapping"	[SWS_Rte_03788] [SWS_Rte_03868] [SWS_Rte_05088] [SWS_Rte_05089] [SWS_Rte_06741] [SWS_Rte_07047] [SWS_Rte_07048] [SWS_Rte_07049] [SWS_Rte_07050] [SWS_Rte_07051] [SWS_Rte_07052] [SWS_Rte_07053] [SWS_Rte_07194] [SWS_Rte_07195] [SWS_Rte_07421] [SWS_Rte_07422] [SWS_Rte_07423] [SWS_Rte_07424] [SWS_Rte_07425] [SWS_Rte_07426] [SWS_Rte_07427] [SWS_Rte_07589] [SWS_Rte_07590] [SWS_Rte_07591]

		[SWS_Rte_07592] [SWS_Rte_07593] [SWS_Rte_07594] [SWS_Rte_07595] [SWS_Rte_07596] [SWS_Rte_07830] [SWS_Rte_07831] [SWS_Rte_07832] [SWS_Rte_08787]
[SRS_Rte_00149]	Support "Specification of Compiler Abstraction"	[SWS_Rte_01164] [SWS_Rte_03787] [SWS_Rte_07194] [SWS_Rte_07195] [SWS_Rte_07593] [SWS_Rte_07594] [SWS_Rte_07595] [SWS_Rte_07596] [SWS_Rte_07641]
[SRS_Rte_00150]	Support "Specification of Platform Types"	[SWS_Rte_01164] [SWS_Rte_07641]
[SRS_Rte_00152]	Support for port-defined argument values	[SWS_Rte_01166] [SWS_Rte_01360]
[SRS_Rte_00153]	Support for Measurement	[SWS_Rte_03900] [SWS_Rte_03901] [SWS_Rte_03902] [SWS_Rte_03903] [SWS_Rte_03904] [SWS_Rte_03950] [SWS_Rte_03951] [SWS_Rte_03972] [SWS_Rte_03973] [SWS_Rte_03974] [SWS_Rte_03975] [SWS_Rte_03976] [SWS_Rte_03977] [SWS_Rte_03978] [SWS_Rte_03979] [SWS_Rte_03980] [SWS_Rte_03981] [SWS_Rte_03982] [SWS_Rte_05087] [SWS_Rte_05101] [SWS_Rte_05102] [SWS_Rte_05120] [SWS_Rte_05121] [SWS_Rte_05122] [SWS_Rte_05123] [SWS_Rte_05124] [SWS_Rte_05125] [SWS_Rte_05136] [SWS_Rte_05168] [SWS_Rte_05169] [SWS_Rte_05170] [SWS_Rte_05172] [SWS_Rte_05174] [SWS_Rte_05175] [SWS_Rte_05176] [SWS_Rte_06206] [SWS_Rte_06700] [SWS_Rte_06701] [SWS_Rte_06702] [SWS_Rte_06726] [SWS_Rte_07160] [SWS_Rte_07174] [SWS_Rte_07197] [SWS_Rte_07198] [SWS_Rte_07344] [SWS_Rte_07349] [SWS_Rte_70086] [SWS_Rte_80073] [SWS_Rte_80153] [SWS_Rte_82001]
[SRS_Rte_00154]	Support for Calibration	[SWS_Rte_03835] [SWS_Rte_03905] [SWS_Rte_03906] [SWS_Rte_03907] [SWS_Rte_03908] [SWS_Rte_03909] [SWS_Rte_03910] [SWS_Rte_03911] [SWS_Rte_03912] [SWS_Rte_03913] [SWS_Rte_03914] [SWS_Rte_03915] [SWS_Rte_03916] [SWS_Rte_03922] [SWS_Rte_03932] [SWS_Rte_03933] [SWS_Rte_03934] [SWS_Rte_03935] [SWS_Rte_03936] [SWS_Rte_03942] [SWS_Rte_03943] [SWS_Rte_03947] [SWS_Rte_03948] [SWS_Rte_03949]

		[SWS_Rte_03958] [SWS_Rte_03959] [SWS_Rte_03960] [SWS_Rte_03961] [SWS_Rte_03962] [SWS_Rte_03963] [SWS_Rte_03964] [SWS_Rte_03965] [SWS_Rte_03968] [SWS_Rte_03970] [SWS_Rte_03971] [SWS_Rte_05112] [SWS_Rte_05145] [SWS_Rte_05194] [SWS_Rte_06815] [SWS_Rte_06816] [SWS_Rte_07029] [SWS_Rte_07030] [SWS_Rte_07033] [SWS_Rte_07034] [SWS_Rte_07035] [SWS_Rte_07096] [SWS_Rte_07185] [SWS_Rte_07186] [SWS_Rte_07693]
[SRS_Rte_00155]	API to access calibration parameters	[SWS_Rte_01252] [SWS_Rte_01300] [SWS_Rte_03835] [SWS_Rte_03927] [SWS_Rte_03928] [SWS_Rte_03929] [SWS_Rte_03930] [SWS_Rte_03949] [SWS_Rte_03952] [SWS_Rte_07093] [SWS_Rte_07094] [SWS_Rte_07095]
[SRS_Rte_00156]	Support for different calibration data emulation methods	[SWS_Rte_03905] [SWS_Rte_03906] [SWS_Rte_03908] [SWS_Rte_03909] [SWS_Rte_03910] [SWS_Rte_03911] [SWS_Rte_03913] [SWS_Rte_03914] [SWS_Rte_03915] [SWS_Rte_03916] [SWS_Rte_03922] [SWS_Rte_03932] [SWS_Rte_03933] [SWS_Rte_03934] [SWS_Rte_03935] [SWS_Rte_03936] [SWS_Rte_03942] [SWS_Rte_03943] [SWS_Rte_03947] [SWS_Rte_03948] [SWS_Rte_03960] [SWS_Rte_03961] [SWS_Rte_03962] [SWS_Rte_03963] [SWS_Rte_03964] [SWS_Rte_03965] [SWS_Rte_03968] [SWS_Rte_03970] [SWS_Rte_03971] [SWS_Rte_05145] [SWS_Rte_06816]
[SRS_Rte_00157]	Support for calibration parameters in NVRAM	[SWS_Rte_03936]
[SRS_Rte_00158]	Support separation of calibration parameters	[SWS_Rte_03907] [SWS_Rte_03908] [SWS_Rte_03911] [SWS_Rte_03912] [SWS_Rte_03959] [SWS_Rte_05145] [SWS_Rte_05194] [SWS_Rte_07096]
[SRS_Rte_00159]	Sharing of calibration parameters	[SWS_Rte_02749] [SWS_Rte_02750] [SWS_Rte_03958] [SWS_Rte_05112] [SWS_Rte_07186]
[SRS_Rte_00160]	Debounced start of Runnable Entities	[SWS_Rte_02697]
[SRS_Rte_00161]	Activation offset of Runnable Entities	[SWS_Rte_07000]
[SRS_Rte_00162]	"1:n" External Trigger communication	[SWS_Rte_06210] [SWS_Rte_07200] [SWS_Rte_07201] [SWS_Rte_07207] [SWS_Rte_07212] [SWS_Rte_07213] [SWS_Rte_07214] [SWS_Rte_07215] [SWS_Rte_07216] [SWS_Rte_07218] [SWS_Rte_07229] [SWS_Rte_07543] [SWS_Rte_08906] [SWS_Rte_70124]

[SRS_Rte_00163]	Support for InterRunnable Triggering	[SWS_Rte_07203] [SWS_Rte_07204] [SWS_Rte_07208] [SWS_Rte_07220] [SWS_Rte_07221] [SWS_Rte_07223] [SWS_Rte_07224] [SWS_Rte_07226] [SWS_Rte_07227] [SWS_Rte_07228] [SWS_Rte_07229] [SWS_Rte_07555]
[SRS_Rte_00164]	Ensure a unique naming of generated types visible in the global namespace	[SWS_Rte_02317] [SWS_Rte_02318] [SWS_Rte_02319] [SWS_Rte_02320] [SWS_Rte_03609] [SWS_Rte_03610] [SWS_Rte_06706] [SWS_Rte_06707] [SWS_Rte_06708] [SWS_Rte_06812] [SWS_Rte_06813] [SWS_Rte_07110] [SWS_Rte_07111] [SWS_Rte_07114] [SWS_Rte_07115] [SWS_Rte_07116] [SWS_Rte_07117] [SWS_Rte_07118] [SWS_Rte_07119] [SWS_Rte_07144] [SWS_Rte_07145] [SWS_Rte_07146]
[SRS_Rte_00165]	Suppress identical "C" type re-definitions	[SWS_Rte_07105] [SWS_Rte_07107] [SWS_Rte_07112] [SWS_Rte_07113] [SWS_Rte_07134] [SWS_Rte_07143] [SWS_Rte_07167] [SWS_Rte_07169]
[SRS_Rte_00166]	Use the AUTOSAR Standard Types in the global namespace if the AUTOSAR data type is mapped to an AUTOSAR Standard Type	[SWS_Rte_07036] [SWS_Rte_07037] [SWS_Rte_07104] [SWS_Rte_07109] [SWS_Rte_07148] [SWS_Rte_07149] [SWS_Rte_07162] [SWS_Rte_07163] [SWS_Rte_07166]
[SRS_Rte_00167]	Encapsulate a Software Component local name space	[SWS_Rte_01004] [SWS_Rte_02310] [SWS_Rte_02311] [SWS_Rte_02575] [SWS_Rte_03619] [SWS_Rte_03809] [SWS_Rte_03810] [SWS_Rte_03854] [SWS_Rte_05051] [SWS_Rte_05052] [SWS_Rte_06513] [SWS_Rte_06515] [SWS_Rte_06518] [SWS_Rte_06519] [SWS_Rte_06520] [SWS_Rte_06530] [SWS_Rte_06541] [SWS_Rte_06542] [SWS_Rte_06551] [SWS_Rte_06552] [SWS_Rte_06716] [SWS_Rte_06717] [SWS_Rte_06718] [SWS_Rte_07122] [SWS_Rte_07140] [SWS_Rte_07410] [SWS_Rte_07411] [SWS_Rte_07412] [SWS_Rte_07414] [SWS_Rte_08401] [SWS_Rte_08402] [SWS_Rte_08416]
[SRS_Rte_00168]	Typing of RTE API.	[SWS_Rte_07104]

[SRS_Rte_00169]	Map code and memory allocated by the RTE to memory sections	[SWS_Rte_03868] [SWS_Rte_05088] [SWS_Rte_05089] [SWS_Rte_06741] [SWS_Rte_07047] [SWS_Rte_07048] [SWS_Rte_07049] [SWS_Rte_07050] [SWS_Rte_07051] [SWS_Rte_07052] [SWS_Rte_07053] [SWS_Rte_07421] [SWS_Rte_07422] [SWS_Rte_07423] [SWS_Rte_07424] [SWS_Rte_07425] [SWS_Rte_07426] [SWS_Rte_07427] [SWS_Rte_07589] [SWS_Rte_07590] [SWS_Rte_07591] [SWS_Rte_07592] [SWS_Rte_08787]
[SRS_Rte_00170]	Provide used memory sections description	[SWS_Rte_05086] [SWS_Rte_05089] [SWS_Rte_06725] [SWS_Rte_82000]
[SRS_Rte_00171]	Support for fixed and constant data	[SWS_Rte_03930]
[SRS_Rte_00176]	Sharing of NVRAM data	[SWS_Rte_07301]
[SRS_Rte_00177]	Support of NvBlockComponent Type	[SWS_Rte_03883] [SWS_Rte_03884] [SWS_Rte_04535] [SWS_Rte_04565] [SWS_Rte_04566] [SWS_Rte_04567] [SWS_Rte_04568] [SWS_Rte_06211] [SWS_Rte_06212] [SWS_Rte_07303] [SWS_Rte_07312] [SWS_Rte_07317] [SWS_Rte_07343] [SWS_Rte_07353] [SWS_Rte_07355] [SWS_Rte_07398] [SWS_Rte_07399] [SWS_Rte_07632] [SWS_Rte_07633] [SWS_Rte_08063] [SWS_Rte_08064] [SWS_Rte_08080] [SWS_Rte_08081] [SWS_Rte_08082] [SWS_Rte_08083] [SWS_Rte_08084] [SWS_Rte_08085] [SWS_Rte_08086] [SWS_Rte_08087] [SWS_Rte_08088] [SWS_Rte_08089] [SWS_Rte_08090] [SWS_Rte_08111]
[SRS_Rte_00178]	Data consistency of NvBlock ComponentType	[SWS_Rte_03878] [SWS_Rte_07310] [SWS_Rte_07311] [SWS_Rte_07315] [SWS_Rte_07316] [SWS_Rte_07319] [SWS_Rte_07350] [SWS_Rte_07601] [SWS_Rte_07602] [SWS_Rte_07613] [SWS_Rte_07614]
[SRS_Rte_00179]	Support of Update Flag for Data Reception	[SWS_Rte_01413] [SWS_Rte_04528] [SWS_Rte_07385] [SWS_Rte_07386] [SWS_Rte_07387] [SWS_Rte_07390] [SWS_Rte_07391] [SWS_Rte_07392] [SWS_Rte_07393] [SWS_Rte_07654] [SWS_Rte_07689] [SWS_Rte_72000] [SWS_Rte_72001] [SWS_Rte_72002] [SWS_Rte_72003] [SWS_Rte_72021] [SWS_Rte_72022]

[SRS_Rte_00180]	DataSemantics range check during runtime	[SWS_Rte_01371] [SWS_Rte_01372] [SWS_Rte_01374] [SWS_Rte_03839] [SWS_Rte_03840] [SWS_Rte_03841] [SWS_Rte_03842] [SWS_Rte_03843] [SWS_Rte_03845] [SWS_Rte_03846] [SWS_Rte_03847] [SWS_Rte_03848] [SWS_Rte_03849] [SWS_Rte_03861] [SWS_Rte_06829] [SWS_Rte_07038] [SWS_Rte_08016] [SWS_Rte_08024] [SWS_Rte_08025] [SWS_Rte_08026] [SWS_Rte_08027] [SWS_Rte_08028] [SWS_Rte_08029] [SWS_Rte_08030] [SWS_Rte_08031] [SWS_Rte_08032] [SWS_Rte_08033] [SWS_Rte_08034] [SWS_Rte_08035] [SWS_Rte_08036] [SWS_Rte_08037] [SWS_Rte_08038] [SWS_Rte_08039] [SWS_Rte_08040] [SWS_Rte_08041] [SWS_Rte_08042] [SWS_Rte_08065]
[SRS_Rte_00181]	Conversion between internal and network data types	[SWS_Rte_03827] [SWS_Rte_03828] [SWS_Rte_04536] [SWS_Rte_04538]
[SRS_Rte_00182]	Self Scaling Signals at Port Interfaces	[SWS_Rte_01374] [SWS_Rte_03815] [SWS_Rte_03816] [SWS_Rte_03817] [SWS_Rte_03818] [SWS_Rte_03819] [SWS_Rte_03820] [SWS_Rte_03821] [SWS_Rte_03822] [SWS_Rte_03823] [SWS_Rte_03829] [SWS_Rte_03830] [SWS_Rte_03831] [SWS_Rte_03832] [SWS_Rte_03833] [SWS_Rte_03855] [SWS_Rte_03856] [SWS_Rte_03857] [SWS_Rte_03860] [SWS_Rte_07038] [SWS_Rte_07091] [SWS_Rte_07092] [SWS_Rte_07099] [SWS_Rte_07925] [SWS_Rte_07926] [SWS_Rte_07928] [SWS_Rte_08801]
[SRS_Rte_00183]	RTE Read API returning the dataElement value	[SWS_Rte_07394] [SWS_Rte_07395] [SWS_Rte_07396] [SWS_Rte_91122]
[SRS_Rte_00184]	RTE Status "Never Received"	[SWS_Rte_04529] [SWS_Rte_06829] [SWS_Rte_07381] [SWS_Rte_07382] [SWS_Rte_07383] [SWS_Rte_07384] [SWS_Rte_07643] [SWS_Rte_07644] [SWS_Rte_07645] [SWS_Rte_08005] [SWS_Rte_08008] [SWS_Rte_08009] [SWS_Rte_08046] [SWS_Rte_08047] [SWS_Rte_08048] [SWS_Rte_08096] [SWS_Rte_08097] [SWS_Rte_08098]

[SRS_Rte_00185]	RTE API with Rte_IFeedback	[SWS_Rte_02589] [SWS_Rte_02590] [SWS_Rte_02608] [SWS_Rte_02666] [SWS_Rte_03836] [SWS_Rte_06820] [SWS_Rte_06821] [SWS_Rte_06822] [SWS_Rte_06823] [SWS_Rte_06824] [SWS_Rte_06826] [SWS_Rte_06827] [SWS_Rte_07367] [SWS_Rte_07374] [SWS_Rte_07375] [SWS_Rte_07376] [SWS_Rte_07378] [SWS_Rte_07379] [SWS_Rte_07646] [SWS_Rte_07647] [SWS_Rte_07648] [SWS_Rte_07650] [SWS_Rte_07651] [SWS_Rte_07652] [SWS_Rte_07660] [SWS_Rte_72019]
[SRS_Rte_00189]	A2L Generation Support	[SWS_Rte_03998] [SWS_Rte_05087] [SWS_Rte_05118] [SWS_Rte_05119] [SWS_Rte_05120] [SWS_Rte_05121] [SWS_Rte_05122] [SWS_Rte_05123] [SWS_Rte_05124] [SWS_Rte_05125] [SWS_Rte_05126] [SWS_Rte_05127] [SWS_Rte_05128] [SWS_Rte_05129] [SWS_Rte_05130] [SWS_Rte_05131] [SWS_Rte_05132] [SWS_Rte_05133] [SWS_Rte_05135] [SWS_Rte_05136] [SWS_Rte_05137] [SWS_Rte_05138] [SWS_Rte_05139] [SWS_Rte_05140] [SWS_Rte_05141] [SWS_Rte_05142] [SWS_Rte_05143] [SWS_Rte_05144] [SWS_Rte_05152] [SWS_Rte_05153] [SWS_Rte_05154] [SWS_Rte_05155] [SWS_Rte_05156] [SWS_Rte_05157] [SWS_Rte_05158] [SWS_Rte_05159] [SWS_Rte_05160] [SWS_Rte_05161] [SWS_Rte_05162] [SWS_Rte_06702] [SWS_Rte_06726] [SWS_Rte_07097] [SWS_Rte_08313] [SWS_Rte_08314] [SWS_Rte_08315] [SWS_Rte_08316] [SWS_Rte_08317] [SWS_Rte_82001]
[SRS_Rte_00191]	Support for Variant Handling	[SWS_Rte_05168] [SWS_Rte_05169] [SWS_Rte_05174] [SWS_Rte_05175] [SWS_Rte_05176] [SWS_Rte_06500] [SWS_Rte_06501] [SWS_Rte_06507] [SWS_Rte_06509] [SWS_Rte_06510] [SWS_Rte_06512] [SWS_Rte_06543] [SWS_Rte_06546] [SWS_Rte_06547] [SWS_Rte_06549] [SWS_Rte_06550] [SWS_Rte_06553] [SWS_Rte_06611] [SWS_Rte_06612] [SWS_Rte_06613] [SWS_Rte_06814] [SWS_Rte_06815] [SWS_Rte_06816] [SWS_Rte_08066] [SWS_Rte_08067] [SWS_Rte_08068] [SWS_Rte_08069] [SWS_Rte_08070]

[SRS_Rte_00192]	Support multiple trace clients	[SWS_Rte_04592] [SWS_Rte_04593] [SWS_Rte_04594] [SWS_Rte_04595] [SWS_Rte_04596] [SWS_Rte_04597] [SWS_Rte_04598] [SWS_Rte_04599] [SWS_Rte_04600] [SWS_Rte_04601] [SWS_Rte_04602] [SWS_Rte_04603] [SWS_Rte_04604] [SWS_Rte_04605] [SWS_Rte_04606] [SWS_Rte_04607] [SWS_Rte_04608] [SWS_Rte_04609] [SWS_Rte_04610] [SWS_Rte_04611] [SWS_Rte_04612] [SWS_Rte_04613] [SWS_Rte_04614] [SWS_Rte_05086] [SWS_Rte_05091] [SWS_Rte_05092] [SWS_Rte_05093] [SWS_Rte_05106] [SWS_Rte_06725] [SWS_Rte_82000] [SWS_Rte_CONSTR_09065] [SWS_Rte_CONSTR_09066]
[SRS_Rte_00193]	Support for Runnable Entity execution chaining	[SWS_Rte_07800] [SWS_Rte_07802]
[SRS_Rte_00195]	No activation of Runnable Entities in terminated or restarting partitions	[SWS_Rte_07604] [SWS_Rte_07606]
[SRS_Rte_00196]	Inter-partition communication consistency	[SWS_Rte_02761] [SWS_Rte_05147] [SWS_Rte_07610] [SWS_Rte_82002]
[SRS_Rte_00200]	Support of unconnected R-Ports	[SWS_Rte_01330] [SWS_Rte_01331] [SWS_Rte_01333] [SWS_Rte_01334] [SWS_Rte_03785] [SWS_Rte_04530] [SWS_Rte_06210] [SWS_Rte_07655] [SWS_Rte_07663] [SWS_Rte_70125]
[SRS_Rte_00201]	Contract Phase with Variant Handling support	[SWS_Rte_03882] [SWS_Rte_06500] [SWS_Rte_06502] [SWS_Rte_06505] [SWS_Rte_06514] [SWS_Rte_06515] [SWS_Rte_06516] [SWS_Rte_06518] [SWS_Rte_06519] [SWS_Rte_06520] [SWS_Rte_06521] [SWS_Rte_06522] [SWS_Rte_06523] [SWS_Rte_06524] [SWS_Rte_06525] [SWS_Rte_06526] [SWS_Rte_06527] [SWS_Rte_06528] [SWS_Rte_06529] [SWS_Rte_06530] [SWS_Rte_06531] [SWS_Rte_06539] [SWS_Rte_06540] [SWS_Rte_06541] [SWS_Rte_06542] [SWS_Rte_06543] [SWS_Rte_06546] [SWS_Rte_06551] [SWS_Rte_06552] [SWS_Rte_06620] [SWS_Rte_06638]
[SRS_Rte_00202]	Support for array size variants	[SWS_Rte_06500] [SWS_Rte_06505] [SWS_Rte_06543] [SWS_Rte_06546]
[SRS_Rte_00203]	API to read system constant	[SWS_Rte_03854] [SWS_Rte_06513] [SWS_Rte_06514] [SWS_Rte_06517]
[SRS_Rte_00204]	Support the selection / de-selection of SWC prototypes	[SWS_Rte_06601]
[SRS_Rte_00206]	Support the selection of a signal provider	[SWS_Rte_06601] [SWS_Rte_06602] [SWS_Rte_06603] [SWS_Rte_06604] [SWS_Rte_06605] [SWS_Rte_06606]

[SRS_Rte_00207]	Support N to M communication patterns while unresolved variations are affecting these communications	[SWS_Rte_06601] [SWS_Rte_06602] [SWS_Rte_06603] [SWS_Rte_06604] [SWS_Rte_06605] [SWS_Rte_06606]
[SRS_Rte_00210]	Support for inter OS application communication	[SWS_Rte_02728] [SWS_Rte_02732] [SWS_Rte_02752] [SWS_Rte_02753] [SWS_Rte_02754] [SWS_Rte_02755] [SWS_Rte_02756] [SWS_Rte_03853] [SWS_Rte_07606] [SWS_Rte_08400] [SWS_Rte_08504] [SWS_Rte_08506] [SWS_Rte_82003]
[SRS_Rte_00211]	Cyclic time based scheduling of BSW Schedulable Entities	[SWS_Rte_02697] [SWS_Rte_04542] [SWS_Rte_04543] [SWS_Rte_07282] [SWS_Rte_07514] [SWS_Rte_07574] [SWS_Rte_07584]
[SRS_Rte_00212]	Activation Offset of BSW Schedulable Entities	[SWS_Rte_07520]
[SRS_Rte_00213]	Mode Switches for BSW Modules	[SWS_Rte_02500] [SWS_Rte_02562] [SWS_Rte_02563] [SWS_Rte_02564] [SWS_Rte_02587] [SWS_Rte_02630] [SWS_Rte_02661] [SWS_Rte_02662] [SWS_Rte_02663] [SWS_Rte_02664] [SWS_Rte_02665] [SWS_Rte_02667] [SWS_Rte_02668] [SWS_Rte_02669] [SWS_Rte_02707] [SWS_Rte_02708] [SWS_Rte_04542] [SWS_Rte_04543] [SWS_Rte_06839] [SWS_Rte_07055] [SWS_Rte_07150] [SWS_Rte_07151] [SWS_Rte_07152] [SWS_Rte_07153] [SWS_Rte_07154] [SWS_Rte_07157] [SWS_Rte_07173] [SWS_Rte_07258] [SWS_Rte_07259] [SWS_Rte_07260] [SWS_Rte_07282] [SWS_Rte_07286] [SWS_Rte_07293] [SWS_Rte_07294] [SWS_Rte_07514] [SWS_Rte_07530] [SWS_Rte_07531] [SWS_Rte_07532] [SWS_Rte_07534] [SWS_Rte_07535] [SWS_Rte_07538] [SWS_Rte_07539] [SWS_Rte_07540] [SWS_Rte_07541] [SWS_Rte_07556] [SWS_Rte_07557] [SWS_Rte_07558] [SWS_Rte_07559] [SWS_Rte_07560] [SWS_Rte_07561] [SWS_Rte_07564] [SWS_Rte_07694] [SWS_Rte_08600] [SWS_Rte_08601] [SWS_Rte_08905]
[SRS_Rte_00214]	Common Mode handling for Basic SW and Application SW	[SWS_Rte_02697] [SWS_Rte_07258] [SWS_Rte_07259] [SWS_Rte_07286] [SWS_Rte_07535] [SWS_Rte_07564] [SWS_Rte_07582] [SWS_Rte_07583]
[SRS_Rte_00215]	API for Mode switch notification to the SchM	[SWS_Rte_07255] [SWS_Rte_07256] [SWS_Rte_07261] [SWS_Rte_08507]

[SRS_Rte_00216]	Triggering of BSW Schedulable Entities by occurrence of External Trigger	[SWS_Rte_04542] [SWS_Rte_04543] [SWS_Rte_07213] [SWS_Rte_07214] [SWS_Rte_07216] [SWS_Rte_07218] [SWS_Rte_07282] [SWS_Rte_07514] [SWS_Rte_07542] [SWS_Rte_07544] [SWS_Rte_07545] [SWS_Rte_07546] [SWS_Rte_07548] [SWS_Rte_07549] [SWS_Rte_08906]
[SRS_Rte_00217]	Synchronized activation of Runnable Entities and BSW Schedulable Entities	[SWS_Rte_02697] [SWS_Rte_07218] [SWS_Rte_07549]
[SRS_Rte_00218]	API for Triggering BSW modules by Triggered Events	[SWS_Rte_07263] [SWS_Rte_07264] [SWS_Rte_07266] [SWS_Rte_07267]
[SRS_Rte_00219]	Support for interlaced execution sequences of Runnable Entities and BSW Schedulable Entities	[SWS_Rte_02697] [SWS_Rte_07517] [SWS_Rte_07518]
[SRS_Rte_00220]	ECU life cycle dependent scheduling	[SWS_Rte_02538] [SWS_Rte_07580]
[SRS_Rte_00221]	Support for "BSW integration" builds	[SWS_Rte_07569] [SWS_Rte_07585]
[SRS_Rte_00222]	Support shared exclusive areas in BSW Service Modules and the corresponding Service Component	[SWS_Rte_07250] [SWS_Rte_07251] [SWS_Rte_07252] [SWS_Rte_07253] [SWS_Rte_07254] [SWS_Rte_07522] [SWS_Rte_07523] [SWS_Rte_07524] [SWS_Rte_07578] [SWS_Rte_07579]
[SRS_Rte_00223]	Callout for partition termination notification	[SWS_Rte_07330] [SWS_Rte_07331] [SWS_Rte_07334] [SWS_Rte_07335] [SWS_Rte_07617] [SWS_Rte_07619] [SWS_Rte_07620] [SWS_Rte_07622]
[SRS_Rte_00224]	Callout for partition restart request	[SWS_Rte_07188] [SWS_Rte_07336] [SWS_Rte_07338] [SWS_Rte_07339] [SWS_Rte_07340] [SWS_Rte_07341] [SWS_Rte_07342] [SWS_Rte_07643] [SWS_Rte_07644] [SWS_Rte_07645]
[SRS_Rte_00228]	Fan-out NvBlock callback function	[SWS_Rte_07623] [SWS_Rte_07624] [SWS_Rte_07625] [SWS_Rte_07626] [SWS_Rte_07627] [SWS_Rte_07628] [SWS_Rte_07629] [SWS_Rte_07630] [SWS_Rte_07631] [SWS_Rte_07671] [SWS_Rte_07672]
[SRS_Rte_00229]	Support for Variant Handling of BSW Modules	[SWS_Rte_06500] [SWS_Rte_06503] [SWS_Rte_06504] [SWS_Rte_06507] [SWS_Rte_06508] [SWS_Rte_06532] [SWS_Rte_06533] [SWS_Rte_06534] [SWS_Rte_06535] [SWS_Rte_06536] [SWS_Rte_06537] [SWS_Rte_06543] [SWS_Rte_06546] [SWS_Rte_06548] [SWS_Rte_08789] [SWS_Rte_08790]
[SRS_Rte_00230]	Triggering of BSW Schedulable Entities by occurrence of Internal Trigger	[SWS_Rte_07229] [SWS_Rte_07551] [SWS_Rte_07552] [SWS_Rte_07553] [SWS_Rte_07554]

[SRS_Rte_00231]	Support native interface between Rte and Com for Strings and uint8 arrays	[SWS_Rte_01377] [SWS_Rte_01378] [SWS_Rte_04583] [SWS_Rte_04584] [SWS_Rte_07408] [SWS_Rte_07817] [SWS_Rte_CONSTR_04584]
[SRS_Rte_00232]	Synchronization of runnable entities	[SWS_Rte_07804] [SWS_Rte_07805] [SWS_Rte_07806] [SWS_Rte_07807]
[SRS_Rte_00233]	Generation of the Basic Software Module Description	[SWS_Rte_05086] [SWS_Rte_05165] [SWS_Rte_05166] [SWS_Rte_05167] [SWS_Rte_05177] [SWS_Rte_05179] [SWS_Rte_05180] [SWS_Rte_05181] [SWS_Rte_05182] [SWS_Rte_05183] [SWS_Rte_05184] [SWS_Rte_05185] [SWS_Rte_05186] [SWS_Rte_05187] [SWS_Rte_05188] [SWS_Rte_05189] [SWS_Rte_05190] [SWS_Rte_05191] [SWS_Rte_05192] [SWS_Rte_06725] [SWS_Rte_07085] [SWS_Rte_08305] [SWS_Rte_08404] [SWS_Rte_82000]
[SRS_Rte_00234]	Support for Record Type sub-setting	[SWS_Rte_07091] [SWS_Rte_07092] [SWS_Rte_07099]
[SRS_Rte_00235]	Support queued triggers	[SWS_Rte_06720] [SWS_Rte_06721] [SWS_Rte_06722] [SWS_Rte_06723] [SWS_Rte_07087] [SWS_Rte_07088] [SWS_Rte_07089] [SWS_Rte_07090]
[SRS_Rte_00236]	Support for ModelInterface Mapping	[SWS_Rte_08511] [SWS_Rte_08512] [SWS_Rte_08513] [SWS_Rte_08514]
[SRS_Rte_00237]	Time recurrent activation of Runnable Entities	[SWS_Rte_04563] [SWS_Rte_04564] [SWS_Rte_04569] [SWS_Rte_04570] [SWS_Rte_04571] [SWS_Rte_06728] [SWS_Rte_06729] [SWS_Rte_06730]
[SRS_Rte_00238]	Allow enabling of RTE-Feature to get the activating Event of Executable Entity	[SWS_Rte_01126] [SWS_Rte_07194] [SWS_Rte_07195] [SWS_Rte_07282] [SWS_Rte_08051] [SWS_Rte_08052] [SWS_Rte_08053] [SWS_Rte_08054] [SWS_Rte_08055] [SWS_Rte_08056] [SWS_Rte_08057] [SWS_Rte_08058] [SWS_Rte_08059] [SWS_Rte_08060] [SWS_Rte_08071]
[SRS_Rte_00239]	Support rule-based initialization of composite DataPrototypes and compound primitive Data Prototypes	[SWS_Rte_06733] [SWS_Rte_06734] [SWS_Rte_06735] [SWS_Rte_06736] [SWS_Rte_06764] [SWS_Rte_06765] [SWS_Rte_08542] [SWS_Rte_08792]
[SRS_Rte_00240]	Support of init runnables for initialization purposes	[SWS_Rte_03630] [SWS_Rte_03631] [SWS_Rte_03632] [SWS_Rte_06748] [SWS_Rte_06749] [SWS_Rte_06750] [SWS_Rte_06751] [SWS_Rte_06752] [SWS_Rte_06753] [SWS_Rte_06754] [SWS_Rte_06755] [SWS_Rte_06756] [SWS_Rte_06757] [SWS_Rte_06758] [SWS_Rte_06759] [SWS_Rte_06760] [SWS_Rte_06761] [SWS_Rte_06762] [SWS_Rte_06767] [SWS_Rte_06768] [SWS_Rte_06769] [SWS_Rte_06770]

[SRS_Rte_00241]	Support for Local or Remote Handling of BSW Service Calls on Partitioned Systems	[SWS_Rte_08765]
[SRS_Rte_00243]	Support for inter-partition communication of BSW modules	[SWS_Rte_08420] [SWS_Rte_08421] [SWS_Rte_08422] [SWS_Rte_08733] [SWS_Rte_08734] [SWS_Rte_08735] [SWS_Rte_08736] [SWS_Rte_08737] [SWS_Rte_08738] [SWS_Rte_08739] [SWS_Rte_08743] [SWS_Rte_08744] [SWS_Rte_08747] [SWS_Rte_08748] [SWS_Rte_08751] [SWS_Rte_08752] [SWS_Rte_08753] [SWS_Rte_08754] [SWS_Rte_08755] [SWS_Rte_08756] [SWS_Rte_08763] [SWS_Rte_08764] [SWS_Rte_08765] [SWS_Rte_08766]
[SRS_Rte_00244]	Support for bypass	[SWS_Rte_06033] [SWS_Rte_06034] [SWS_Rte_06035] [SWS_Rte_06036] [SWS_Rte_06037] [SWS_Rte_06038] [SWS_Rte_06039] [SWS_Rte_06040] [SWS_Rte_06041] [SWS_Rte_06042] [SWS_Rte_06043] [SWS_Rte_06044] [SWS_Rte_06045] [SWS_Rte_06046] [SWS_Rte_06047] [SWS_Rte_06048] [SWS_Rte_06049] [SWS_Rte_06050] [SWS_Rte_06051] [SWS_Rte_06052] [SWS_Rte_06053] [SWS_Rte_06054] [SWS_Rte_06055] [SWS_Rte_06056] [SWS_Rte_06057] [SWS_Rte_06058] [SWS_Rte_06059] [SWS_Rte_06060] [SWS_Rte_06061] [SWS_Rte_06064] [SWS_Rte_06065] [SWS_Rte_06066] [SWS_Rte_06067] [SWS_Rte_06068] [SWS_Rte_06069] [SWS_Rte_06073] [SWS_Rte_06074] [SWS_Rte_06075] [SWS_Rte_06076] [SWS_Rte_06077] [SWS_Rte_06079] [SWS_Rte_06080] [SWS_Rte_06081] [SWS_Rte_06082] [SWS_Rte_06083] [SWS_Rte_06084] [SWS_Rte_06085] [SWS_Rte_06086] [SWS_Rte_06087] [SWS_Rte_06088] [SWS_Rte_06089] [SWS_Rte_06090] [SWS_Rte_06091] [SWS_Rte_06092] [SWS_Rte_06093] [SWS_Rte_06094] [SWS_Rte_06095] [SWS_Rte_06096] [SWS_Rte_06097] [SWS_Rte_06098] [SWS_Rte_06099] [SWS_Rte_06100] [SWS_Rte_06101] [SWS_Rte_06102] [SWS_Rte_06103] [SWS_Rte_06104] [SWS_Rte_06105] [SWS_Rte_06106] [SWS_Rte_06107] [SWS_Rte_06108] [SWS_Rte_06109] [SWS_Rte_06110]

		[SWS_Rte_06111] [SWS_Rte_06112] [SWS_Rte_06113] [SWS_Rte_06114] [SWS_Rte_06115] [SWS_Rte_06120] [SWS_Rte_07833] [SWS_Rte_07834] [SWS_Rte_07835] [SWS_Rte_07836] [SWS_Rte_07837] [SWS_Rte_07838] [SWS_Rte_07839] [SWS_Rte_07840] [SWS_Rte_07841] [SWS_Rte_70094] [SWS_Rte_70095] [SWS_Rte_CONSTR_80011]
[SRS_Rte_00245]	Support of Writing Strategies for NV data	[SWS_Rte_03879] [SWS_Rte_03880] [SWS_Rte_03881] [SWS_Rte_04565] [SWS_Rte_04566] [SWS_Rte_04567] [SWS_Rte_04568] [SWS_Rte_07416] [SWS_Rte_08080] [SWS_Rte_08081] [SWS_Rte_08082] [SWS_Rte_08083] [SWS_Rte_08084] [SWS_Rte_08085] [SWS_Rte_08086] [SWS_Rte_08087] [SWS_Rte_08088] [SWS_Rte_08089] [SWS_Rte_08090] [SWS_Rte_08091] [SWS_Rte_08092] [SWS_Rte_08093] [SWS_Rte_08094] [SWS_Rte_08111]
[SRS_Rte_00246]	Support of Efficient COM for large data	[SWS_Rte_01376] [SWS_Rte_01379] [SWS_Rte_01380] [SWS_Rte_01381] [SWS_Rte_01382] [SWS_Rte_01383] [SWS_Rte_01384] [SWS_Rte_01385] [SWS_Rte_01386] [SWS_Rte_01387] [SWS_Rte_01388] [SWS_Rte_01389] [SWS_Rte_01390] [SWS_Rte_01391] [SWS_Rte_01392] [SWS_Rte_01393] [SWS_Rte_01394] [SWS_Rte_01395] [SWS_Rte_01396] [SWS_Rte_01397] [SWS_Rte_01398] [SWS_Rte_01399] [SWS_Rte_01400] [SWS_Rte_01401] [SWS_Rte_01402] [SWS_Rte_01403] [SWS_Rte_01404] [SWS_Rte_01405] [SWS_Rte_01406] [SWS_Rte_01407] [SWS_Rte_01408] [SWS_Rte_01409] [SWS_Rte_01410] [SWS_Rte_01411] [SWS_Rte_82016]
[SRS_Rte_00247]	The Rte shall execute transformer chains for SWC communication	[SWS_Rte_04540] [SWS_Rte_04541] [SWS_Rte_06023] [SWS_Rte_08110] [SWS_Rte_08515] [SWS_Rte_08516] [SWS_Rte_08517] [SWS_Rte_08518] [SWS_Rte_08519] [SWS_Rte_08520] [SWS_Rte_08521] [SWS_Rte_08522] [SWS_Rte_08523] [SWS_Rte_08524] [SWS_Rte_08525] [SWS_Rte_08526] [SWS_Rte_08527] [SWS_Rte_08528] [SWS_Rte_08529] [SWS_Rte_08530] [SWS_Rte_08538] [SWS_Rte_08570] [SWS_Rte_08571] [SWS_Rte_08587]

		[SWS_Rte_08588] [SWS_Rte_08589] [SWS_Rte_08590] [SWS_Rte_08596] [SWS_Rte_08597] [SWS_Rte_08598] [SWS_Rte_08599] [SWS_Rte_08793] [SWS_Rte_08794] [SWS_Rte_08795] [SWS_Rte_08796] [SWS_Rte_08797] [SWS_Rte_08798] [SWS_Rte_08799]
[SRS_Rte_00248]	The Rte shall provide the buffer for the data transformation	[SWS_Rte_03867] [SWS_Rte_08531] [SWS_Rte_08532] [SWS_Rte_08534] [SWS_Rte_08535] [SWS_Rte_08536] [SWS_Rte_08537] [SWS_Rte_08550]
[SRS_Rte_00249]	The Rte shall provide transformation errors to the SWCs	[SWS_Rte_03608] [SWS_Rte_03887] [SWS_Rte_03888] [SWS_Rte_03889] [SWS_Rte_03890] [SWS_Rte_03891] [SWS_Rte_04572] [SWS_Rte_04573] [SWS_Rte_04574] [SWS_Rte_04575] [SWS_Rte_04576] [SWS_Rte_05300] [SWS_Rte_05301] [SWS_Rte_07417] [SWS_Rte_07418] [SWS_Rte_07419] [SWS_Rte_07420] [SWS_Rte_08424] [SWS_Rte_08539] [SWS_Rte_08540] [SWS_Rte_08541] [SWS_Rte_08558] [SWS_Rte_08559] [SWS_Rte_08562] [SWS_Rte_08563] [SWS_Rte_08564] [SWS_Rte_08565] [SWS_Rte_08566] [SWS_Rte_08567] [SWS_Rte_08568] [SWS_Rte_08569] [SWS_Rte_08574] [SWS_Rte_08582] [SWS_Rte_08584] [SWS_Rte_08585] [SWS_Rte_08791]
[SRS_Rte_00251]	Array based signal group handling with Com	[SWS_Rte_08586]
[SRS_Rte_00252]	Encapsulate a BSW Module local name space	[SWS_Rte_03983] [SWS_Rte_03984] [SWS_Rte_03985] [SWS_Rte_03990] [SWS_Rte_03991] [SWS_Rte_03992] [SWS_Rte_03994] [SWS_Rte_03995] [SWS_Rte_03996] [SWS_Rte_03997] [SWS_Rte_07415]
[SRS_Rte_00253]	The RTE shall execute data transformation for SWC/BSW communication within one ECU	[SWS_Rte_08105] [SWS_Rte_08107] [SWS_Rte_08108] [SWS_Rte_08109]
[SRS_Rte_00261]	The RTE shall support optional struct members.	[SWS_Rte_03611] [SWS_Rte_03612] [SWS_Rte_03613] [SWS_Rte_03614] [SWS_Rte_03615] [SWS_Rte_03616] [SWS_Rte_03617] [SWS_Rte_03618] [SWS_Rte_08911] [SWS_Rte_08912]

[SRS_Rte_00300]	RTE Implementation Plug-Ins for explicit communication	[SWS_Rte_08910] [SWS_Rte_70019] [SWS_Rte_70020] [SWS_Rte_70021] [SWS_Rte_70022] [SWS_Rte_70023] [SWS_Rte_70024] [SWS_Rte_70025] [SWS_Rte_70026] [SWS_Rte_70032] [SWS_Rte_70039] [SWS_Rte_70042] [SWS_Rte_70043] [SWS_Rte_70044] [SWS_Rte_70045] [SWS_Rte_70048] [SWS_Rte_70049] [SWS_Rte_70050] [SWS_Rte_70051] [SWS_Rte_70052] [SWS_Rte_70053] [SWS_Rte_70054] [SWS_Rte_70055] [SWS_Rte_70056] [SWS_Rte_70057] [SWS_Rte_70058] [SWS_Rte_70059] [SWS_Rte_70060] [SWS_Rte_70061] [SWS_Rte_70082] [SWS_Rte_70083] [SWS_Rte_70084] [SWS_Rte_70085] [SWS_Rte_70087] [SWS_Rte_70088] [SWS_Rte_70090] [SWS_Rte_70091] [SWS_Rte_70100] [SWS_Rte_70101] [SWS_Rte_70102] [SWS_Rte_70107] [SWS_Rte_70110] [SWS_Rte_70111] [SWS_Rte_70112] [SWS_Rte_70113] [SWS_Rte_70114] [SWS_Rte_70125] [SWS_Rte_70126] [SWS_Rte_70127] [SWS_Rte_70128] [SWS_Rte_70129] [SWS_Rte_70130] [SWS_Rte_70131] [SWS_Rte_70132] [SWS_Rte_70133] [SWS_Rte_70134] [SWS_Rte_70136] [SWS_Rte_70137] [SWS_Rte_70138] [SWS_Rte_70139] [SWS_Rte_70140] [SWS_Rte_70141] [SWS_Rte_72000] [SWS_Rte_72001] [SWS_Rte_72002] [SWS_Rte_72003] [SWS_Rte_72009] [SWS_Rte_72010] [SWS_Rte_72011] [SWS_Rte_72012] [SWS_Rte_72013] [SWS_Rte_72014] [SWS_Rte_72015] [SWS_Rte_72016] [SWS_Rte_72017] [SWS_Rte_72018] [SWS_Rte_72019] [SWS_Rte_72020] [SWS_Rte_72021] [SWS_Rte_72022] [SWS_Rte_80016] [SWS_Rte_80017] [SWS_Rte_80018] [SWS_Rte_80019] [SWS_Rte_80031] [SWS_Rte_80032] [SWS_Rte_80033] [SWS_Rte_80034] [SWS_Rte_80035] [SWS_Rte_80036] [SWS_Rte_80037] [SWS_Rte_80038] [SWS_Rte_80039] [SWS_Rte_80040] [SWS_Rte_80041] [SWS_Rte_80043]
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		[SWS_Rte_80057] [SWS_Rte_80058] [SWS_Rte_80059] [SWS_Rte_80060] [SWS_Rte_80061] [SWS_Rte_80063] [SWS_Rte_80064] [SWS_Rte_80065] [SWS_Rte_80066] [SWS_Rte_80075] [SWS_Rte_80100] [SWS_Rte_80101] [SWS_Rte_80103] [SWS_Rte_80104] [SWS_Rte_80105] [SWS_Rte_80128] [SWS_Rte_80129] [SWS_Rte_80148] [SWS_Rte_80150] [SWS_Rte_80154] [SWS_Rte_82012] [SWS_Rte_82013] [SWS_Rte_82014] [SWS_Rte_82015] [SWS_Rte_89020] [SWS_Rte_89021] [SWS_Rte_91000] [SWS_Rte_91119] [SWS_Rte_91122] [SWS_Rte_CONSTR_80002] [SWS_Rte_CONSTR_80003] [SWS_Rte_CONSTR_80200] [SWS_Rte_CONSTR_80202]
[SRS_Rte_00301]	RTE Implementation Plug-Ins for implicit communication	[SWS_Rte_70003] [SWS_Rte_70004] [SWS_Rte_70013] [SWS_Rte_70015] [SWS_Rte_70016] [SWS_Rte_70017] [SWS_Rte_70018] [SWS_Rte_70032] [SWS_Rte_70039] [SWS_Rte_70042] [SWS_Rte_70043] [SWS_Rte_70046] [SWS_Rte_70048] [SWS_Rte_70049] [SWS_Rte_70078] [SWS_Rte_70082] [SWS_Rte_70083] [SWS_Rte_70084] [SWS_Rte_70085] [SWS_Rte_70087] [SWS_Rte_70088] [SWS_Rte_70108] [SWS_Rte_80010] [SWS_Rte_80011] [SWS_Rte_80012] [SWS_Rte_80013] [SWS_Rte_80014] [SWS_Rte_80015] [SWS_Rte_80031] [SWS_Rte_80032] [SWS_Rte_80033] [SWS_Rte_80034] [SWS_Rte_80035] [SWS_Rte_80036] [SWS_Rte_80037] [SWS_Rte_80038] [SWS_Rte_80039] [SWS_Rte_80040] [SWS_Rte_80041] [SWS_Rte_80044] [SWS_Rte_80046] [SWS_Rte_80047] [SWS_Rte_80048] [SWS_Rte_80049] [SWS_Rte_80050] [SWS_Rte_80056] [SWS_Rte_80057] [SWS_Rte_80058] [SWS_Rte_80059] [SWS_Rte_80060] [SWS_Rte_80061] [SWS_Rte_80063] [SWS_Rte_80064] [SWS_Rte_80076] [SWS_Rte_80079] [SWS_Rte_80084] [SWS_Rte_80103] [SWS_Rte_80104] [SWS_Rte_80105] [SWS_Rte_80128] [SWS_Rte_80129] [SWS_Rte_80149] [SWS_Rte_80151] [SWS_Rte_80154] [SWS_Rte_82009] [SWS_Rte_82010] [SWS_Rte_82011] [SWS_Rte_82012] [SWS_Rte_82017] [SWS_Rte_82018] [SWS_Rte_89020] [SWS_Rte_89021]

		[SWS_Rte_91000] [SWS_Rte_91119] [SWS_Rte_91122] [SWS_Rte_CONSTR_80002] [SWS_Rte_CONSTR_80003] [SWS_Rte_CONSTR_80200] [SWS_Rte_CONSTR_80202]
[SRS_Rte_00302]	RTE Implementation Plug-Ins for exclusive areas	[SWS_Rte_70007] [SWS_Rte_70027] [SWS_Rte_70028] [SWS_Rte_70032] [SWS_Rte_70039] [SWS_Rte_80020] [SWS_Rte_80021] [SWS_Rte_80022] [SWS_Rte_80023] [SWS_Rte_80024] [SWS_Rte_80079] [SWS_Rte_82011] [SWS_Rte_CONSTR_80000] [SWS_Rte_CONSTR_80001]
[SRS_Rte_00303]	RTE Implementation Plug-Ins for global copy instantiation	[SWS_Rte_08910] [SWS_Rte_70043] [SWS_Rte_70050] [SWS_Rte_70051] [SWS_Rte_70056] [SWS_Rte_70057] [SWS_Rte_70085] [SWS_Rte_70086] [SWS_Rte_70127] [SWS_Rte_70128] [SWS_Rte_70129] [SWS_Rte_70130] [SWS_Rte_70131] [SWS_Rte_70132] [SWS_Rte_70133] [SWS_Rte_70134] [SWS_Rte_70139] [SWS_Rte_70140] [SWS_Rte_72009] [SWS_Rte_72010] [SWS_Rte_72021] [SWS_Rte_72022] [SWS_Rte_80065] [SWS_Rte_80066] [SWS_Rte_80073] [SWS_Rte_82013] [SWS_Rte_82014] [SWS_Rte_82015]
[SRS_Rte_00304]	Multiple RTE Plug-Ins	[SWS_Rte_70027] [SWS_Rte_70028] [SWS_Rte_70047] [SWS_Rte_70062] [SWS_Rte_70063] [SWS_Rte_70070] [SWS_Rte_70071] [SWS_Rte_70077] [SWS_Rte_80020] [SWS_Rte_80021] [SWS_Rte_80051] [SWS_Rte_80052] [SWS_Rte_80053] [SWS_Rte_80054] [SWS_Rte_80055] [SWS_Rte_80071] [SWS_Rte_80072] [SWS_Rte_CONSTR_80019] [SWS_Rte_CONSTR_80030] [SWS_Rte_CONSTR_80201] [SWS_Rte_CONSTR_80203]
[SRS_Rte_00305]	Graduated validation strategy	[SWS_Rte_70040] [SWS_Rte_80029] [SWS_Rte_80030] [SWS_Rte_80152] [SWS_Rte_CONSTR_80013]
[SRS_Rte_00306]	Standardized interfaces for RTE Implementation Plug-Ins	[SWS_Rte_08910] [SWS_Rte_70000] [SWS_Rte_70001] [SWS_Rte_70002] [SWS_Rte_70003] [SWS_Rte_70004] [SWS_Rte_70005] [SWS_Rte_70006] [SWS_Rte_70007] [SWS_Rte_70008] [SWS_Rte_70009] [SWS_Rte_70010] [SWS_Rte_70011] [SWS_Rte_70012] [SWS_Rte_70013] [SWS_Rte_70015] [SWS_Rte_70016] [SWS_Rte_70017] [SWS_Rte_70018] [SWS_Rte_70019] [SWS_Rte_70020] [SWS_Rte_70021] [SWS_Rte_70022] [SWS_Rte_70023]

	[SWS_Rte_70024]	[SWS_Rte_70025]
	[SWS_Rte_70026]	[SWS_Rte_70027]
	[SWS_Rte_70028]	[SWS_Rte_70029]
	[SWS_Rte_70030]	[SWS_Rte_70031]
	[SWS_Rte_70032]	[SWS_Rte_70033]
	[SWS_Rte_70034]	[SWS_Rte_70035]
	[SWS_Rte_70036]	[SWS_Rte_70037]
	[SWS_Rte_70038]	[SWS_Rte_70039]
	[SWS_Rte_70046]	[SWS_Rte_70047]
	[SWS_Rte_70050]	[SWS_Rte_70051]
	[SWS_Rte_70052]	[SWS_Rte_70053]
	[SWS_Rte_70054]	[SWS_Rte_70055]
	[SWS_Rte_70056]	[SWS_Rte_70057]
	[SWS_Rte_70058]	[SWS_Rte_70059]
	[SWS_Rte_70060]	[SWS_Rte_70061]
	[SWS_Rte_70062]	[SWS_Rte_70063]
	[SWS_Rte_70064]	[SWS_Rte_70070]
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	[SWS_Rte_70078]	[SWS_Rte_70087]
	[SWS_Rte_70088]	[SWS_Rte_70090]
	[SWS_Rte_70091]	[SWS_Rte_70098]
	[SWS_Rte_70099]	[SWS_Rte_70100]
	[SWS_Rte_70101]	[SWS_Rte_70102]
	[SWS_Rte_70107]	[SWS_Rte_70108]
	[SWS_Rte_70125]	[SWS_Rte_70126]
	[SWS_Rte_70127]	[SWS_Rte_70128]
	[SWS_Rte_70129]	[SWS_Rte_70130]
	[SWS_Rte_70131]	[SWS_Rte_70132]
	[SWS_Rte_70133]	[SWS_Rte_70134]
	[SWS_Rte_70135]	[SWS_Rte_70136]
	[SWS_Rte_70137]	[SWS_Rte_70138]
	[SWS_Rte_70139]	[SWS_Rte_70140]
	[SWS_Rte_72000]	[SWS_Rte_72001]
	[SWS_Rte_72002]	[SWS_Rte_72003]
	[SWS_Rte_72009]	[SWS_Rte_72010]
	[SWS_Rte_72011]	[SWS_Rte_72012]
	[SWS_Rte_72013]	[SWS_Rte_72014]
	[SWS_Rte_72015]	[SWS_Rte_72016]
	[SWS_Rte_72017]	[SWS_Rte_72018]
	[SWS_Rte_72019]	[SWS_Rte_72020]
	[SWS_Rte_72021]	[SWS_Rte_72022]
	[SWS_Rte_80000]	[SWS_Rte_80001]
	[SWS_Rte_80002]	[SWS_Rte_80003]
	[SWS_Rte_80005]	[SWS_Rte_80006]
	[SWS_Rte_80007]	[SWS_Rte_80008]
	[SWS_Rte_80009]	[SWS_Rte_80010]
	[SWS_Rte_80011]	[SWS_Rte_80012]
	[SWS_Rte_80013]	[SWS_Rte_80014]

		[SWS_Rte_80015] [SWS_Rte_80016] [SWS_Rte_80017] [SWS_Rte_80018] [SWS_Rte_80019] [SWS_Rte_80020] [SWS_Rte_80021] [SWS_Rte_80025] [SWS_Rte_80026] [SWS_Rte_80027] [SWS_Rte_80028] [SWS_Rte_80051] [SWS_Rte_80052] [SWS_Rte_80053] [SWS_Rte_80054] [SWS_Rte_80055] [SWS_Rte_80065] [SWS_Rte_80066] [SWS_Rte_80071] [SWS_Rte_80072] [SWS_Rte_80075] [SWS_Rte_80078] [SWS_Rte_80079] [SWS_Rte_80100] [SWS_Rte_80101] [SWS_Rte_80131] [SWS_Rte_80148] [SWS_Rte_80149] [SWS_Rte_80150] [SWS_Rte_80151] [SWS_Rte_82009] [SWS_Rte_82010] [SWS_Rte_82011] [SWS_Rte_82013] [SWS_Rte_82014] [SWS_Rte_82015] [SWS_Rte_82017] [SWS_Rte_82018] [SWS_Rte_89020] [SWS_Rte_89021] [SWS_Rte_89022] [SWS_Rte_89023] [SWS_Rte_91000] [SWS_Rte_91113] [SWS_Rte_91114] [SWS_Rte_91115] [SWS_Rte_91117] [SWS_Rte_91119] [SWS_Rte_91121] [SWS_Rte_91122]
[SRS_Rte_00307]	RTE Implementation Plug-Ins for cross core communication	[SWS_Rte_70093] [SWS_Rte_80077] [SWS_Rte_CONSTR_80010]
[SRS_Rte_00309]	RTE Implementation Plug-Ins for cross safety partition communication	[SWS_Rte_70093] [SWS_Rte_80077] [SWS_Rte_CONSTR_80010]
[SRS_Rte_00310]	Shared mode queue	[SWS_Rte_06832] [SWS_Rte_06833] [SWS_Rte_06834] [SWS_Rte_06835] [SWS_Rte_06836] [SWS_Rte_06837] [SWS_Rte_06838] [SWS_Rte_06839] [SWS_Rte_06840] [SWS_Rte_70032] [SWS_Rte_70039] [SWS_Rte_70098] [SWS_Rte_80083] [SWS_Rte_CONSTR_80012]
[SRS_Rte_00311]	Core synchronous transitions for mode switches	[SWS_Rte_80111] [SWS_Rte_80112] [SWS_Rte_80113] [SWS_Rte_80114] [SWS_Rte_80115] [SWS_Rte_80116] [SWS_Rte_80117] [SWS_Rte_80118] [SWS_Rte_80119] [SWS_Rte_80120] [SWS_Rte_80121] [SWS_Rte_80122] [SWS_Rte_80123] [SWS_Rte_80124] [SWS_Rte_80125]

[SRS_Rte_00312]	RTE Implementation Plug-Ins for transformers in client server communication	[SWS_Rte_02321] [SWS_Rte_02322] [SWS_Rte_70032] [SWS_Rte_70039] [SWS_Rte_70062] [SWS_Rte_70063] [SWS_Rte_70064] [SWS_Rte_70070] [SWS_Rte_70071] [SWS_Rte_70077] [SWS_Rte_70079] [SWS_Rte_70080] [SWS_Rte_70081] [SWS_Rte_70089] [SWS_Rte_70110] [SWS_Rte_70111] [SWS_Rte_70112] [SWS_Rte_70113] [SWS_Rte_70114] [SWS_Rte_80067] [SWS_Rte_80068] [SWS_Rte_80069] [SWS_Rte_80070] [SWS_Rte_80071] [SWS_Rte_80072] [SWS_Rte_80074] [SWS_Rte_80106] [SWS_Rte_80107] [SWS_Rte_80108] [SWS_Rte_80109] [SWS_Rte_80110] [SWS_Rte_80126] [SWS_Rte_89022] [SWS_Rte_89023] [SWS_Rte_CONSTR_80004] [SWS_Rte_CONSTR_80005] [SWS_Rte_CONSTR_80006] [SWS_Rte_CONSTR_80009] [SWS_Rte_CONSTR_80204] [SWS_Rte_CONSTR_80205]
[SRS_Rte_00313]	Description of RTE Implementation Plug-in properties	[SWS_Rte_70092]
[SRS_Rte_00314]	Avoid nesting of critical sections	[SWS_Rte_80025]
[SRS_Rte_00315]	Protection of mode machine instance access	[SWS_Rte_70032] [SWS_Rte_70039] [SWS_Rte_70096] [SWS_Rte_70097] [SWS_Rte_70098] [SWS_Rte_70103] [SWS_Rte_70104] [SWS_Rte_70105] [SWS_Rte_70106] [SWS_Rte_70109] [SWS_Rte_70115] [SWS_Rte_80080] [SWS_Rte_80081] [SWS_Rte_80082] [SWS_Rte_80085]
[SRS_Rte_00316]	RTE Implementation Plug-Ins for compatibility mode	[SWS_Rte_80044] [SWS_Rte_80045]
[SRS_Rte_00317]	RTE Implementation Plug-Ins for transformers in trigger communication	[SWS_Rte_02321] [SWS_Rte_02322] [SWS_Rte_70079] [SWS_Rte_70080] [SWS_Rte_70081] [SWS_Rte_70110] [SWS_Rte_70111] [SWS_Rte_70112] [SWS_Rte_70113] [SWS_Rte_70114] [SWS_Rte_80068] [SWS_Rte_80069] [SWS_Rte_80070] [SWS_Rte_80102] [SWS_Rte_80145] [SWS_Rte_80146] [SWS_Rte_80147] [SWS_Rte_89022] [SWS_Rte_91117] [SWS_Rte_CONSTR_80009] [SWS_Rte_CONSTR_80014] [SWS_Rte_CONSTR_80015] [SWS_Rte_CONSTR_80016] [SWS_Rte_CONSTR_80017] [SWS_Rte_CONSTR_80029]

[SRS_Rte_00318]	Modular Runtime Environment	[SWS_Rte_CONSTR_80019] [SWS_Rte_CONSTR_80030] [SWS_Rte_CONSTR_80201] [SWS_Rte_CONSTR_80203]
[SRS_Rte_00319]	RTE Implementation Plug-Ins for parameter communication	[SWS_Rte_70120] [SWS_Rte_70121] [SWS_Rte_70141] [SWS_Rte_70142] [SWS_Rte_80127] [SWS_Rte_80130] [SWS_Rte_80131] [SWS_Rte_80153] [SWS_Rte_91121] [SWS_Rte_CONSTR_80020] [SWS_Rte_CONSTR_80021] [SWS_Rte_CONSTR_80022] [SWS_Rte_CONSTR_80023]
[SRS_Rte_00320]	RTE Implementation Plug-Ins for implicit communication II	[SWS_Rte_70136] [SWS_Rte_70137]
[SRS_Rte_00321]	RTE Implementation Plug-Ins for mode communication	[SWS_Rte_70122] [SWS_Rte_70123] [SWS_Rte_80132] [SWS_Rte_80133] [SWS_Rte_80134] [SWS_Rte_80135] [SWS_Rte_80136] [SWS_Rte_80137] [SWS_Rte_80138] [SWS_Rte_80139] [SWS_Rte_80140] [SWS_Rte_80141] [SWS_Rte_91113] [SWS_Rte_91114] [SWS_Rte_91115] [SWS_Rte_CONSTR_80026] [SWS_Rte_CONSTR_80027] [SWS_Rte_CONSTR_80028]
[SRS_Rte_00322]	Support of Metadata	[SWS_Rte_03620] [SWS_Rte_03621] [SWS_Rte_03622] [SWS_Rte_03623] [SWS_Rte_03624] [SWS_Rte_03625] [SWS_Rte_03626] [SWS_Rte_03627] [SWS_Rte_03628] [SWS_Rte_03629]

Table 1.2: Requirements tracing

2 RTE Overview

2.1 The RTE in the Context of AUTOSAR

The Run-Time Environment (RTE) is at the heart of the AUTOSAR ECU architecture. The RTE is the realization (for a particular ECU) of the interfaces of the AUTOSAR Virtual Function Bus (VFB). The RTE provides the infrastructure services that enable communication to occur between AUTOSAR software-components as well as acting as the means by which AUTOSAR software-components access basic software modules including the OS and communication service.

The RTE encompasses both the variable elements of the system infrastructure that arise from the different mappings of components to ECUs as well as standardized RTE services.

In principle the RTE can be logically divided into two sub-parts realizing:

- the communication between software components
- the scheduling of the software components

To fully describe the concept of the RTE, the Basic Software Scheduler has to be considered as well. The Basic Software Scheduler schedules the schedulable entities of the basic software modules. In some documents the schedulable entities are also called main processing functions.

Due to the situation that the same OS Task might be used for the scheduling of software components and basic software modules the scheduling part of the RTE is strongly linked with the Basic Software Scheduler and can not be clearly separated.

The RTE and the Basic Software Scheduler is generated¹ for each ECU to ensure that the RTE and Basic Software Scheduler is optimal for the ECU [[SRS_Rte_00023](#)].

2.2 AUTOSAR Concepts

This section introduces some important AUTOSAR concepts and how they are implemented within the context of the RTE.

2.2.1 AUTOSAR Software-components

In AUTOSAR, “application” software is conceptually located above the AUTOSAR RTE and consists of “AUTOSAR application software-components” that are ECU and loca-

¹An implementation is free to *configure* rather than *generate* the RTE and Basic Software Scheduler. The remainder of this specification refers to generation for reasons of simplicity only and these references should not be interpreted as ruling out either a wholly configured, or partially generated and partially configured, RTE and Basic Software Scheduler implementation.

tion independent and “AUTOSAR sensor-actuator components” that are dependent on ECU hardware and thus not readily relocatable for reasons of performance/efficiency. This means that, subject to constraints imposed by the system designer, an AUTOSAR software-component can be deployed to any available ECU during system configuration. The RTE is then responsible for ensuring that components can communicate and that the system continues to function as expected wherever the components are deployed. Considering sensor/actuator software components, they may only directly address the local ECU abstraction. Therefore, access to remote ECU abstraction shall be done through an intermediate sensor/actuator software component which broadcasts the information on the remote ECU. Hence, moving the sensor/actuator software components on different ECUs, may then imply to also move connected devices (sensor/actuator) to the same ECU (provided that efficient access is needed).

An AUTOSAR software-component is defined by a *type* definition that defines the component’s interfaces. A component type is instantiated when the component is deployed to an ECU. A component type can be instantiated more than once on the same ECU in which case the component type is said to be “multiple instantiated”. The RTE supports per-instance memory sections that enable each component instance to have private states.

The RTE supports both AUTOSAR software-components where the source is available (“source-code software-components”) [SRS_Rte_00024] and AUTOSAR software-components where only the object code (“object-code software components”) is available [SRS_Rte_00140].

Details of AUTOSAR software-components in relation to the RTE are presented in Section 4.1.3.

2.2.2 Basic Software Modules

As well as “AUTOSAR software-components” an AUTOSAR ECU includes basic software modules. Basic software modules can access the ECU abstraction layer as well as other basic software modules directly and are thus neither ECU nor location independent ².

An “AUTOSAR software-component” *cannot* directly access basic software modules – all communication is via AUTOSAR interfaces and therefore under the control of the RTE. The requirement to not have direct access applies to all *Basic Software Modules* including the operating system [SRS_Rte_00020] and the communication service.

²The functionality provided by a basic software module cannot be relocated in another ECU. However, the source of some basic software modules can be reused on other ECUs.

2.2.3 Communication

The communication interface of an AUTOSAR software-component consists of several ports (which are characterized by port-interfaces). An AUTOSAR software-component can communicate through its interfaces with other AUTOSAR software-components (whether that component is located on the same ECU or on a different ECU) or with basic software modules that have ports and runnables (i.e. `ServiceSwComponents`, `EcuAbstractionSwComponents` and `ComplexDeviceDriverSwComponents`) and are located on the same ECU. This communication can *only* occur via the component's ports. A port can be categorized by either a sender-receiver or client-server port-interface. A sender-receiver interface provides a message passing facility whereas a client-server interface provides function invocation.

2.2.3.1 Communication Paradigms

The RTE provides different paradigms for the communication between software-component instances: sender-receiver (signal passing), client-server (function invocation), mode switch, and `NvBlockSwComponentType` interaction.

Each communication paradigm can be applied to intra-partition software-component distribution (which includes both intra-task and inter-task distribution, within the same Partition), inter-Partition software-component distribution, and inter-ECU software-component distribution. Intra-task communication occurs between runnable entities that are mapped to the same OS task whereas inter-task communication occurs between runnable entities mapped to different tasks of the same Partition and can therefore involve a context switch. Inter-Partition communication occurs between runnable entities in components mapped to different partitions of the same ECU and therefore involve a context switch and crossing a protection boundary (memory protection, timing protection, isolation on a core). Inter-ECU communication occurs between runnable entities in components that have been mapped to different ECUs and so is inherently concurrent and involves potentially unreliable communication.

Details of the communication paradigms that are supported by the RTE are contained in Section 4.3.

2.2.3.2 Communication Modes

The RTE supports two modes for sender-receiver communication:

- **Explicit** — A component uses explicit RTE API calls to send and receive data elements [[SRS_Rte_00098](#)].
- **Implicit** — The RTE automatically reads a specified set of data elements before a runnable is invoked and automatically writes (a different) set of data elements after the runnable entity has terminated [[SRS_Rte_00128](#)] [[SRS_Rte_00129](#)].

The term “implicit” is used here since the runnable does not actively initiate the reception or transmission of data.

Implicit and explicit communication is considered in greater detail in Section [4.3.1.5](#).

2.2.3.3 Static Communication

[SWS_Rte_06026] [The RTE shall support static communication only.] ([SRS_Rte_00025](#))

Static communication includes only those communication connections where the source(s) and destination(s) of all communication is known at the point the RTE is generated. [[SRS_Rte_00025](#)]. This includes also connections which are subject to variability because the variant handling concept of AUTOSAR does only support the selection of connectors from a superset of possible connectors to define a particular variant.

Dynamic reconfiguration of communication is not supported due to the run-time and code overhead which would therefore limit the range of devices for which the RTE is suitable.

2.2.3.4 Multiplicity

As well as point to point communication (i.e. “1:1”) the RTE supports communication connections with multiple providers or requires:

- When using sender-receiver communication, the RTE supports both “1:n” (single sender with multiple receivers) [[SRS_Rte_00028](#)] and “n:1” (multiple senders and a single receiver) [[SRS_Rte_00131](#)] communication with the restriction that multiple senders are not allowed for [mode switch notifications](#), see meta-model restrictions [[SWS_Rte_02670](#)].

The execution of the multiple senders or receivers is not coordinated by the RTE. This means that the actions of different software-components are independent – the RTE does not ensure that different senders transmit data simultaneously and does not ensure that all receivers read data or receive events simultaneously.

- When using client-server communication, the RTE supports “n:1” (multiple clients and a single server) [[SRS_Rte_00029](#)] communication. The RTE does *not* support “1:n” (single client with multiple servers) client-server communication.

Irrespective of whether “1:1”, “n:1” or “1:n” communication is used, the RTE is responsible for implementing the communication connections and therefore the AUTOSAR software-component is unaware of the configuration. This permits an AUTOSAR software-component to be redeployed in a different configuration without modification.

2.2.4 Concurrency

AUTOSAR software-components have no direct access to the OS and hence there are no “tasks” in an AUTOSAR application. Instead, concurrent activity within AUTOSAR is based around [RunnableEntity](#)s within components that are invoked by the RTE.

The AUTOSAR VFB specification [1] defines a runnable entity as a “sequence of instructions that can be started by the Run-Time Environment”. A component provides usually one³ or more runnable entities [[SRS_Rte_00031](#)] and each runnable entity has exactly one entry point. An entry point defines the *symbol* within the software-component’s code that provides the implementation of a runnable entity.

The RTE is responsible for invoking runnable entities – AUTOSAR software-components are not able to (dynamically) create private threads of control. Hence, all activity within an AUTOSAR application is initiated by the triggering of runnable entities by the RTE as a result of [RTEEvents](#).

An [RTEEvent](#) encompasses all possible situations that can trigger execution of a runnable entity by the RTE. The different classes of [RTEEvent](#) are defined in Section [5.7.5](#).

The RTE supports runnable entities in any component that has an AUTOSAR interface - this includes AUTOSAR software-components and basic software modules.⁴

Runnable entities are divided into multiple categories with each category supporting different facilities. The categories supported by the RTE are described in Section [4.2.2.3](#).

2.3 The RTE Generator

The RTE generator is one of a set of tools⁵ that create the realization of the AUTOSAR virtual function bus for an ECU based on information in the *ECU Configuration Description*. The RTE Generator is responsible for creating the AUTOSAR software-component API functions that link AUTOSAR software-components to the OS and manage communication between AUTOSAR software-components and between AUTOSAR software-components and basic software modules.

Additionally the RTE Generator creates both the *Basic Software Scheduler* and the *Basic Software Scheduler* API functions for each particular instance of a *Basic Software Module*.

The RTE generation process for SWCs has two main phases:

³There are use cases where a SWC might exist without any [RunnableEntity](#).

⁴The OS and COM are basic software modules but present a *standardized interface* to the RTE and have no AUTOSAR interface. The OS and COM therefore do not have runnable entities.

⁵The RTE generator works in conjunction with other tools, for example, the OS and COM generators, to fully realize the AUTOSAR VFB.

- **RTE Contract phase** – a limited set of information about a component, principally the AUTOSAR interface definitions, is used to create an application header file for a component type. The application header file defines the “contract” between component and RTE.
- **RTE Generation phase** - all relevant information about components, their deployment to ECUs and communication connections is used to generate the RTE and optionally the loc configuration [4]. One RTE is generated for each ECU in the system.

The two-phase development model ensures that the RTE generated application header files are available for use for source-code AUTOSAR software-components as well as object-code AUTOSAR software-components with both types of component having access to all definitions created as part of the RTE generation process.

The RTE generation process, and the necessary inputs in each phase, are considered in more detail in chapter 3.

2.4 Design Decisions

This section details decisions that affect both the general direction that has been taken as well as the actual content of this document.

1. The role of this document is to specify RTE behavior, not RTE implementation. Implementation details should not be considered to be part of the RTE software specification unless they are explicitly marked as RTE requirements.
2. An AUTOSAR system consists of multiple ECUs each of which contains an RTE that may have been generated by different RTE generators. Consequently, the specification of how RTEs from multiple vendors interoperate is considered to be within the scope of this document.
3. The RTE does not have sufficient information to be able to derive a mapping from runnable entity to OS task. The decision was therefore taken to require that the mapping be specified as part of the RTE input.
4. Support for C++ is provided by making the C RTE API available for C++ components rather than specifying a completely separate object-oriented API. This decision was taken for two reasons; firstly the same interface for the C and C++ simplifies the learning curve and secondly a single interface greatly simplifies both the specification and any subsequent implementations.
5. There is no support within the specification for Java.
6. The AUTOSAR meta-model is a highly expressive language for defining systems however for reasons of practicality certain restrictions and constraints have been placed on the use of the meta-model. The restrictions are described in Appendix A.

3 RTE Generation Process

This chapter describes the methodology of the RTE and Basic Software Scheduler generation. For a detailed description of the overall AUTOSAR methodology refer to methodology document [6].

[SWS_Rte_02514] [The RTE generator shall produce the same RTE API, RTE code, SchM API and SchM code when the input information is the same.] ([SRS_Rte_00065](#))

The RTE Generator gets involved in the AUTOSAR Methodology several times in different roles. Technically the RTE Generator can be implemented as one tool which is invoked with options to switch between the different roles. Or the RTE Generator could be a set of separate tools. In the following section the individual applications of the RTE Generator are described based on the roles that are take, not necessarily the actual tools.

The RTE Generator is used in different roles for the following phases:

- RTE Contract Phase
- Basic Software Scheduler Contract Phase
- PreBuild Data Set Contract Phase
- Basic Software Scheduler Generation Phase
- RTE Generation Phase
- PreBuild Data Set Generation Phase
- PostBuild Data Set Generation Phase

RTE Generator for Software-Components

In Figure [3.1](#) the overall AUTOSAR Methodology wrt. Application SW-Components and the RTE Generator.

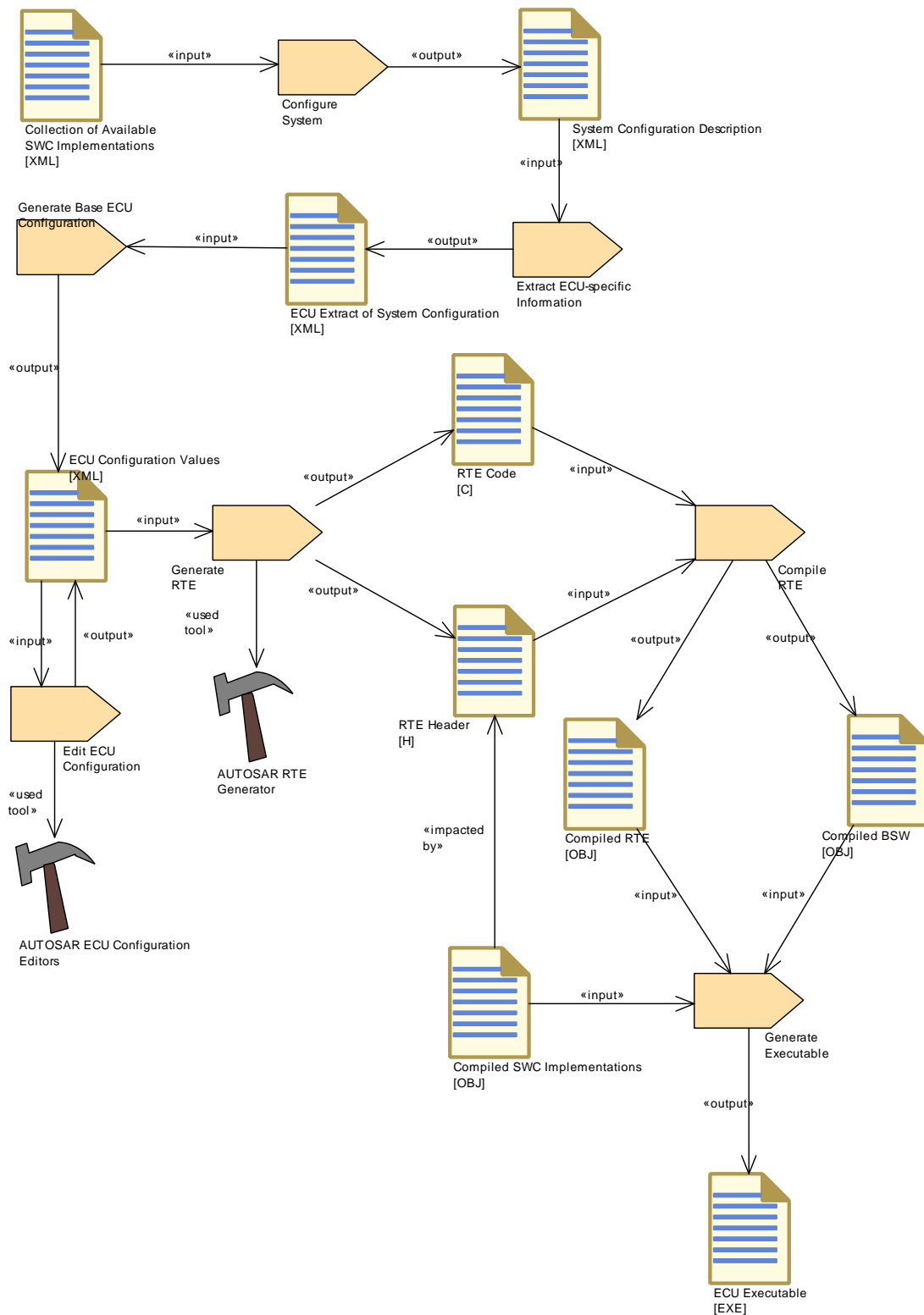


Figure 3.1: System Build Methodology

The whole vehicle functionality is described with means of `CompositionSwComponents`, `SwComponentPrototypes` and `AtomicSwComponents` [2]. In the `CompositionSwComponent` descriptions the connections between the software-

components' ports are also defined. Such a collection of software-components connected to each other, without the mapping on actual ECUs, is called the VFB view.

During the 'Configure System' step the needed software-components, the available ECUs and the System Constraints are resolved into a System Configuration Description. Now the `SwComponentPrototypes` and thus the associated `AtomicSwComponents` are mapped on the available ECUs.

Since in the VFB view the communication relationships between the `AtomicSwComponents` have been described and the mapping of each `SwComponentPrototypes` and `AtomicSwComponents` to a specific ECU has been fixed, the communication matrix can be generated. In the `SwComponentType Description` (using the format of the AUTOSAR Software Component Template [2]) the data that is exchanged through ports is defined in an abstract way. Now the 'System Configuration Generator' needs to define system signals (including the actual signal length and the frames in which they will be transmitted) to be able to transmit the application data over the network. COM signals that correspond to the system signals will be later used by the 'RTE Generator' to actually transmit the application data.

In the next step the 'System Configuration Description' is split into descriptions for each individual ECU. During the generation of the Ecu Extract also the hierarchical structure of the `CompositionSwComponents` of the VFB view is flattened and the `SwComponentPrototypes` of the ECU Extract represent actual instances. The Ecu Extract only contains information necessary to configure one ECU individually and it is fed into the ECU Configuration for each ECU.

[SWS_Rte_05000] [The RTE is configured and generated for each ECU instance individually.] ([SRS_Rte_00021](#))

The 'ECU Configuration Editors' (see also Section 3.3) are working iteratively on the 'ECU Configuration Values' until all configuration issues are resolved. There will be the need for several configuration editors, each specialized on a specific part of ECU Configuration. So one editor might be configuring the COM stack (not the communication matrix but the interaction of the individual modules) while another editor is used to configure the RTE.

Since the configuration of a specific Basic-SW module is not entirely independent from other modules there is the need to apply the editors several times to the 'ECU Configuration Values' to ensure all configuration parameters are consistent.

Only when the configuration issues are resolved the 'RTE Generator' will be used to generate the actual RTE code (see also Section 3.4.2) which will then be compiled and linked together with the other Basic-SW modules and the software-components code.

The 'RTE Generator' needs to cope with many sources of information since the necessary information for the RTE Generator is based on the 'ECU Configuration Values' which might be distributed over several files and itself references to multiple other AUTOSAR descriptions.

[SWS_Rte_08769] [RTE Generator shall support for reading single files and of sets of files that are stored in a file system. The tool shall provide a mechanism to select a specific file and sets of files in the file system.] ([SRS_Rte_00048](#))

An AUTOSAR XML description can be shipped in several files. Some files could contain data types others could contain interfaces, etc.

[SWS_Rte_08770] [An RTE Generator tools SHALL support the merging of AUTOSAR models that have been split up and stored in multiple partial models while reading an set of files. Thereby the to be supported minimum granularity of an AUTOSAR model is defined by `<<atpSplitable>>`. The Merging of a model also includes the resolution of references. The RTE Generator SHALL be able to read the submodels in any order. There is no preference.] ([SRS_Rte_00048](#))

[SWS_Rte_08771] [RTE Generator SHALL support the interpretation and creation of AUTOSAR XML descriptions. These descriptions SHALL be 'well-formed' and 'valid' as defined by the XML recommendation, W3C XML 1.1 Specification, whether used with or without the document's corresponding AUTOSAR XML schema(s). In other words: Even if the tool does not use standard XML mechanisms for validating the XML descriptions it SHALL ensure that the XML descriptions can be successfully validated against the AUTOSAR XML schema.] ([SRS_Rte_00048](#))

[SWS_Rte_08772] [If an RTE Generator wants to validate an AUTOSAR XML description against an AUTOSAR schema, it SHALL provide the necessary schema files in its own resources.

An RTE Generator shall use the SYSTEM-Identifier in the `xsi:schemaLocation` to identify an appropriate schema file.] ([SRS_Rte_00048](#))

[SWS_Rte_08773] [RTE Generator shall provide a serialization for XML.] ([SRS_Rte_00048](#))

[SWS_Rte_08774] [RTE Generator shall not change model content passed to the Generator] ([SRS_Rte_00048](#))

[SWS_Rte_08775] [An RTE Generator MAY support the AUTOSAR extension mechanism `SDGs` if applicable.

If the RTE Generator does not need the additional information for its intended purpose it SHALL ignore the irrelevant extensions `SDGs`.] ([SRS_Rte_00048](#))

[SWS_Rte_08776] [An RTE Generator may use well structured error messages.] ([SRS_Rte_00048](#))

The following list is a collection of proposed information items in particular applicable to log files used for exchanging information about errors.

- **ErrorCode** – A symbolic name for the message text
- **StandardErrorCode** – The reference to the AUTOSAR error code

- **ConstraintCode** – Reference to the semantic constraint mentioned in the AUTOSAR template specification.
- **Signature** – Signature of the message for duplicate checks
- **Timestamp** – A time stamp for the message
- **ShortName** – A unique identification which allows to refer to particular error messages
This can also be used to establish references between error messages, e.g. for screening and also to trace back to root cause
- **Desc** – The human readable message text
- **Component** – Such information item may help the user to locate the problem in the model
- **BaseUrl** – An url for a base directory which can be used as basis for file references in a log file. This is typically the root directory of a project structure.
- **ColumnNumber** – The column of the error position
- **LineNumber** – The line number of the error position
- **LongName** – The title of the error message
- **ObjectCategory** – The category of for example the involved ApplicationPrimitive-DataType (e.g.VALUE)
- **PrimaryErrorReference** – Reference to the root cause if applicable
- **ScopeEntryReference** – Reference to a scoping message if applicable
- **Object** – The shortName based reference to the AUTOSAR element which caused the error
- **ToolName** – The name of the tool which reported the error
- **ToolVersion** – The version of the tools which reported the error
- **IncidentUrl** – The Url which refers to the artifact in which the error occurs
- **Value** – The actual found value which caused the problem

This is just a rough sketch of the main steps necessary to build an ECU with AUTOSAR and how the RTE is involved in this methodology. For a more detailed description of the AUTOSAR Methodology please refer to the methodology document [6]. In the next sections the steps with RTE interaction are explained in more detail.

RTE Generator for Basic Software Scheduler

In Figure 3.2 the overall AUTOSAR Methodology wrt. Basis Software Scheduler and the RTE Generator interaction.

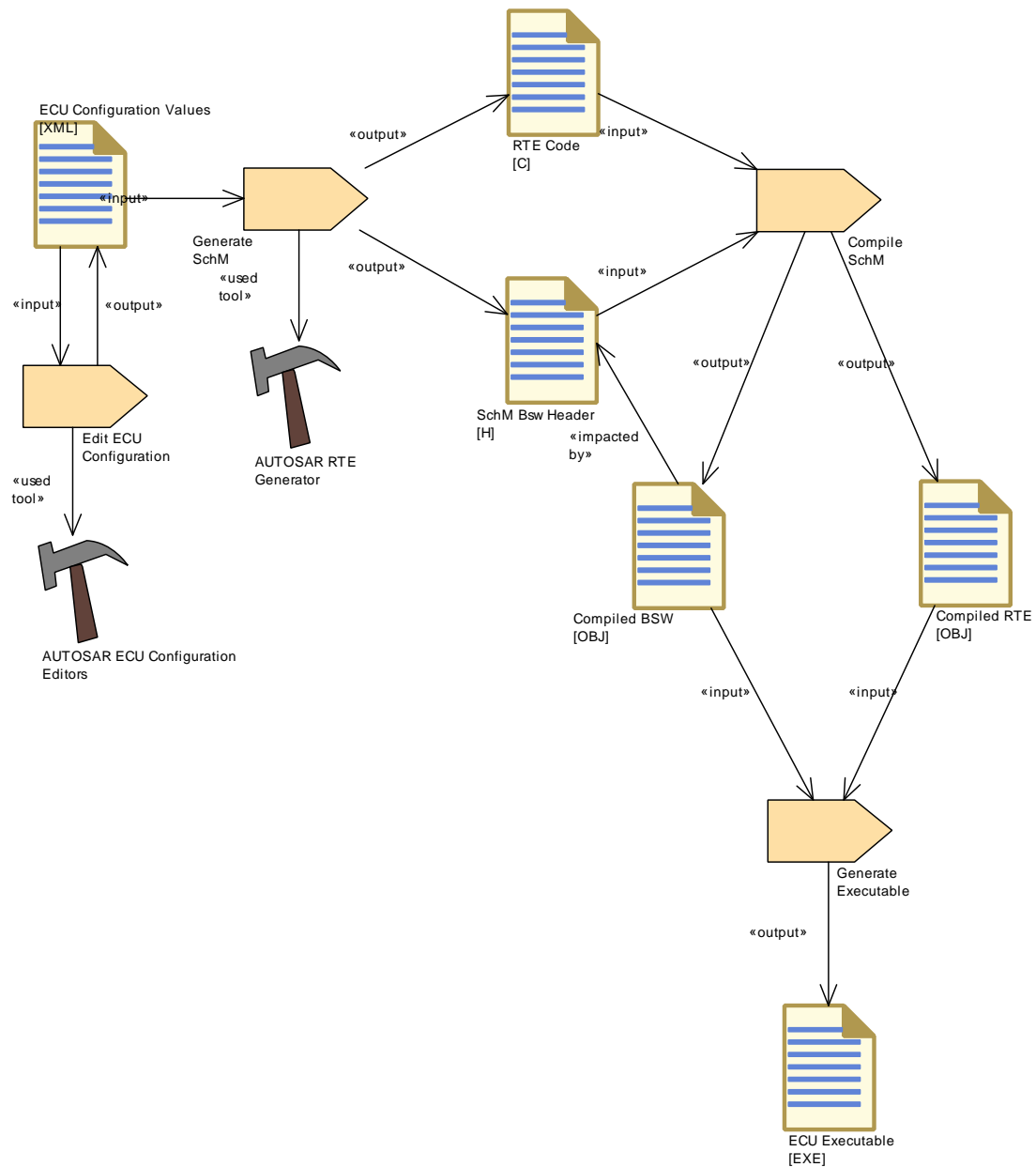


Figure 3.2: Basic Software Scheduler Methodology

The ECU Configuration phase is the start of the Basic Software Scheduler configuration where all the requirements of the different Basic Software Modules are collected. The Input information is provided in the Basic Software Module Descriptions [9] of the individual Basic Software Modules.

The Basic Software Scheduler configuration is then generated into the Basic Software Scheduler code which is compiled and built into the Ecu executable.

3.1 Contract Phase

3.1.1 RTE Contract Phase

To be able to support the AUTOSAR software-component development with RTE-specific APIs the 'Component API' (application header file) is generated from the 'software-component Internal Behavior Description' (see Figure 3.1) by the RTE Generator in the so called 'RTE Contract Phase' (see Figure 3.3).

In the software-component Interface description – which is using the AUTOSAR Software Component Template – at least the AUTOSAR Interfaces of the particular software-component have to be described. This means the software-component Types with Ports and their Interfaces. In the software-component Internal Behavior description additionally the Runnable Entities and the RTE Events are defined. From this information the RTE Generator can generate specific APIs to access the Ports and send and receive data.

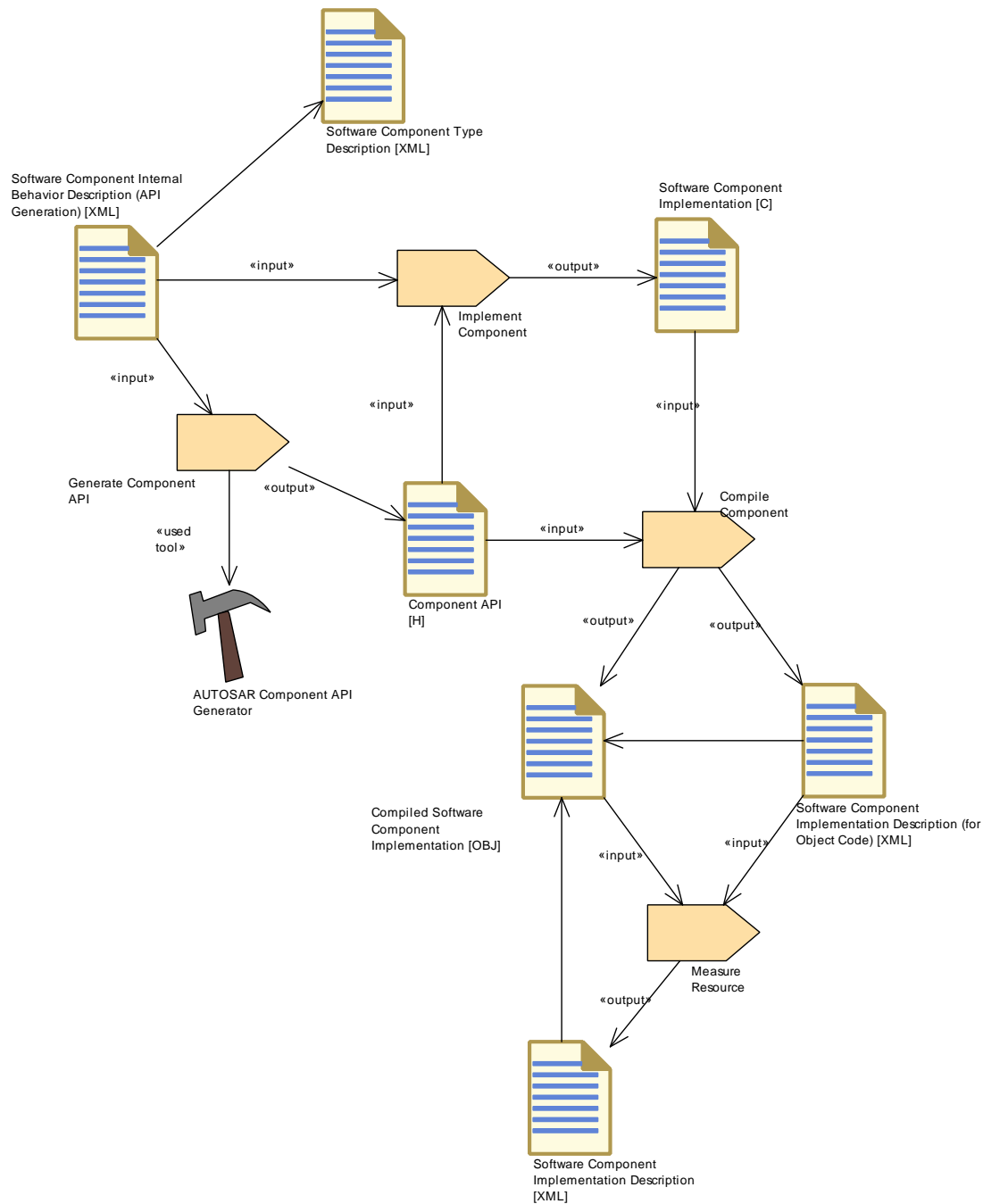


Figure 3.3: RTE Contract Phase

With the generated 'Component API' (application header file) the Software Component developer can provide the Software Component's source code without being concerned as to whether the communication will later be local or using some network(s).

It has to be considered that the AUTOSAR software-component development process is iterative and that the AUTOSAR software-component description might be changed during the development of the AUTOSAR software-component. This requires the application header file to be regenerated to reflect the changes done in the software-component description.

When the software-component has been compiled successfully the 'Component Implementation Description Generation' tool will analyze the resulting object files and enhance the software-component description with the information from the specific implementation. This includes information about the actual memory needs for ROM as well as for RAM and goes into the 'Component Implementation Description' section of the AUTOSAR Software Component Template.

Please note that in case of implemented [PreCompileTime variability](#) additionally the *PreBuild Data Set Contract Phase* is required [3.2](#) to be able to compile the software component.

So when a software-component is delivered it will consist of the following parts:

- SW-Component Type Description
- SW-Component Internal Behavior Description
- The actual SW-Component implementation and/or compiled SW-Component
- SW-Component Implementation Description

The above listed information will be needed to provide enough information for the System Generation steps when the whole system is assembled.

3.1.2 Basic Software Scheduler Contract Phase

To be able to support the *Basic Software Module* development with *Basic Software Scheduler* specific APIs the *Module Interlink Header* ([6.3.2](#)) and *Module Interlink Types Header* ([6.3.1](#)) containing the definitions and declaration for the *Basic Software Scheduler* API related to the single *Basic Software Module* instance is generated by the RTE Generator in the so called '*Basic Software Scheduler Contract Phase*'.

The required input is

- *Basic Software Module Description* and
- *Basic Software Module Internal Behavior* and
- *Basic Software Module Implementation*

Please note that in case of implemented [PreCompileTime variability](#) additionally the *PreBuild Data Set Contract Phase* is required [3.2](#) to be able to compile the *Basic Software Module*.

3.2 PreBuild Data Set Contract Phase

In the *RTE PreBuild Data Set Contract Phase* are the *Condition Value Macros* (see [5.3.8.2.1](#)) generated which are required to resolve the implemented [pre-build variability](#) of a particular software component or *Basic Software Module*.

The particular values are defined via [PredefinedVariants](#). These [PredefinedVariant](#) elements containing definition of [SwSystemconstValues](#) for [SwSystemconsts](#) which shall be applied when resolving the variability during ECU Configuration.

The output of this phase is the *RTE Configuration Header File* [5.3.8](#). This file is required to compile a particular variant of a software component using [PreCompileTime variability](#). The *Condition Value Macros* are used for the implementation of [PreCompileTime variability](#) with preprocessor statements and therefore are needed to run the C preprocessor resolving the implemented variability.

3.3 Edit ECU Configuration of the RTE

During the configuration of an ECU the RTE also needs to be configured. This is divided into several steps which have to be performed iteratively: The configuration of the RTE and the configuration of other modules.

So first the 'RTE Configuration Editor' needs to collect all the information needed to establish an operational RTE. This gathering includes information on the software-component instances and their communication relationships, the Runnable Entities and the involved RTE-Events and so on. The main source for all this information is the 'ECU Configuration Values', which might provide references to further descriptions like the software-component description or the System Configuration description.

An additional input source is the Specification of Timing Extensions [\[14\]](#). This template can be used to specify the execution order of runnable entities (see section 'Execution order constraint'). An 'RTE Configuration Editor' can use the information to create and check the configuration of the Rte Event to Os task mapping (see section [8.5.1](#)).

The usage of 'ECU Configuration Editors' covering different parts of the 'ECU Configuration Values' will – if there are no cyclic dependencies which do not converge – converge to a stable configuration and then the ECU Configuration process is finished. A detailed description of the ECU Configuration can be found in [\[5\]](#). The next phase is the generation of the actual RTE code.

3.4 Generation Phase

After the ECU has been entirely configured the generation of the actual RTE inclusive the *Basic Software Scheduler* part can be performed. Since all the relationships to and from the other Basic-SW modules have been already resolved during the ECU Configuration phase, the generation can be performed in parallel for all modules (see Figure 3.4).

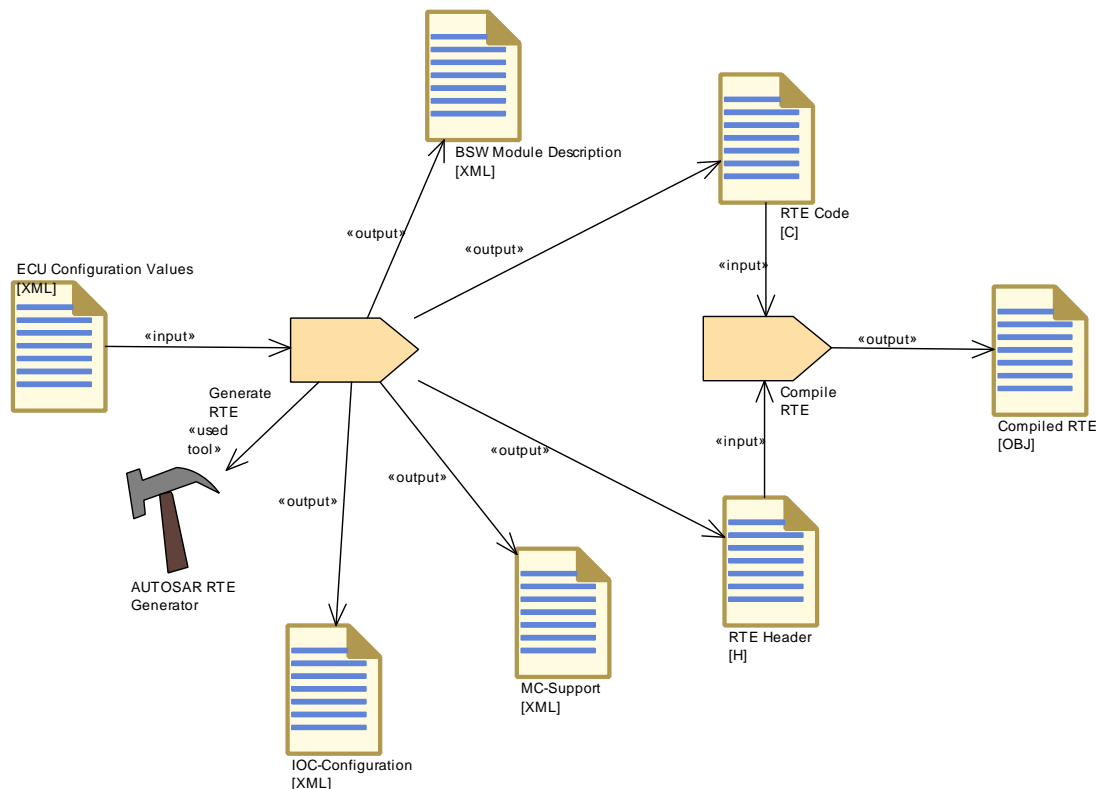


Figure 3.4: RTE Generation Phase

The *Basic Software Scheduler* is a part of the *Rte* and therefore not explicitly shown in figure 3.4.

3.4.1 Basic Software Scheduler Generation Phase

Depending on the complexity of the ECU and the cooperation model of the different software vendors it might be required to integrate the *Basic Software* stand alone without software components.

Therefore the RTE Generator has to support the generation of the *Basic Software Scheduler* without software component related RTE fragments. The *Basic Software Scheduler Generation Phase* is only applicable for software builds which are not containing any kind of software components.

[SWS_Rte_07569] [In the *Basic Software Scheduler Generation Phase* the RTE Generator shall generate the *Basic Software Scheduler* without the RTE functionality.] ([SRS_Rte_00221](#))

In this case the RTE Generator generates the API for *Basic Software Modules* and the *Basic Software Scheduling* code only. When the input contains software component related information this information raises an error.

For instance:

- *Application Header Files* are not generated for the software components contained in the ECU extract.
- Mapped [RTEEvents](#) are not permitted and the runnable calls are not generated into the OS task bodies. Nevertheless all OS task bodies related to the *Basic Software Scheduler* configuration are generated.
- Mode machine instances mapped to the RTE are not supported.

[SWS_Rte_07585] [In the *Basic Software Scheduler Generation Phase* the RTE Generator shall reject input configuration containing software component related information.] ([SRS_Rte_00221](#))

The RTE Generator in the *Basic Software Scheduler Generation Phase* is also responsible to generate additional artifacts which contribute to the further build, deployment and calibration of the ECU's software.

[SWS_Rte_06725] [The RTE Generator in *Basic Software Scheduler Generation Phase* shall provide its *Basic Software Module Description* in order to capture the generated RTE's / Basic Software Scheduler attributes.] ([SRS_Rte_00170](#), [SRS_Rte_00192](#), [SRS_Rte_00233](#))

Details about the Basic Software Module Description generation can be found in section [3.4.4](#).

[SWS_Rte_06726] [The RTE Generator in *Basic Software Scheduler Generation Phase* shall provide an *MC-Support* (Measurement and Calibration) description as part of the *Basic Software Module Description*.] ([SRS_Rte_00153](#), [SRS_Rte_00189](#))

Details about the *MC-Support* can be found in section [4.2.9.4](#).

For software builds which are containing software components the *RTE Generation Phase* [3.4.2](#) is applicable where the *Basic Software Scheduler* part of the RTE is generated as well.

3.4.2 RTE Generation Phase

The actual AUTOSAR software-components and Basic-SW modules code will be linked together with the RTE and *Basic Software Scheduler* code to build the entire ECU software.

Please note that in case of implemented [PreCompileTime variability](#) additionally the *PreBuild Data Set Generation Phase* is required (see section 3.5) to be able to compile the ECU software. Further on in case of implemented [post-build variability](#) *PostBuild Data Set Generation Phase* is required (see section 3.6) to be able to link the full ECU software.

The RTE Generator in the *Generation Phase* is also responsible to generate additional artifacts which contribute to the further build, deployment and calibration of the ECU's software.

[SWS_Rte_05086] [The RTE Generator in Generation Phase shall provide its *Basic Software Module Description* in order to capture the generated RTE's attributes.] ([SRS_Rte_00170](#), [SRS_Rte_00192](#), [SRS_Rte_00233](#))

Details about the Basic Software Module Description generation can be found in section 3.4.4.

[SWS_Rte_05087] [The RTE Generator in Generation Phase shall provide an *MC-Support* (Measurement and Calibration) description as part of the *Basic Software Module Description*.] ([SRS_Rte_00153](#), [SRS_Rte_00189](#))

Details about the *MC-Support* can be found in section 4.2.9.4.

[SWS_Rte_05147] [The RTE Generator in Generation Phase shall provide the configuration for the *loc* module [4] if the *loc* module is used.] ([SRS_Rte_00196](#))

The RTE generates the IOC configurations and uses an implementation specific deterministic generation scheme. This generation scheme can be used by implementations to reuse these IOC configurations (e.g. if the configuration switch `strictConfigurationCheck` is used).

[SWS_Rte_08400] [The RTE Generator in Generation Phase shall generate internal *ImplementationDataTypes* types used for IOC configuration, if the IOC module is used.] ([SRS_Rte_00210](#))

The corresponding C data types will be generated into the *Rte_Type.h*. This *Rte_Type.h* header file will be used by the IOC to get the types for the IOC API.

Changing the RTE generator will require a new IOC configuration generation.

Details about the *loc* module can be found in section 4.3.4.1.

[SWS_Rte_08305] [The RTE Generator in Generation Phase shall ignore XML-Content categorized as ICS.] ([SRS_Rte_00233](#))

[ARPackage](#) with category ICS describes an Implementation Conformance Statement. (See TPS Basic Software Module Description [9] for more details.)

3.4.3 Cluster Generation Phase

The actual AUTOSAR software-components and Basic-SW modules code will be linked together with the RTE and *Basic Software Scheduler* code to build the entire `CpSoftwareCluster`.

Please note that in case of implemented `PreCompileTime variability` additionally the *PreBuild Data Set Generation Phase* is required (see section 3.5) to be able to compile the `CpSoftwareCluster` code. Further on in case of implemented `post-build variability` *PostBuild Data Set Generation Phase* is required (see section 3.6) to be able to link the `CpSoftwareCluster` code.

The RTE Generator in the *Cluster Generation Phase* is also responsible to generate additional artifacts which contribute to the further build, deployment and calibration of the `CpSoftwareCluster`.

[SWS_Rte_82000]{DRAFT} [The RTE Generator in Cluster Generation Phase shall provide its *Basic Software Module Description* in order to capture the generated RTE's attributes.]([SRS_Rte_00170](#), [SRS_Rte_00192](#), [SRS_Rte_00233](#))

Details about the Basic Software Module Description generation can be found in section 3.4.4.

[SWS_Rte_82001]{DRAFT} [The RTE Generator in Cluster Generation Phase shall provide an *MC-Support* (Measurement and Calibration) description as part of the *Basic Software Module Description*.]([SRS_Rte_00153](#), [SRS_Rte_00189](#))

Details about the *MC-Support* can be found in section 4.2.9.4.

[SWS_Rte_82002]{DRAFT} [The RTE Generator in Cluster Generation Phase shall provide the configuration for the `loc` module [4] if the IOC module is used.]([SRS_Rte_00196](#))

The RTE generates the IOC configurations and uses an implementation specific deterministic generation scheme. This generation scheme can be used by implementations to reuse these IOC configurations (e.g. if the configuration switch `strictConfigurationCheck` is used).

[SWS_Rte_82003]{DRAFT} [The RTE Generator in Cluster Generation Phase shall generate internal `ImplementationDataTypes` types used for IOC configuration, if the IOC module is used.]([SRS_Rte_00210](#))

Changing the RTE generator will require a new IOC configuration generation.

Details about the IOC module can be found in section 4.3.4.1.

3.4.4 Basic Software Module Description generation

The Basic Software Module Description [9] generated by the RTE Generator in generation phase describes features of the actual RTE code. The following requirements

specify which elements of the Basic Software Module Description are mandatory to be generated by the RTE Generator.

3.4.4.1 Bsw Module Description

[SWS_Rte_05165] [The RTE Generator in Generation Phase shall provide the `BswModuleDescription` element of the Basic Software Module Description for the generated RTE.] ([SRS_Rte_00233](#))

[SWS_Rte_08404] [The RTE `BswModuleDescription` shall be provided in `ARPackage` `AUTOSAR_Rte` according to AUTOSAR Generic Structure Template [10] (chapter "Identifying M1 elements in packages").] ([SRS_Rte_00233](#))

[SWS_Rte_05177] [The RTE Generator in Generation Phase shall provide the `BswModuleEntry` and a reference to it from the `BswModuleDescription` in the role `implementedEntry` for each *Standardized Interface* provided by the RTE (see Layered Software Architecture [15] page *tz76a* and page *94ju5*). The provided *Standardized Interfaces* are the Rte Lifecycle API and the SchM Lifecycle API.] ([SRS_Rte_00233](#))

[SWS_Rte_05179] [The RTE Generator in Generation Phase shall provide the `BswModuleDependency` in the `BswModuleDescription` with the role `bswModuleDependency` for each callback API provided by the RTE and called by the respective Basic Software Module. The reference from the `BswModuleDependency` to the `BswModuleEntry` shall be in the role `calledEntry`. The calling Basic Software Module is specified in the attribute `targetModuleId` of the `BswModuleDependency`.] ([SRS_Rte_00233](#))

For all the APIs the RTE code is invoking in other Basic Software Modules the dependencies are described via requirement [\[SWS_Rte_05180\]](#).

[SWS_Rte_05180] [The RTE Generator in Generation Phase shall provide the `BswModuleDependency` in the `BswModuleDescription` with the role `bswModuleDependency` for each API called by the RTE in another Basic Software Module. The reference from the `BswModuleDependency` to the `BswModuleEntry` shall be in the role `calledEntry`. The called Basic Software Module is specified in the attribute `targetModuleId` of the `BswModuleDependency`.] ([SRS_Rte_00233](#))

[SWS_Rte_07085] [If the Basic Software Module Description for the generated RTE depends from elements in Basic Software Module Descriptions of other Basic Software Modules the RTE Generator shall use the full qualified path name to this elements according the rules in "Identifying M1 elements in packages" of the document AUTOSAR Generic Structure Template [10].] ([SRS_Rte_00233](#))

For instance the description of the the hook function

```
1 void Rte_Dlt_Task_Activate(TaskType task)
```

for the Dlt needs the [ImplementationDataType](#) "TaskType" from the OS in order to describe the data type of the [SwServiceArg](#) "task" in the description of the related [BswModuleEntry](#).

In this case the full qualified path name to the [ImplementationDataType](#) "TaskType" shall be

```
1 AUTOSAR_OS/ImplementationDataTypes/TaskType
```

The full example about the description is given below:

```
<AR-PACKAGE>
  <SHORT-NAME>AUTOSAR_RTE</SHORT-NAME>
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>BswModuleEntrys</SHORT-NAME>
      <ELEMENTS>
        <BSW-MODULE-ENTRY>
          <SHORT-NAME>Rte_Dlt_Task_Activate</SHORT-NAME>
          <ARGUMENTS>
            <SW-SERVICE-ARG>
              <SHORT-NAME>task</SHORT-NAME>
              <CATEGORY>TYPE_REFERENCE</CATEGORY>
              <SW-DATA-DEF-PROPS>
                <SW-DATA-DEF-PROPS-VARIANTS>
                  <SW-DATA-DEF-PROPS-CONDITIONAL>
                    <IMPLEMENTATION-DATA-TYPE-REF DEST="IMPLEMENTATION-
                      DATA-TYPE">AUTOSAR_OS/ImplementationDataTypes/
                        TaskType</IMPLEMENTATION-DATA-TYPE-REF>
                  </SW-DATA-DEF-PROPS-CONDITIONAL>
                </SW-DATA-DEF-PROPS-VARIANTS>
              </SW-DATA-DEF-PROPS>
            </SW-SERVICE-ARG>
          </ARGUMENTS>
        </BSW-MODULE-ENTRY>
      </ELEMENTS>
    </AR-PACKAGE>
```

3.4.4.2 Bsw Internal Behavior

[SWS_Rte_05166] [The RTE Generator in Generation Phase shall provide the [BswInternalBehavior](#) element in the [BswModuleDescription](#) of the Basic Software Module Description for the generated RTE.] ([SRS_Rte_00233](#))

[SWS_Rte_05181] [The RTE Generator in Generation Phase shall provide the [BswCalledEntity](#) element in the [BswInternalBehavior](#) for each C-function implementing the lifecycle APIs and the SchM Lifecycle API. The [BswCalledEntity](#) shall have a reference to the respective [BswModuleEntry](#) ([\[SWS_Rte_05177\]](#)) in the role `implementedEntry`.] ([SRS_Rte_00233](#))

[SWS_Rte_05182] [The RTE Generator in Generation Phase shall provide the `VariableDataPrototype` element in the `BswInternalBehavior` in the role `staticMemory` for each variable memory object the RTE allocates.] ([SRS_Rte_00233](#))

[SWS_Rte_05183] [The RTE Generator in Generation Phase shall provide the `ParameterDataPrototype` element in the `BswInternalBehavior` in the role `constantMemory` for each constant memory object the RTE allocates.] ([SRS_Rte_00233](#))

3.4.4.3 Bsw Implementation

[SWS_Rte_05167] [The RTE Generator in Generation Phase shall provide the `BswImplementation` element and a reference to the `BswInternalBehavior` of the Basic Software Module Description in the role `behavior`.] ([SRS_Rte_00233](#))

[SWS_Rte_05187] [The RTE Generator in Generation Phase shall provide the `programmingLanguage` element in the `BswImplementation` element according to the actual RTE implementation.] ([SRS_Rte_00233](#))

[SWS_Rte_05186] [The RTE Generator in Generation Phase shall provide the `swVersion` element in the `BswImplementation` element according to the input information from the RTE Ecu configuration ([[SWS_Rte_05184](#)], [[SWS_Rte_05185](#)]).] ([SRS_Rte_00233](#))

[SWS_Rte_05190] [The RTE Generator in Generation Phase shall provide the `arReleaseVersion` element in the `BswImplementation` element according to AUTOSAR release version the RTE Generator is based on.] ([SRS_Rte_00233](#))

[SWS_Rte_05188] [The RTE Generator in Generation Phase shall provide the `usedCodeGenerator` element in the `BswImplementation` element according to the actual RTE implementation.] ([SRS_Rte_00233](#))

[SWS_Rte_05189] [The RTE Generator in Generation Phase shall provide the `vendorId` element in the `BswImplementation` element according to the input information from the RTE Ecu configuration (`RteCodeVendorId`).] ([SRS_Rte_00233](#))

The `RteCodeVendorId` specifies the vendor id of the actual user of the RTE Generator, not the id of the RTE Vendor itself.

[SWS_Rte_05191] [If the generated RTE code is hardware specific (due to vendor specific optimizations of the RTE Generator) then the reference to the applicable `HwElements` from the ECU Resource Description [[16](#)] shall be provided in the `BswImplementation` element with the role `hwElement`.] ([SRS_Rte_00233](#))

[SWS_Rte_05192] [The RTE Generator in Generation Phase shall provide the `DependencyOnArtifact` element in the `BswImplementation` with the role `generatedArtifact` for all c- and header-files which are required to compile the Rte code. This does not include other Basic Software modules or Application Software.] ([SRS_Rte_00233](#))

Note: The use case is the support of the build-environment (automatic or manual).

Attributes shall be used in this context as follow:

- `category` shall be used as defined in Generic Structure Template [10] (e.g. SWSRC, SWOBJ, SWHDR)
- `domain` is optional and can be chosen freely
- `revisionLabel` shall contain the revision label out of RTE Configuration
- `shortLabel` is the name of artifact

Details on the description of `DependencyOnArtifact` can be found in the Generic Structure Template [10].

Additional elements of the *Basic Software Module Description* which shall be exported are specified in later requirements e.g. in section 4.2.9.4.

3.5 PreBuild Data Set Generation Phase

During the *PreBuild Data Set Generation Phase* are the *Condition Value Macros* (see 5.3.8.2.1) generated which are required to resolve the implemented *pre-build variability* of the software components, generated RTE and *Basic Software Scheduler*.

The particular values are defined via the `EcucVariationResolver` configuration selecting `PredefinedVariants`. These `PredefinedVariant` elements containing definition of `SwSystemconstValues` for `SwSystemconsts` which shall be applied when resolving the variability during ECU Configuration.

The values of the *Condition Value Macros* are the results of evaluated `ConditionByFormulas` of the related `VariationPoints`. These `ConditionByFormulas` referencing `SwSystemconsts` in the formula expressions. It is supported that the assigned `SwSystemconstValue` might contain again a formula expressions referencing `SwSystemconsts`. Therefore the input might be a tree of formula expressions and `SwSystemconstValues` but the leaf `SwSystemconstValues` are required to be values which are not dependent from other `SwSystemconsts` to ensure that the evaluation of the tree results in a unique number.

[SWS_Rte_06610] [The RTE generator shall validate the resolved pre-build variants and check the integrity with regards to the meta model. Any meta model violation shall result in the rejection of the input configuration.] (*SRS_Rte_00018*)

The output of this phase is the *RTE Configuration Header File* 5.3.8. This file is required to compile a particular variant of ECU software including software component code and RTE code using *PreCompileTime variability*. The *Condition Value Macros* are used for the implementation of *PreCompileTime variability* with preprocessor statements and therefore are needed to run the C preprocessor resolving the implemented variability.

3.6 PostBuild Data Set Generation Phase

In the optional *PostBuild Data Set Generation Phase* the `PredefinedVariant` values are generated which are required to resolve the implemented `post-build variability` of the software components and generated RTE.

The output of this phase are the *RTE Post Build Variant Sets* 5.3.10. This file is required to link the ECU software and to select a particular PostBuild variant in the generated RTE code during start up when the *Basic Software Scheduler* is initialized.

[SWS_Rte_06611] [If the DET is enabled then the RTE shall generate validation code which at runtime (i.e. during initialization) validates the resolved post-build variants and check the integrity with regards to the active variants. If a violation is detected the RTE shall report a development error to the DET. To execute this validation RTE initialization will get a pointer to the `RtePostBuildVariantConfiguration` instance to allow it to validate the selected variant.](*SRS_Rte_00191*)

[SWS_Rte_06612] [The RTE generator shall create an RTE Post Build Data Set configuration (i.e. `Rte_PBcfg.c`) representing the collection of `PredefinedVariant` definitions (typically for each subsystem and/or system configuration) providing and defining the post build variants of the RTE.](*SRS_Rte_00191*)

Note that the `Rte_PBcfg.h` is generated during the Rte Generation phase. An `Rte_PBcfg.c` may also have to be generated at that time to reserve memory (with default values).

Additional details about these configuration files are described in section 5.3.10.

An RTE variant can consist of a collection of `PredefinedVariants`. Each `PredefinedVariant` contains a collection of `PostBuildVariantCriterionValues` which assigns a value to a specific `PostBuildVariantCriterion` which in turn is used to resolve the variability at runtime by evaluating a `PostBuildVariantCondition`. Different `PredefinedVariants` could assign different values to the same `PostBuildVariantCriterion` and as such create conflicts for a specific `PostBuildVariantCriterionValueSet`. It is allowed to have different assignments if these assignment assign the same value.

[SWS_Rte_06613] [The RTE Generator shall reject configurations where different `PredefinedVariants` assign different values to the same `PostBuildVariantCriterion` for the same `RtePostBuildVariantConfiguration`.](*SRS_Rte_00018*, *SRS_Rte_00191*)

[SWS_Rte_06814] [The RTE Generator shall reject configurations where multiple post build variant instances of `ParameterDataPrototypes` are used but where not exactly one instance in one `RtePostBuildVariantConfiguration` is selected.](*SRS_Rte_00018*, *SRS_Rte_00191*)

Further information can be found in section 4.2.9.3.7.

3.7 RTE Configuration interaction with other BSW Modules

The generated RTE interacts heavily with other AUTOSAR Basic Software Modules like Com and Os. The configuration values for the different BSW Modules are stored in individual structures of ECU Configuration it is however essential that the common used values are synchronized between the different BSW Module's configurations. AUTOSAR does not provide a standardized way how the individual configurations can be synchronized, it is assumed that during the generation of the BSW Modules the input information provided to the individual BSW Module is in sync with the input information provided to other (dependent) BSW Modules.

The AUTOSAR BSW Module code-generation methodology is heavily relying on the logical distinction between Configuration editors and configuration generators. These tools do not necessarily have to be implemented as two separate tools, it just shall be possible to distinguish the different roles the tools take during a certain step in the methodology.

For the RTE it is assumed that tool support for the resolution of interactions between the Rte and other BSW Modules is needed to allow an efficient configuration of the Rte. It is however not specified how and in which tools this support shall be implemented.

The RTE Generator in Generation Phase needs information about other BSW Module's configurations based on the configuration input of the Rte itself (there are references in the configuration of the Rte which point to configuration values of other BSW Modules). If during RTE Generation Phase the provided input information is inconsistent wrt. the Rte input the Rte Generator will have to consider the input as invalid configuration.

[SWS_Rte_05149] [The RTE Generator in Generation Phase shall consider errors in the Rte configuration input information as invalid configuration.] ([SRS_Rte_00018](#))

Due to implementation freedom of the RTE Generator it is possible to correct / update provided input configurations of other BSW Modules based on the RTE configuration requirements. But to allow a stable build process it is also possible to disallow such an update behavior.

[SWS_Rte_05150] [If the external configuration switch `strictConfigurationCheck` is set to `true` the Rte Generator shall not create or modify any configuration input.] ([SRS_Rte_00065](#))

If the external configuration switch `strictConfigurationCheck` (see [\[SWS_Rte_05148\]](#)) is set to `false` the Rte Generator may update the input configuration information of the Rte and other BSW Modules.

Example: If the Rte configuration is referencing an `OsTask` which is not configured in the provided Os configuration, the RTE Generator would behave like:

- In case [\[SWS_Rte_05150\]](#) applies: Only show an error message.
- Otherwise: Possible behavior: Show a warning message and modify the Os configuration to contain the `OsTask` which is referred to by the Rte configuration (Of course the Os configuration of this new `OsTask` needs to be refined afterwards).

4 RTE Functional Specification

4.1 Architectural concepts

4.1.1 Scope

In this section the concept of an AUTOSAR software-component and its usage within the RTE is introduced.

The AUTOSAR Software Component Template [2] defines the kinds of software-components within the AUTOSAR context. These are shown in Figure 4.1. The abstract `SwComponentType` can not be instantiated, so there can only be either a `CompositionSwComponentType`, a `ParameterSwComponentType`, or a specialized class `ApplicationSwComponentType`, `ServiceProxySwComponentType`, `SensorActuatorSwComponentType`, `NvBlockSwComponentType`, `ServiceSwComponentType`, `ComplexDeviceDriverSwComponentType`, or `EcuAbstractionSwComponentType` of the abstract class `AtomicSwComponentType`.

In the following document the term `AtomicSwComponentType` is used as collective term for all the mentioned non-abstract derived meta-classes.

The `SwComponentType` is defining the type of an AUTOSAR software-component which is independent of any usage and can be potentially re-used several times in different scenarios. In a composition the types are occurring in specific roles which are called `SwComponentPrototypes`. The prototype is the utilization of a type within a certain scenario. In AUTOSAR any `SwComponentType` can be used as a type for a prototype.

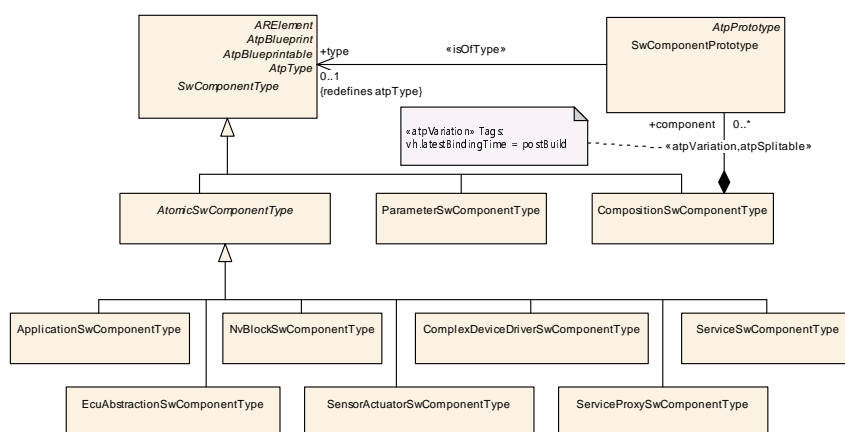


Figure 4.1: AUTOSAR software-component classification

The AUTOSAR software-components shown in Figure 4.1 are located above and below the RTE in the architectural Figure 4.2.

Below the RTE there are also software entities that have an AUTOSAR Interface. These are the AUTOSAR services, the ECU Abstraction and the Complex Device Drivers. For these software not only the AUTOSAR Interface will be described but

also information about their internal structure will be available in the Basic Software Module Description.

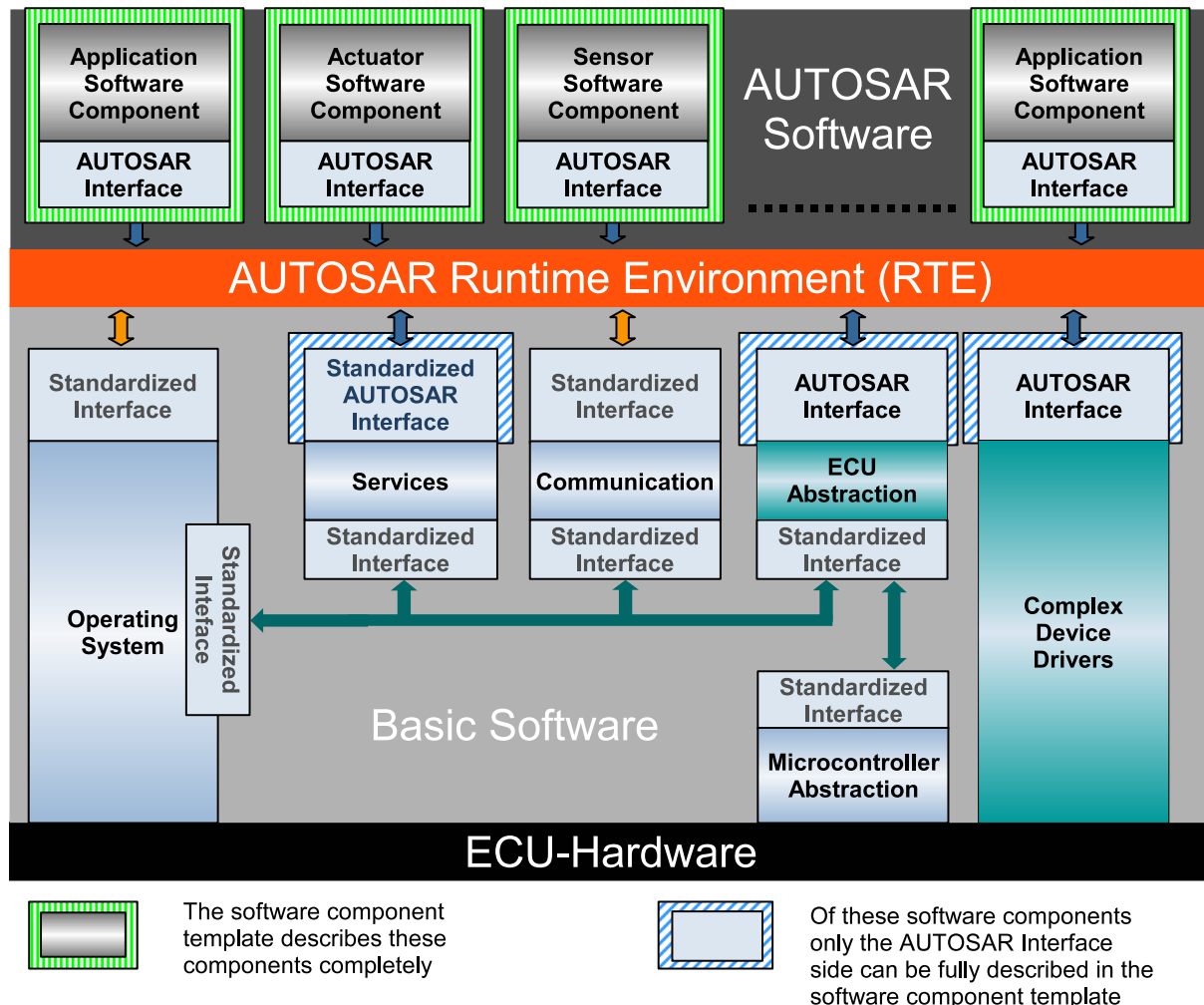


Figure 4.2: AUTOSAR ECU architecture diagram

In the next sections the different AUTOSAR software-components kinds will be described in detail with respect to their influence on the RTE.

4.1.2 RTE and Data Types

The AUTOSAR Meta Model defines [ApplicationDataTypes](#) and [ImplementationDataTypes](#). A [AutosarDataPrototype](#) can be typed by an [ApplicationDataType](#) or an [ImplementationDataType](#). But the RTE Generator only implements [ImplementationDataTypes](#) as C data types and uses these C data types to type the RTE API which is related to [DataPrototypes](#). Therefore it is required in the input configuration that every [ApplicationDataType](#) used for the typing of a [DataPrototype](#) which is relevant for RTE generation is mapped to an [ImplementationDataType](#) with a [DataTypeMap](#). Which [DataTypeMap](#) is applicable for an

particular software component respectively `Basic Software Module` is defined by the `DataTypeMappingSets` referenced by the `InternalBehavior`.

[SWS_Rte_07028] [The RTE Generator shall reject input configurations containing a `AutosarDataPrototype` which influences the generated RTE and which is typed by an `ApplicationDataType` not mapped to an `ImplementationDataType`.] (*SRS_Rte_00018*)

Nevertheless a subset of the attributes given by the `ApplicationDataTypes` are relevant for the RTE generator for instance

- to create the `McSupportData` (see section 4.2.9.4) information
- to calculate the conversion formula in case of *Data Conversion* (see section 4.3.5 and 4.3.7)
- to calculate numerical representation of values required for the RTE code but defined in the physical representation (e.g. `initialValues` and `invalidValues`).

[SWS_Rte_01374] [When a value is required for the RTE code and is provided as an `ApplicationValueSpecification`, if there is an applicable `ConstantSpecificationMapping` then the RTE Generator shall use the `ValueSpecification` referenced by its `implConstant` as the definitive numerical representation of the value regardless of any `compuMethod`.] (*SRS_Rte_00180*, *SRS_Rte_00182*)

[SWS_Rte_07038] [When a value is required for the RTE code and is provided as an `ApplicationValueSpecification`, if there is no applicable `ConstantSpecificationMapping` then the RTE Generator shall calculate the numerical representation according to the conversion defined by an `compuMethod`. This shall be supported for categories `VALUE`, `VAL_BLK`, `STRUCTURE`, `ARRAY`, and `BOOLEAN`. In case of category `VAL_BLK`, `STRUCTURE` and `ARRAY`, this applies only for the primitive leaf elements. If there is no `CompuMethod` provided the conversion is treated like an `CompuMethod` of category `IDENTICAL`.] (*SRS_Rte_00180*, *SRS_Rte_00182*)

In **[SWS_Rte_01374]** and **[SWS_Rte_07038]**, an "applicable `ConstantSpecificationMapping`" is one that is aggregated by the relevant `SwComponentType` and which references the `ApplicationValueSpecification` in its `applConstant`.

4.1.3 RTE and AUTOSAR Software-Components

The description of an AUTOSAR software-component is divided into the sections

- hierarchical structure
- ports and interfaces
- internal behavior
- implementation

which will be addressed separately in the following sections.

[SWS_Rte_07196] [The RTE Generator shall respect the precedence of data properties defined via `SwDataDefProps` as defined in the *Software Component Template* [2].]()

Requirement **[SWS_Rte_07196]** means that:

1. `SwDataDefProps` defined on `ApplicationDataType` which may be overwritten by
2. `SwDataDefProps` defined on `ImplementationDataType` which may be overwritten by
3. `SwDataDefProps` defined on `AutosarDataPrototype` which may be overwritten by
4. `SwDataDefProps` defined on `InstantiationDataDefProps` which may be overwritten by
5. `SwDataDefProps` defined on `AccessPoint` respectively `Argument` which may be overwritten by
6. `SwDataDefProps` defined on `FlatInstanceDescriptor` which may be overwritten by
7. `SwDataDefProps` defined on `McDataInstance`

The `SwDataDefProps` defined on `McDataInstance` are not relevant for the RTE generation but rather the documentation of the generated RTE.

Especially the attributes `swAddrMethod`, `swCalibrationAccess`, `swImplPolicy` and `dataConstr` do have an impact on the generated RTE. In the following document only the attribute names are mentioned with the semantic that this refers to the most significant one.

4.1.3.1 Hierarchical Structure of Software-Components

In AUTOSAR the structure of an E/E-system is described using the AUTOSAR Software Component Template and especially the mechanism of compositions. Such a Top Level Composition assembles subsystems and connects their ports.

Of course such a composition utilizes a lot of hierarchical levels where compositions instantiate other composition types and so on. But at some low hierarchical level each composition only consists of `AtomicSwComponentType` instances. And those instances of `AtomicSwComponentTypes` are what the RTE is going to be working with.

4.1.3.2 Ports, Interfaces and Connections

Each AUTOSAR software-component (`SwComponentType`) can have ports (`PortPrototype`). An AUTOSAR software-component has provide ports (`PPortPrototype`) and/or has require ports (`RPortPrototype`) to communicate with other AUTOSAR software-components. The `requiredInterface` or `providedInterface` (`PortInterface`) determines if the port is a sender/receiver or a client/server port. The attribute `isService` is used with AUTOSAR Services (see section 4.1.5).

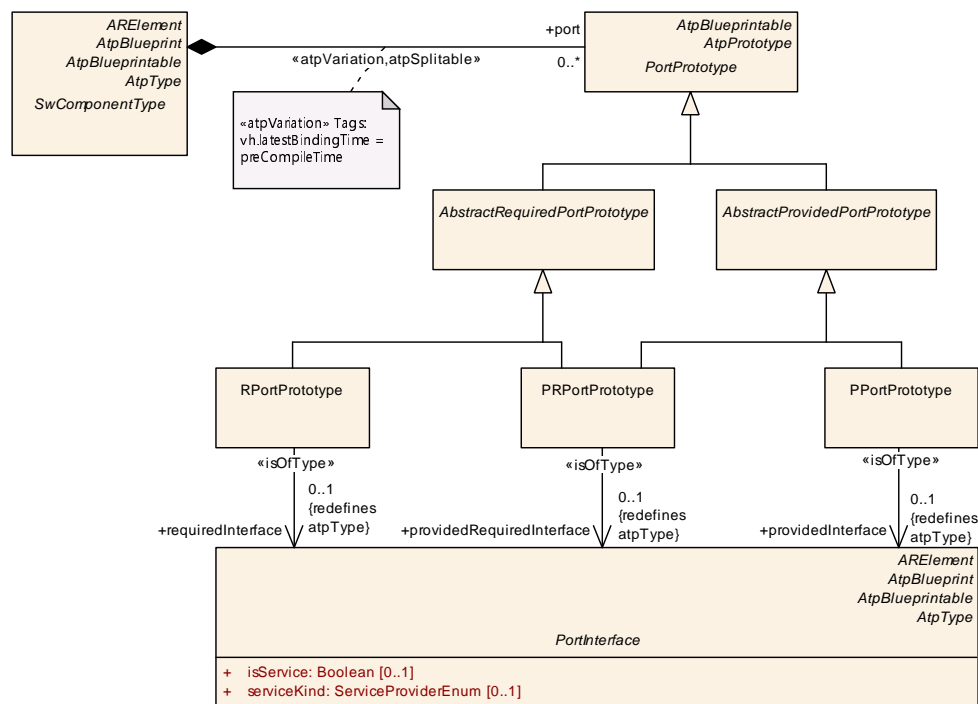


Figure 4.3: Software-Components and Ports

When compositions are built of instances the ports can be connected either within the composition or made accessible to the outside of the composition. For the connections inside a composition the `AssemblySwConnector` is used, while the `DelegationSwConnector` is used to connect ports from the inside of a composition to the outside. Ports not connected will be handled according to the requirement [SRS_Rte_00139].

The next step is to map the SW-C instances on ECUs and to establish the communication relationships. From this step the actual communication is derived, so it is now fixed if a connection between two instance's ports is going to be over a communication bus or locally within one ECU.

[SWS_Rte_02200] [The RTE shall implement the communication paths specified by the ECU Configuration description.] ([SRS_Rte_00027](#))

[SWS_Rte_02201] [The RTE shall implement the semantic of the communication attributes given by the AUTOSAR software-component description. The semantic of the given communication mechanism shall not change regardless of whether the communication partner is located on the same partition, on another partition of the same ECU

or on a remote ECU, or whether the communication is done by the RTE itself or by the RTE calling COM or IOC.]([SRS_Rte_00027](#))

E.g., according to [[SWS_Rte_02200](#)] and [[SWS_Rte_02201](#)] the RTE is not permitted to change the semantic of an asynchronous client to synchronous because both client and server are mapped to the very same ECU.

4.1.3.3 Internal Behavior

Only for [AtomicSwComponentTypes](#) the internal structure is exposed in the [SwcInternalBehavior](#) description. Here the definition of the [RunnableEntity](#)s and used [RTEEvents](#) is done (see Figure 4.4).

The AUTOSAR MetaModel enforces that there is at most one [SwcInternalBehavior](#) per [AtomicSwComponentType](#)

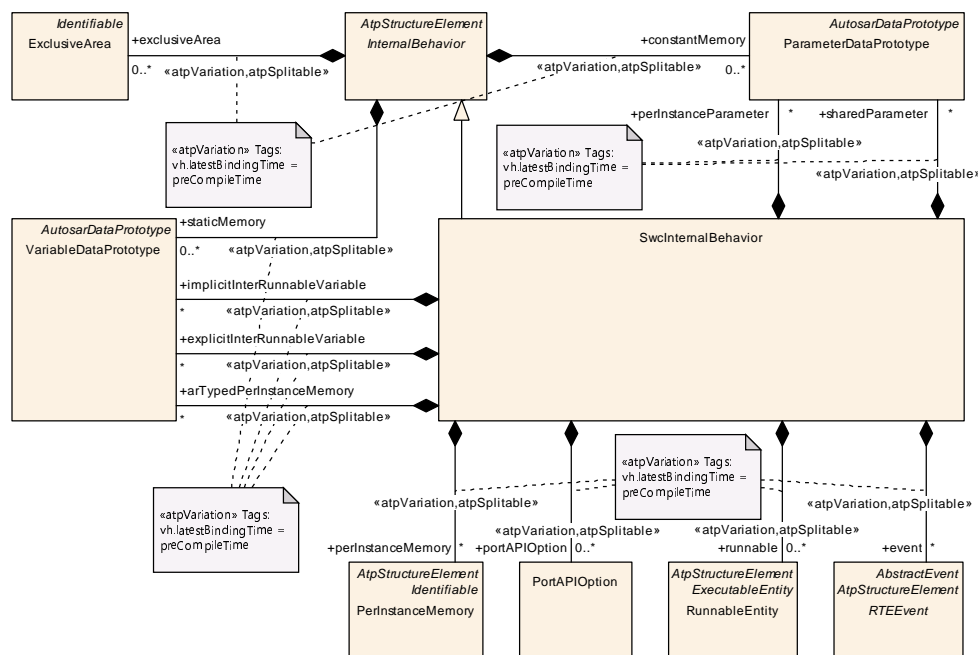


Figure 4.4: Software-component internal behavior

[RunnableEntity](#)s (also abbreviated simply as Runnable) are the smallest code fragments that are provided by AUTOSAR software-components and those basic software modules that implement *AUTOSAR Interfaces*. They are represented by the meta-class [RunnableEntity](#), see Figure 4.5.

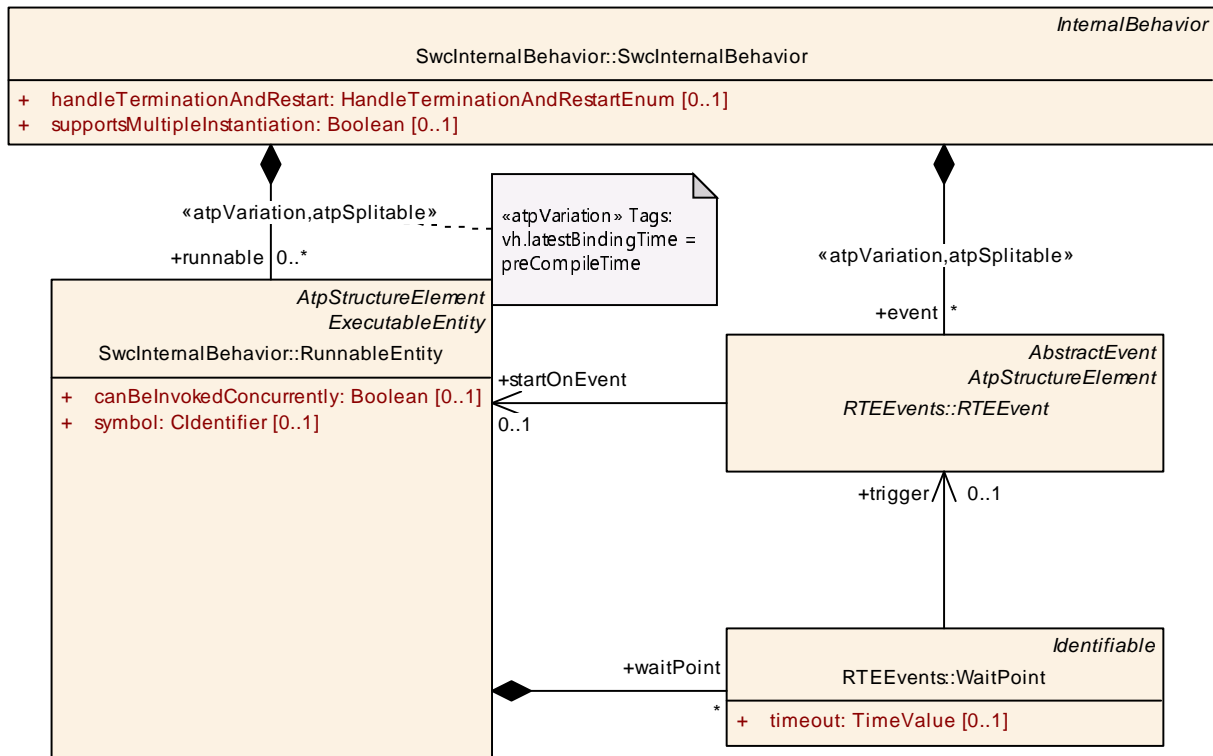


Figure 4.5: Software-component runnable entity, wait points and RTE Events

In general, software components are composed of multiple **RunnableEntities** in order to accomplish servers, receivers, feedback, etc.

[SWS_Rte_02202] [The RTE shall support multiple **RunnableEntities** in AUTOSAR software-components.] ([SRS_Rte_00031](#))

RunnableEntities are executed in the context of an OS task/ISR2, their execution is triggered by **RTEEvents**. Section 4.2.2.3 gives a more detailed description of the concept of **RunnableEntities**, Section 4.2.2.6 discusses the problem of mapping **RunnableEntities** to OS tasks. **RTEEvents** and the activation of **RunnableEntities** by **RTEEvents** is treated in Section 4.2.2.4.

[SWS_Rte_02203] [The RTE shall trigger the execution of **RunnableEntities** in accordance with the connected **RTEEvent**.] ([SRS_Rte_00072](#))

[SWS_Rte_02204] [The RTE Generator shall reject configurations where an **RTE-Event** instance which can start a **RunnableEntity** is not mapped to an **Os-Task**/ISR2 nor is qualified for a direct or trusted function call.] ([SRS_Rte_00049](#), [SRS_Rte_00018](#))

[SWS_Rte_07347] [The RTE Generator shall reject configurations where **RunnableEntities** of a SW-C are mapped to tasks or ISR2s of partitions on different cores.] ([SRS_Rte_00036](#), [SRS_Rte_00018](#))

[SWS_Rte_02207] [The RTE shall respect the configured execution order of **RunnableEntities** within one OS task/ISR2.] ([SRS_Rte_00070](#))

[SWS_Rte_08768] [The RTE generator shall reject configuration where the scope of a `VariableAccess` is violated by the system and/or ECU configuration.] (*SRS_Rte_00018*)

[SWS_Rte_CONSTR_09081] **Mapping to partition vs the value of `VariableAccess.scope`** [For every connection between `SwComponentPrototypes` mapped to different partitions the value of `VariableAccess.scope` shall not be set to `VariableAccessScopeEnum.communicationIntraPartition`.] ()

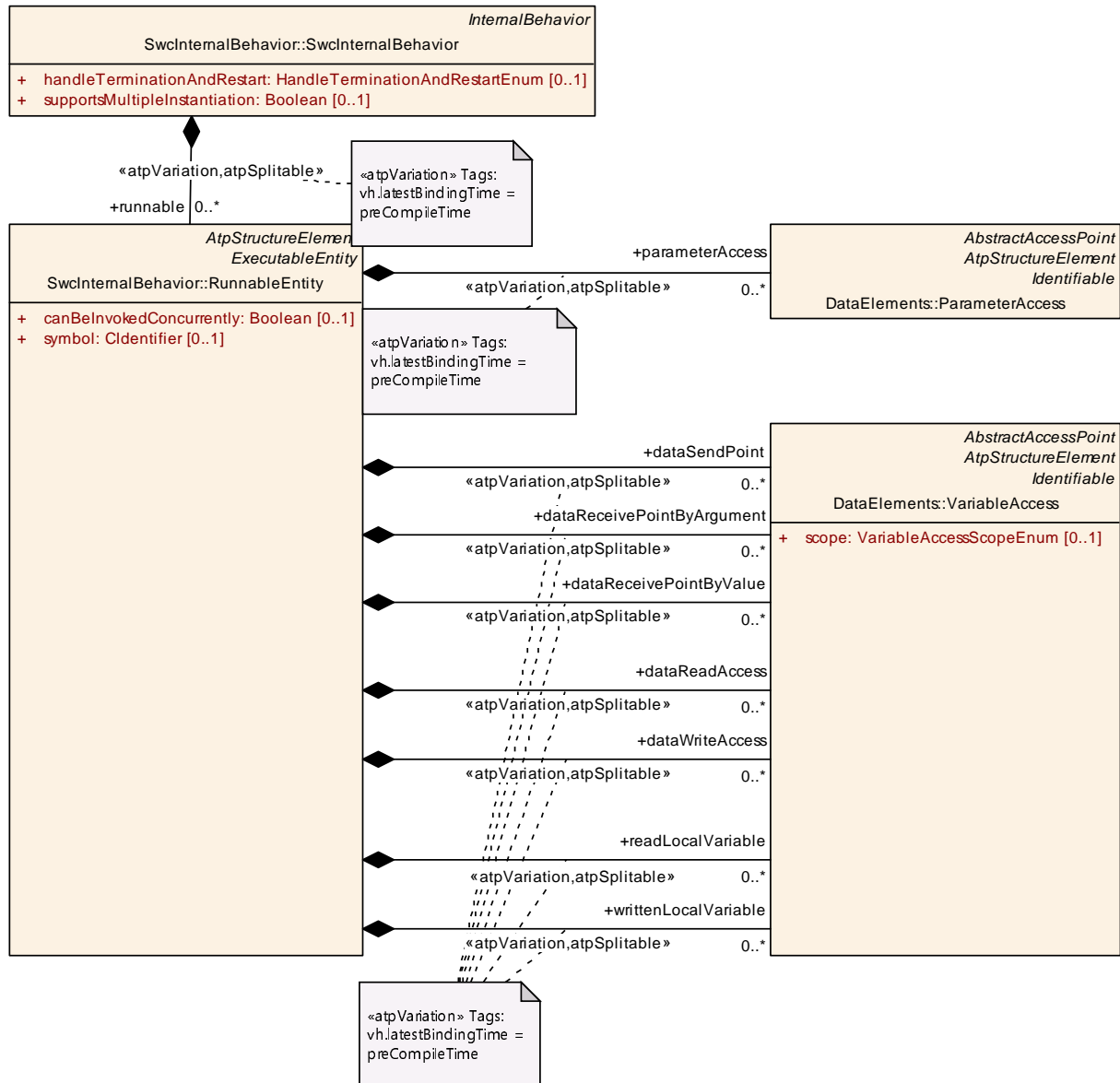


Figure 4.6: Software-component runnable entity and data accesses

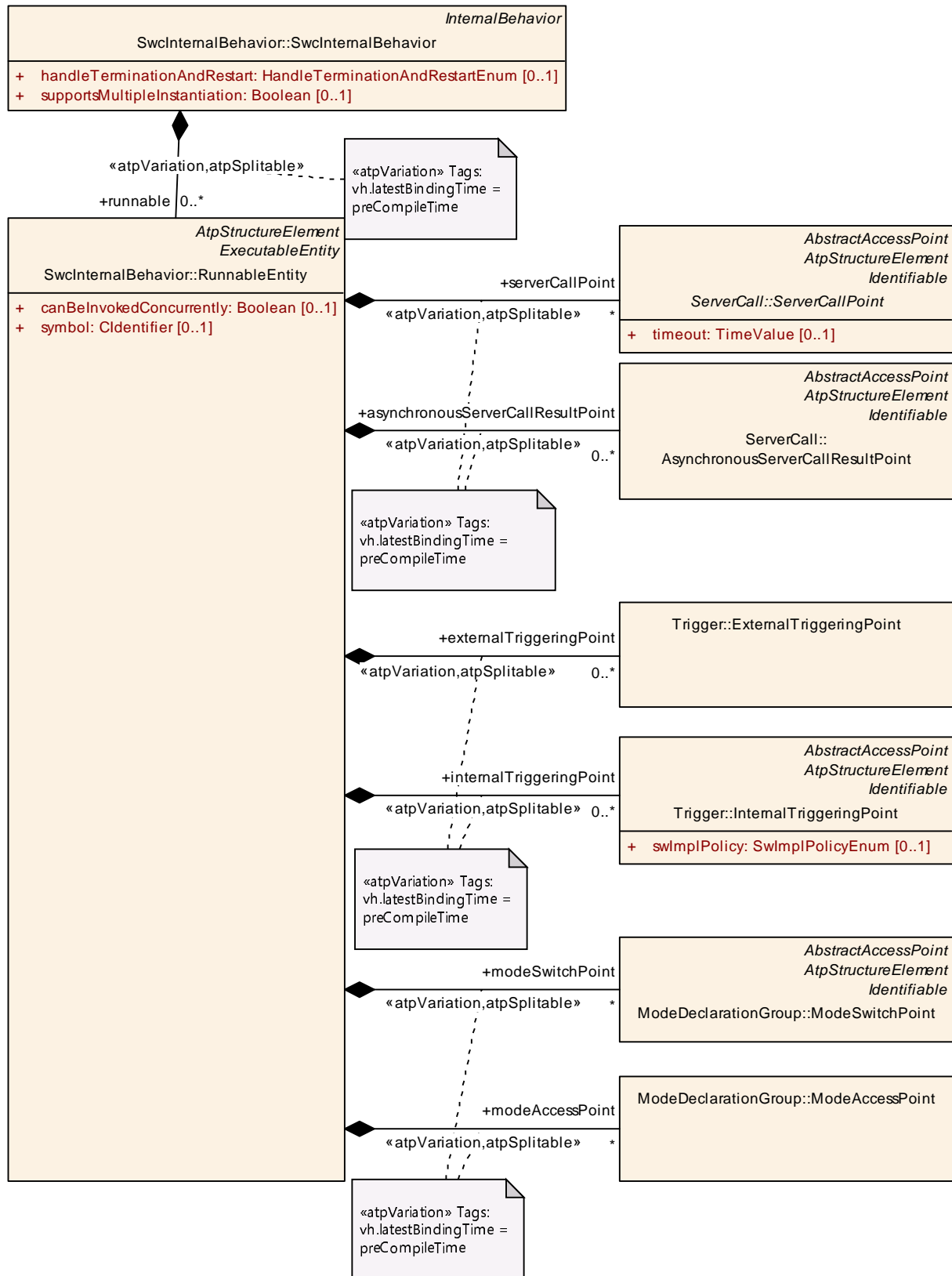


Figure 4.7: Software-component runnable entity and server invocation, trigger, and mode switches

With the information from [SwcInternalBehavior](#) a part of the setup of the AUTOSAR software-component within the RTE and the OS can already be configured. Furthermore, the information (description) of the structure (ports, interfaces) and the internal behavior of an AUTOSAR software component are sufficient for the *RTE Contract Phase*.

However, some detailed information is still missing and this is part of the Implementation description.

4.1.3.4 Implementation

In the Implementation description an actual implementation of an AUTOSAR software-component is described including the memory consumption (see [Figure 4.8](#)).

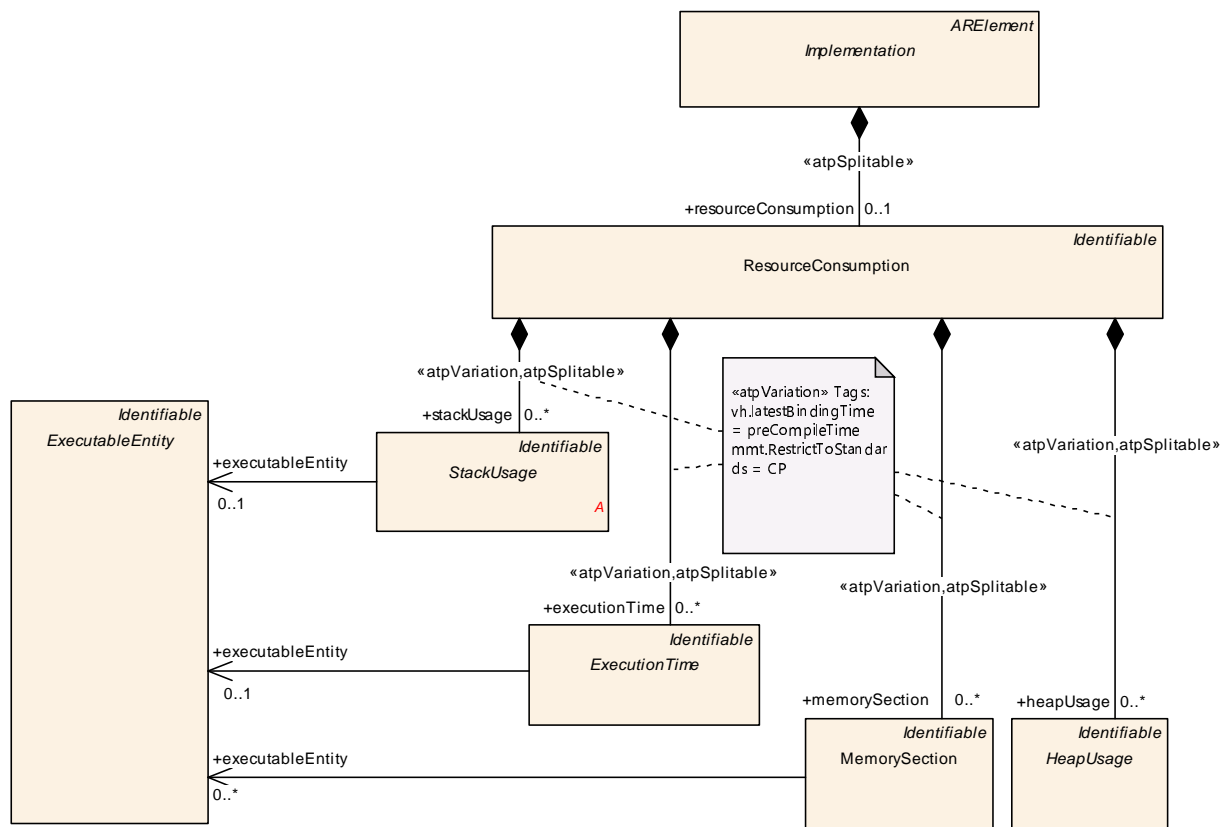


Figure 4.8: Software-component resource consumption

Note that the information from the Implementation part are only required for the *RTE Generation Phase*, if at all.

4.1.4 Instantiation

4.1.4.1 Scope and background

Generally spoken, the term *instantiation* refers to the process of deriving specific instances from a model or template. But, this process can be accomplished on different levels of abstraction. Therefore, the instance of the one level can be the model for the next.

With respect to AUTOSAR four modeling levels are distinguished. They are referred to as the levels *M3* to *M0*.

The level *M3* describes the concepts used to derive an AUTOSAR meta model of level *M2*. This meta model at level *M2* defines a language in order to be able to describe specific attributes of a model at level *M1*, e.g., to be able to describe an specific type of an AUTOSAR software component. E.g., one part of the AUTOSAR meta model is called *Software Component Template* or *SW-C-T* for short and specified in [2]. It is discussed more detailed in section 4.1.3.

At level *M1* engineers will use the defined language in order to design components or interfaces or compositions, say to describe an specific *type* of a *LightManager*. Hereby, e.g., the descriptions of the (atomic) software components will also contain an internal behavior as well as an implementation part as mentioned in section 4.1.3.

Those descriptions are input for the RTE Generator in the so-called 'Contract Phase' (see section 3.1.1). Out of this information specific APIs (in a programming language) to access ports and interfaces will be generated.

Software components generally consist of a set of Runnable Entities. They can now specifically be described in a programming language which can be referred to as "implementation". As one can see in section 4.1.3 this "implementation" then corresponds exactly to one implementation description as well as to one internal behavior description.

M0 refers to a specific running instance on a specific car.

Objects derived from those specified component types can only be executed in a specific run time environment (on a specific target). The objects embody the real and running implementation and shall therefore be referred to as software component instances (on modeling level *M0*). E.g., there could be two component instances derived from the same component type *LightManager* on a specific *light controller* ECU each responsible for different lights. Making instances means that it should be possible to distinguish them even though the objects are descended from the same model.

With respect to this more narrative description the *RTE* as the *run time environment* shall enable the process of instantiation. Thereby the term *instantiation* throughout the document shall refer to the process of deriving and providing explicit particular descriptions of all occurring instances of all types. Therefore, this section will address the problems which can arise out of the instantiation process and will specify the needs for AUTOSAR components and the AUTOSAR RTE respectively.

4.1.4.2 Concepts of instantiation

Regardless of the fact that the (aforementioned) instantiation of AUTOSAR software components can be generally achieved on a per-system basis, the RTE Generator restricts its view to a per-ECU customization (see [SWS_Rte_05000]).

Generally, there are two different kinds of instantiations possible:

- single instantiation – which refers to the case where only *one* object or AUTOSAR software component instance will be derived out of the AUTOSAR software component description
- multiple instantiation – which refers to the case where *multiple* objects or AUTOSAR software component instances will be derived out of the AUTOSAR software component description

[SWS_Rte_02001] [The RTE Generator shall be able to instantiate one or more AUTOSAR software component instances out of a single AUTOSAR software component description.] ([SRS_Rte_00011](#))

[SWS_Rte_02008] [The RTE Generator shall evaluate the attribute *supportsMultipleInstantiation* of the *SwcInternalBehavior* of an AUTOSAR software component description.] ([SRS_Rte_00011](#))

[SWS_Rte_02009] [The RTE Generator shall reject configurations where multiple instantiation is required, but the value of the attribute *supportsMultipleInstantiation* of the *SwcInternalBehavior* of an AUTOSAR software component description is set to *FALSE*.] ([SRS_Rte_00011](#), [SRS_Rte_00018](#))

4.1.4.3 Single instantiation

Single instantiation refers to the easiest case of instantiation.

To be instantiated merely means that the code and the corresponding data of a particular [RunnableEntity](#) are embedded in a runtime context. In general, this is achieved by the context of an OS task (see example 4.1).

Example 4.1

Runnable entity R1 called out of a task context:

```

1      TASK (Task1) {
2          ...
3          R1 ();
4          ...
5      }
```

Since the single instance of the software component is unambiguous per se no additional concepts have to be added.

4.1.4.4 Multiple instantiation

[SWS_Rte_02002] [Multiple objects instantiated from a single AUTOSAR software component (type) shall be identifiable without ambiguity.]([SRS_Rte_00011](#))

There are two *principle* ways to achieve this goal –

- by code duplication (of runnable entities)
- by code sharing (of reentrant runnable entities)

For now it was decided to solely concentrate on code sharing and not to support code duplication.

[SWS_Rte_03015] [The RTE only supports multiple objects instantiated from a single AUTOSAR software component by code sharing, the RTE doesn't support code duplication.]([SRS_Rte_00011](#), [SRS_Rte_00012](#))

Multiple instances can share the same code, if the code is reentrant. For a multi core controller, the possibility to share code between the cores depends on the hardware.

Example 4.2 is similar to the example 4.1, but for a software-component that support multiple instantiations, and where two instances have their R1 [RunnableEntity](#) mapped to the same task.

Example 4.2

Runnable entity R1 called for two instances out of the same task context:

```
1      TASK(Task1) {  
2          ...  
3          R1(instance1);  
4          R1(instance2);  
5          ...  
6      }
```

The same code for R1 is shared by the different instances.

4.1.4.4.1 Reentrant code

In general, side effects can appear if the same code entity is invoked by different threads of execution running, namely tasks or ISR2s. This holds particularly true, if the invoked code entity inherits a state or memory by the means of static variables which are visible to all instances. That would mean that all instances are coupled by those static variables.

Thus, they affect each other. This would lead to data consistency problems on one hand. On the other – and that is even more important – it would introduce a new communication mechanism to AUTOSAR and this is forbidden. AUTOSAR software components can only communicate via ports.

To be complete, it shall be noted that a calling code entity also inherits the reentrancy problems of its callee. This holds especially true in case of recursive calls.

4.1.4.4.2 Unambiguous object identification

[SWS_Rte_02015] [The instantiated AUTOSAR software component objects shall be unambiguously identifiable by an *instance handle*, if multiple instantiation by sharing code is required.]([SRS_Rte_00011](#), [SRS_Rte_00012](#))

4.1.4.4.3 Multiple instantiation and Per-instance memory

An AUTOSAR SW-C can define internal memory only accessible by a SW-C instance itself. This concept is called `PerInstanceMemory`. The memory can only be accessed by the runnable entities of this particular instance. That means in turn, other instances don't have the possibility to access this memory.

`PerInstanceMemory` API principles are explained in Section [5.2.5](#).

The API for `PerInstanceMemory` is specified in Section [5.6.15](#).

4.1.5 RTE and AUTOSAR Services

According to the AUTOSAR glossary [[11](#)] “an AUTOSAR service is a logical entity of the Basic Software offering general functionality to be used by various AUTOSAR software components. The functionality is accessed via standardized AUTOSAR interfaces”.

Therefore, AUTOSAR services provide standardized AUTOSAR Interfaces: ports typed by standardized [PortInterfaces](#).

When connecting AUTOSAR service ports to ports of AUTOSAR software components the RTE maps standard RTE API calls to the symbols defined in the RTE input (i.e. XML) for the AUTOSAR service runnables of the BSW. The key technique to distinguish ECU dependent identifiers for the AUTOSAR services is called “port-defined argument values”, which is described in Section [4.3.2.4](#). Currently “port-defined argument values” are only supported for client-server communication. It is not possible to use a pre-defined symbol for sending or receiving data.

The RTE does not pass an instance handle to the C-based API of AUTOSAR services since the latter are single-instantiatable (see [[SWS_Rte_03806](#)]).

As displayed on figure [4.2](#), there can be direct interactions between the RTE and some Basic Software Modules. This is the case of the Operating System, the AUTOSAR Communication, and the NVRAM Manager.

4.1.6 RTE and ECU Abstraction

The *ECU Abstraction* provides an interface to physical values for AUTOSAR software components. It abstracts the physical origin of signals (their pathes to the ECU hardware ports) and normalizes the signals with respect to their physical appearance (like specific values of current or voltage).

See the AUTOSAR ECU architecture in figure 4.2. From an architectural point of view the ECU Abstraction is part of the *Basic Software* layer and offers AUTOSAR interfaces to AUTOSAR software components.

Seen from the perspective of an RTE, regular AUTOSAR ports are connected. Without any restrictions all communication paradigms specified by the AUTOSAR Virtual Functional Bus (VFB) shall be applicable to the ports, interfaces and connections – sender-receiver just as well as client-server mechanisms.

However, ports of the ECU Abstraction shall always only be connected to ports of specific AUTOSAR software components: sensor or actuator software components. In this sense they are tightly coupled to a particular ECU Abstraction.

Furthermore, it must not be possible (by an RTE) to connect AUTOSAR ports of the ECU Abstraction to AUTOSAR ports of any AUTOSAR component located on a remote ECU (see [SWS_Rte_02051]).

This means, e.g., that sensor-related signals coming from the ECU Abstraction are always received by an AUTOSAR sensor component located on the same ECU. The AUTOSAR sensor component will then process the received signal and deploy it to other AUTOSAR components regardless of whether they are located on the same or any remote ECU. This applies to actuator-related signals accordingly, however, the opposite way around.

[SWS_Rte_02050] [The RTE Generator shall generate a communication path between connected ports of AUTOSAR sensor or actuator software components and the ECU Abstraction in the exact same manner like for connected ports of AUTOSAR software components.]()

[SWS_Rte_02051] [The RTE Generator shall reject configurations which require a communication path from a AUTOSAR software component to an ECU Abstraction located on a remote ECU.](SRS_Rte_00062, SRS_Rte_00018)

Further information about the ECU Abstraction can be found in the corresponding specification document [17].

4.1.7 RTE and Complex Device Driver

A Complex Device Driver has an AUTOSAR Interface, therefore the RTE can deal with the communication on the Complex Device Drivers ports. The Complex Device Driver is allowed to have code entities that are not under control of the RTE but yet still may use the RTE API (e.g. ISR2, BSW main processing functions).

4.1.8 Basic Software Scheduler and Basic Software Modules

4.1.8.1 Description of a Basic Software Module

The description of a Basic Software Module is divided into the sections

- interfaces
- internal behavior
- implementation

For further details see document [\[9\]](#).

4.1.8.2 Basic Software Interfaces

The interface of a *Basic Software Module* is described with *Basic Software Module Entries* (*BswModuleEntry*). For the functionality of the *Basic Software Scheduler* only *BswModuleEntry*s from *BswCallType SCHEDULED* are relevant. Nevertheless for optimization purpose the analysis of the full call tree might be required which requires the consideration of all *BswModuleEntry*'s

4.1.8.3 Basic Software Internal Behavior

The *Basic Software Internal Behavior* specifies the behavior of a BSW module or a BSW cluster w.r.t. the code entities visible by the BSW Scheduler. For the *Basic Software Scheduler* mainly *Basic Software Schedulable Entities* (*BswSchedulableEntity*'s) are relevant. These are *Basic Software Module Entities*, which are designed for control by the *Basic Software Scheduler*. *Basic Software Schedulable Entities* are implementing main processing functions. Furthermore all *Basic Software Schedulable Entities* are allowed to use exclusive areas and for call tree analysis all *Basic Software Module Entities* are relevant.

[SWS_Rte_07514] [The *Basic Software Scheduler* shall support multiple *Basic Software Module Entities* in AUTOSAR Basic Software Modules.] ([SRS_Rte_00211](#), [SRS_Rte_00213](#), [SRS_Rte_00216](#))

[SWS_Rte_07515] [The *Basic Software Scheduler* shall trigger the execution of *Schedulable Entity*'s in accordance with the connected *BswEvent*.] ([SRS_Rte_00072](#))

[SWS_Rte_07516] [The RTE Generator shall reject configurations where a *BswEvent* which can start a *Schedulable Entity* is not mapped to an *OsTask*/ISR2 nor is qualified for a direct or trusted function call.] ([SRS_Rte_00049](#), [SRS_Rte_00018](#))

[SWS_Rte_07517] [The RTE Generator shall respect the configured execution order of *Schedulable Entities* within one OS task/ISR2.] ([SRS_Rte_00219](#))

[SWS_Rte_07518] [The RTE shall support the execution sequences of *Runnable Entities* and *Schedulable Entities* within the same OS task/ISR2 in an arbitrarily configurable order.] ([SRS_Rte_00219](#))

4.1.8.4 Basic Software Implementation

The implementation defines further details of the implantation of the *Basic Software Module*. The *vendorApiInfix* attribute is of particular interest, because it defines the name space extension for multiple instances of the same basic software module. Further on the category of the `codeDescriptor` specifies if the *Basic Software Module* is delivered as source code or as object.

4.1.8.5 Multiple Instances of Basic Software Modules

In difference to the multiple instantiation concept of software components, where the same component code is used for all component instances, basic software modules are multiple instantiated by creation of own code per instance in a different name space. The attribute *vendorApiInfix* allows to define name expansions required for global symbols.

4.1.8.6 AUTOSAR Services / ECU Abstraction / Complex Device Drivers

AUTOSAR Services, *ECU Abstraction* and *Complex Device Drivers* are hybrid of AUTOSAR software-component and *Basic Software Module*. These kinds of modules might use *AUTOSAR Interfaces* to communicate via RTE as well as C-API to directly access other *Basic Software Modules*. Caused by the structure of the *AUTOSAR Meta Model* some entities of the 'C' implementation have to be described twice; on the one hand by the means of the *Software Component Template* [2] and on the other hand by the means of the *Basic Software Module Description Template* [9]. Further on the dualism of port based communication between software component and non-port based communication between *Basic Software Modules* requires in some cases the coordination and synchronization between both principles. The information about elements belonging together is provided by the so called *SwcBswMapping*.

4.1.8.6.1 RunnableEntity / BswModuleEntity mapping

A *Runnable Entity* which is mapped to a *Basic Software Module Entity* has to be treated as one common entity. This means it describes an entity which can use the features of a *Runnable Entity* and a *Basic Software Module Entity* as well. For instance it supports to use the port based API as well as *Basic Software Scheduler* API in one C function.

4.1.8.6.2 Synchronized ModeDeclarationGroupPrototype

Two synchronized *ModeDeclarationGroupPrototype* are resulting in the implementation of one common *mode machine instance*. Consequently the call of the belonging *Rte_Switch* API and the *SchM_Switch* API are having the same effect. For optimization purpose the *Rte_Switch* API might just refer to the *SchM_Switch* API.

4.1.8.6.3 Synchronized Trigger

Two synchronized *Trigger* are behaving like one common *Trigger*. Consequently the call of the belonging *Rte_Trigger* API and the *SchM_Trigger* API are having the same effect. For optimization purpose the *Rte_Trigger* API might just refer to the *SchM_Trigger* API.

4.2 RTE and Basic Software Scheduler Implementation Aspects

4.2.1 Scope

This section describes some specific implementation aspects of an AUTOSAR RTE and the Basic Software Scheduler. It will mainly address

- the mapping of logical concepts (e.g., Runnable Entities, BSW Schedulable Entities) to technical architectures (namely, the AUTOSAR OS)
- the decoupling of pending interrupts (in the Basic Software) and the notification of AUTOSAR software components
- data consistency problems to be solved by the RTE

Therefore this section will also refer to aspects of the interaction of the AUTOSAR RTE and Basic Software Scheduler and the two modules of the AUTOSAR Basic Software with standardized interfaces (see Figure 4.9):

- the module *AUTOSAR Operating System* [18][4]
- the module *AUTOSAR COM* [19][3]

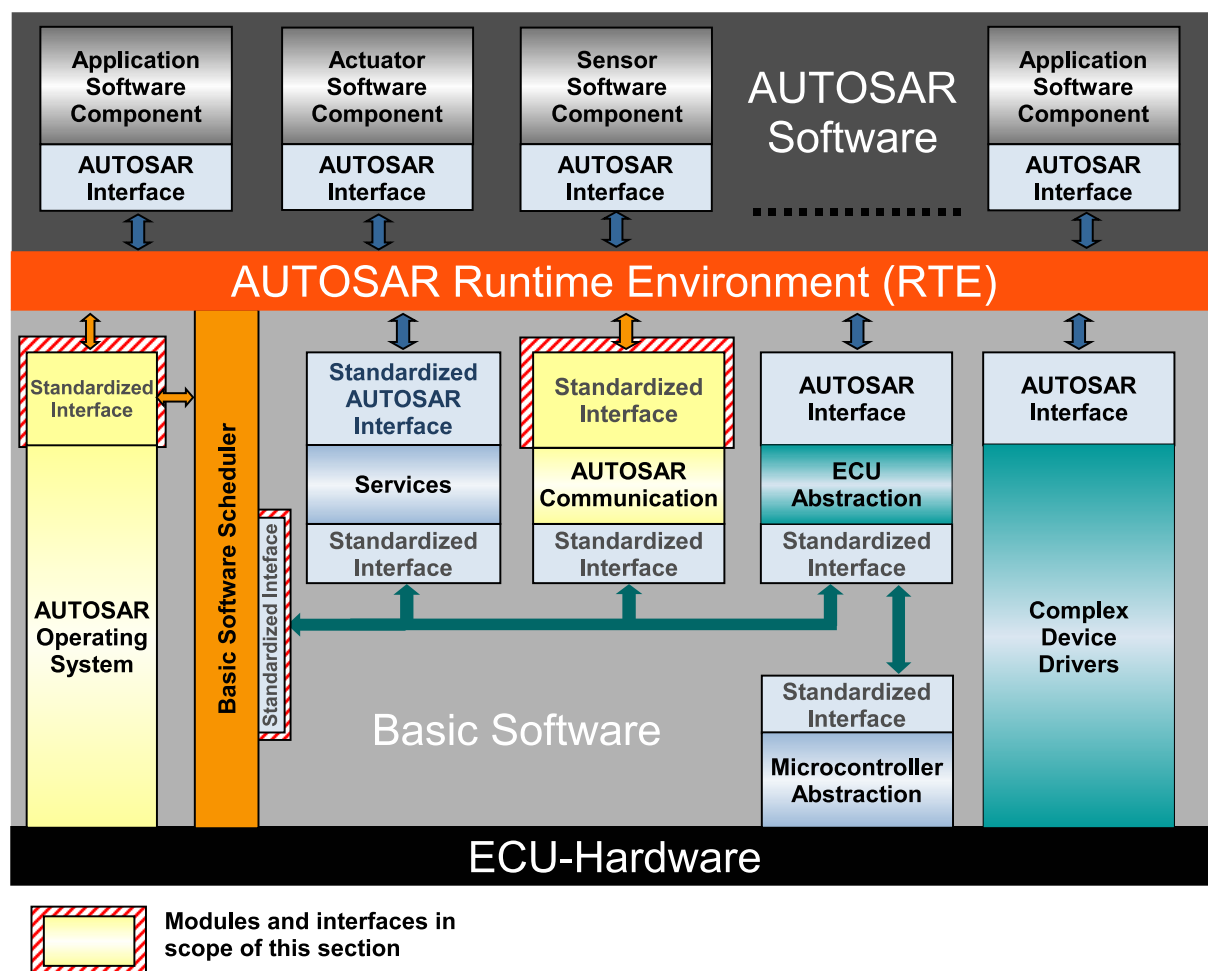


Figure 4.9: Scope of the section on Basic Software modules

Having a standardized interface means *first* that the modules do not provide or request services for/of the *AUTOSAR software components* located above the RTE. They do not have ports and therefore cannot be connected to the aforementioned AUTOSAR software components. AUTOSAR OS as well as AUTOSAR COM are simply invisible for them.

Secondly AUTOSAR OS and AUTOSAR COM are used by the RTE in order to achieve the functionality requested by the AUTOSAR software components. The AUTOSAR COM module is used by the RTE to route a signal over ECU boundaries, but this mechanism is hidden to the sending as well as to the receiving AUTOSAR software component. The AUTOSAR OS module is used for two main purposes. First, OS is used by the RTE to route a signal over core and partition boundaries. Secondly, the AUTOSAR OS module is used by the RTE in order to properly schedule the single Runnables in the sense that the RTE Generator generates Task/ISR2-bodies which contain then the calls to appropriate Runnables.

In this sense the RTE shall also *use* the available means to convert interrupts to notifications in a task context or to guarantee data consistency.

With respect to this view, the RTE is *thirdly not* a generic abstraction layer for AUTOSAR OS and AUTOSAR COM. It is generated for a specific ECU and offers the same *interface* to the AUTOSAR Software Components as the VFB. It implements the functionality of the VFB using modules of the Basic Software, including a specific implementation of AUTOSAR OS and AUTOSAR COM.

The *Basic Software Scheduler* offers services to integrate *Basic Software Modules* for all modules of all layers. Hence, the *Basic Software Scheduler* provides the following functions:

- embed *Basic Software Modules* implementations into the *AUTOSAR OS* context
- trigger `BswSchedulableEntities` of the *Basic Software Modules*
- apply data consistency mechanisms for the *Basic Software Modules*

The integrator's task is to apply given means (of the AUTOSAR OS) in order to assemble BSW modules in a well-defined and efficient manner in a project specific context.

This also means that the BSW Scheduler only uses the AUTOSAR OS. It is not in the least a competing entity for the AUTOSAR OS scheduler.

[SWS_Rte_02250] [The RTE shall only use the AUTOSAR OS, AUTOSAR COM, AUTOSAR Efficient COM for Large Data, AUTOSAR Transformer and AUTOSAR NVRAM Manager in order to provide the RTE functionality to the AUTOSAR components.] ([SRS_Rte_00020](#))

[SWS_Rte_07519] [The *Basic Software Scheduler* shall only use the *AUTOSAR OS* in order to provide the *Basic Software Scheduler* functionality to the *Basic Software Modules*.] ()

[SWS_Rte_06200] [The RTE Generator shall construct task bodies for those tasks which contain `RunnableEntities`.] ([SRS_Rte_00049](#))

[SWS_Rte_82005]{DRAFT} [The RTE Generator in Cluster Generation Phase shall reject configurations where the mappings of *Runnable Entities* via their respective `RTEEvents` require extended tasks.] ([SRS_Rte_00049](#))

[SWS_Rte_04560] [The RTE Generator shall construct ISR bodies for those ISRs which are of category 2 and contain `RunnableEntities`.] ([SRS_Rte_00049](#))

[SWS_Rte_06201] [The RTE Generator shall construct task bodies for those tasks which contain *Basic Software Schedulable Entities*.] ([SRS_Rte_00049](#))

[SWS_Rte_04561] [The RTE Generator shall construct ISR bodies for those ISRs which are of category 2 and contain *Basic Software Schedulable Entities*.] ([SRS_Rte_00049](#))

The information for the construction of task/ISR2 bodies has to be given by the ECU Configuration description. The mapping of *Runnable Entities* to tasks/ISR2s is given as an input by the ECU Configuration description. The RTE Generator does not decide on the mapping of `RunnableEntities` to tasks/ISR2s.

[SWS_Rte_04557] [The RTE Generator shall wrap each definition of a task body with the *Memory Mapping*.

```

1 #define OS_START_SEC_<sadm>
2 #include "Os_MemMap.h"
3
4 <task body definition>
5
6 #define OS_STOP_SEC_<sadm>
7 #include "Os_MemMap.h"

```

where <sadm> is the [shortName](#) of the [SwAddrMethod](#), if configured in *OsMemoryMappingCodeLocationRef* of the according *OsTask*. If *OsMemoryMappingCodeLocationRef* is not defined , <sadm> shall be `CODE_<Taskname>.`] ([SRS_Rte_00049](#), [SRS_BSW_00351](#))

[SWS_Rte_04562] [The RTE Generator shall wrap each definition of a ISR2 body with the *Memory Mapping*.

```

1 #define OS_START_SEC_<sadm>
2 #include "Os_MemMap.h"
3
4 <ISR2 body definition>
5
6 #define OS_STOP_SEC_<sadm>
7 #include "Os_MemMap.h"

```

where <sadm> is the [shortName](#) of the [SwAddrMethod](#), if configured in *OsMemoryMappingCodeLocationRef* of the according *OsIsr*. If *OsMemoryMappingCodeLocationRef* is not defined , <sadm> shall be `CODE_<ISR Name>.`] ([SRS_Rte_00049](#), [SRS_BSW_00351](#))

Note: Requirements [\[SWS_Rte_04557\]](#) and [\[SWS_Rte_04562\]](#) are exceptions to [\[SWS_Rte_05088\]](#).

[SWS_Rte_02254] [The RTE Generator shall reject configurations where input information is missing regarding the mapping of [BswEvents](#) to OS tasks and [RTEEvents](#) (which trigger runnables) to OS tasks/ISR2s.] ([SRS_Rte_00049](#), [SRS_Rte_00018](#))

Note: Not in all cases an event has to be mapped to an [OsTask](#)/ISR2. For example, runnables which shall be called via a direct or trusted function call need no [OsTask](#)/ISR2 mapping.

[SWS_Rte_08417] [The RTE Generator shall reject configurations where input information is missing regarding the construction of tasks or ISR2 bodies.] ([SRS_Rte_00049](#), [SRS_Rte_00018](#))

There are use cases (e.g. a set of tasks with defined call order on different partitions) where another task needs to be explicitly activated when the current task terminates.

With the configuration of [RteOsTaskChains](#) it's possible to configure the intended task chain behavior for such cases.

[SWS_Rte_04558] [In case an `OsTask` is referenced by an `RtePredecessorOsTaskRef` the RTE shall emit in the according task body a `ChainTask` call to the `OsTask` given as `RteSuccessorOsTaskRef` at the location in the task body where the task terminates.] ([SRS_Rte_00049](#))

[SWS_Rte_04559] [When the RTE is required to activate an `OsTask` due to being triggered by an `RTEEvent` (e.g. `DataReceivedEvent`) where the `OsTask` is referenced by an `RtePredecessorOsTaskRef` or an `RteSuccessorOsTaskRef` and is not the ultimate predecessor `OsTask` in the chain, the RTE shall activate that `OsTask`'s ultimate `RtePredecessorOsTaskRef` instead of the `OsTask` it should have normally activated.] ([SRS_Rte_00049](#))

Note: The ultimate predecessor task for an `OsTask` in a task chain can be found by following all `RtePredecessorOsTaskRefs` from the point at which the `OsTask` is referenced by an `RteOsTaskChain` container until the task chain references an `OsTask` as its `RtePredecessorOsTaskRef` which is not referenced as an `RteSuccessorOsTaskRef`. The `OsTask` referenced as `RtePredecessorOsTaskRef` in that final `RteOsTaskChain` container is the ultimate predecessor task.

Example 4.3

Consider an `RteOsTaskChain` configuration where Task1 chains Task2 which in turn chains Task3. In this scenario, if Task2 needs to be activated by the RTE due to a `DataReceivedEvent`, the RTE must activate Task1 instead of Task2 as Task1 is the ultimate predecessor task.

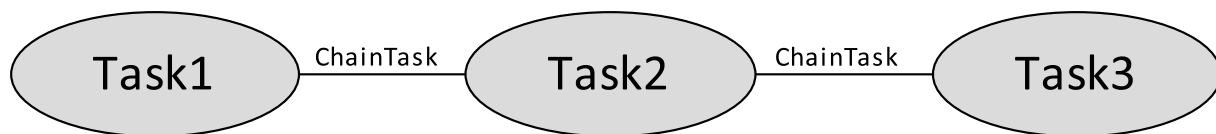


Figure 4.10: Illustration of task chaining sequence

```

1  ...
2  Rte_Write_myPort_myData(uint8 data)
3  {
4      /.../
5      ActivateTask(Task1);
6  }
7  ...
8  TASK(Task1)
9  {
10     /.../
11     ChainTask(Task2);
12 }
13 ...
14 TASK(Task2)
15 {
16     /.../
17     ChainTask(Task3);
18 }
19 ...
20 TASK(Task3)

```

```
21 {  
22   /.../  
23   TerminateTask();  
24 }  
25 ...
```

[SWS_Rte_CONSTR_04558] [An *OsTask* shall be part of at most one task chain. Hence, an *OsTask* shall be referenced by at most one *RtePredecessorOsTaskRef* and by at most one *RteSuccessorOsTaskRef*.] (*SRS_Rte_00049*)

[SWS_Rte_CONSTR_04559] [The configuration of *RteOsTaskChains* shall not define circular chains.] (*SRS_Rte_00049*)

Note: For instance a configuration where T1 chains T2 and T2 chains T1 is not permitted.

4.2.2 OS

This section describes the interaction between the RTE + Basic Software Scheduler and the AUTOSAR OS. The interaction is realized via the standardized interface of the OS - the AUTOSAR OS API. See Figure 4.9.

The OS is statically configured by the ECU Configuration. The RTE generator however may be allowed to create tasks and other OS objects, which are necessary for the runtime environment (see [SWS_Rte_05150]). The mapping of *RunnableEntity*s and *BSW Schedulable Entities* to OS tasks/ISR2s is not the job of the RTE generator. This mapping has to be done in a configuration step before, in the RTE-Configuration phase. The RTE generator is responsible for the generation of OS task or ISR2 bodies, which contain the calls for the *RunnableEntity*s and *BSW Schedulable Entities*. The *RunnableEntity*s and *BSW Schedulable Entities* themselves are OS independent and are not allowed to use OS service calls. The RTE and *Basic Software Scheduler* have to encapsulate such calls via the standardized RTE API respectively *Basic Software Scheduler* API.

4.2.2.1 OS Objects

Tasks

- The RTE generator has to create the task bodies, which contain the calls of the *RunnableEntity*s and *BswSchedulableEntity*s. Note that the term *task body* is used here to describe a piece of code, while the term *task* describes a configuration object of the OS.
- The RTE and *Basic Software Scheduler* controls the task activation/resumption either directly by calling OS services like `SetEvent()` or `ActivateTask()` or

indirectly by initializing OS alarms or starting Schedule-Tables for time-based activation of `RunnableEntity`s. If the task terminates, the generated taskbody also contains the calls of `TerminateTask()` or `ChainTask()`.

- The RTE generator does **not** create tasks. The mapping of `RunnableEntity`s and `BswSchedulableEntity`s to tasks is the input to the RTE generator and is therefore part of the RTE Configuration.
- The RTE configurator has to allocate the necessary tasks in the OS configuration.

ISR2s

- The RTE generator has to create the ISR2 bodies, which contain the calls of the `RunnableEntity`s and `BswSchedulableEntity`s. Note that the term *ISR2 body* is used here to describe a piece of code, while the term *ISR2* describes a configuration object of the OS.
- The RTE generator does **not** create ISRs. The mapping of `RunnableEntity`s and `BswSchedulableEntity`s to ISR2s is the input to the RTE generator and is therefore part of the RTE Configuration.

OS applications

- AUTOSAR OS has in R4.0 a new feature called Inter-OS-Application Communication (IOC). IOC is generated by the OS based on the configuration partially generated by the RTE. The appropriate objects (OS-Applications) are generated by the OS, and are used by RTE to for runnable to task/ISR2 mappings.

Events

- The RTE and *Basic Software Scheduler* may use OS Events for the implementation of the abstract `RTEEvents` and `BswEvents`.
- The RTE and *Basic Software Scheduler* therefore may call the OS service functions `SetEvent()`, `WaitEvent()`, `GetEvent()` and `ClearEvent()`.
- The used OS Events are part of the input information of the RTE generator.
- The RTE configurator has to allocate the necessary events in the OS configuration.

Resources

- The RTE and *Basic Software Scheduler* may use OS Resources (standard or internal) e.g. to implement data consistency mechanisms.
- The RTE and *Basic Software Scheduler* may call the OS services `GetResource()` and `ReleaseResource()`.
- The used Resources are part of the input information of the RTE generator.
- The RTE configurator has to allocate the necessary resources (all types of resources) in the OS configuration.

Interrupt Processing

- An alternative mechanism to get consistent data access is disabling/enabling of interrupts. The AUTOSAR OS provides different service functions to handle interrupt enabling/disabling. The RTE may use these functions and must **not** use compiler/processor dependent functions for the same purpose.

Alarms

- The RTE may use Alarms for timeout monitoring of asynchronous client/server calls. The RTE is responsible for Timeout handling.
- The RTE and *Basic Software Scheduler* may setup cyclic alarms for periodic triggering of `RunnableEntity`s and `BswSchedulableEntity`s (`RunnableEntity` activation via `RTEEvent TimingEvent` respectively `BswSchedulableEntity` activation via `BswEvent BswTimingEvent`)
- The RTE and *Basic Software Scheduler* therefore may call the OS service functions `GetAlarmBase()`, `GetAlarm()`, `SetRelAlarm()`, `SetAbsAlarm()` and `CancelAlarm()`.
- The used Alarms are part of the input information of the RTE generator.
- The RTE configurator has to allocate the necessary alarms in the OS configuration.

Schedule Tables

- The RTE and *Basic Software Scheduler* may setup schedule tables for cyclic task activation (e.g. `RunnableEntity` activation via `RTEEvent TimingEvent`)
- The used schedule tables are part of the input information of the RTE generator.
- The RTE configurator has to allocate the necessary schedule tables in the OS configuration.

Common OS features

Depending on the global scheduling strategy of the OS, the RTE can make decisions about the necessary data consistency mechanisms. E.g. in an ECU, where all tasks are non-preemptive - and as the result also the global scheduling strategy of the complete ECU is non-preemptive - the RTE may optimize the generated code regarding the mechanisms for data consistency.

Hook functions

The AUTOSAR OS Specification defines hook functions, but the RTE SWS does not standardize any usage of those OS hook functions.

4.2.2.2 Basic Software Schedulable Entities

`BswSchedulableEntity`s are *Basic Software Module Entities*, which are designed for control by the BSW Scheduler. `BswSchedulableEntity`s are implementing main processing functions. The configuration of the *Basic Software Scheduler* allows mapping of `BswSchedulableEntity`s to both types; basic tasks and extended tasks and to interrupts of category 2.

`BswSchedulableEntity`s not mapped to a `RunnableEntity` are not allowed to enter a wait state. Therefore such `BswSchedulableEntity`s are comparable to `RunnableEntity`s of category 1. `BswSchedulableEntity`s mapped to a `RunnableEntity` can enter wait states by usage of the RTE API and such `BswSchedulableEntity`s have to be treated according the classification of the mapped `RunnableEntity`. The mapping of `BswSchedulableEntity`s to a `RunnableEntity` is typically used for *AUTOSAR Services*, *ECU Abstraction* and *Complex Device Drivers*. See sections 4.1.8.6.

4.2.2.3 Runnable Entities

The following section describes the `RunnableEntity`s, their categories and their task/ISR2-mapping aspects. The prototypes of the functions implementing `RunnableEntity`s are described in section 5.7

Runnable Entities are the schedulable parts of SW-Cs. *Runnable Entities* are either mapped to tasks/ISR2s or activated by direct or trusted function calls in the context of other Rte APIs, for instance server runnables that are invoked via direct function calls.

The mapping must be described in the ECU Configuration Description. This configuration - or just the RTE relevant parts of it - is the input of the RTE generator.

All `RunnableEntity`s are activated by the RTE as a result of an `RTEEvent`. Possible activation events are described in the meta-model by using `RTEEvents` (see section 4.2.2.4).

If no `RTEEvent` specifies a particular `RunnableEntity` in the role `startOnEvent` then the `RunnableEntity` is never activated by the RTE. Please note that a `RunnableEntity` may be mapped to a `BswSchedulableEntity` as described in section 4.2.2.2 which may lead to activations by the BSW Scheduler.

The categories of `RunnableEntity`s are described in [2]. However, the Software Component Template only describes the categories based on the direct properties of a `RunnableEntity` e.g. if the `RunnableEntity` has a `WaitPoint` then it is considered as category 2. But in an integrated system with a configured Rte, scenarios like direct calls are possible which allow a runnable to run in the context of another runnable. In that case, not only the `WaitPoint` attached to that runnable is significant but also the `WaitPoint` of the directly called runnable. Other cases might exist where

no `WaitPoint` is present but the `Rte` still needs to use a `WaitEvent()` e.g. to implement a `SynchronousServerCallPoint` across core boundaries or to activate a server task with a lower priority than the client task.

`RunnableEntitys` and `BswSchedulableEntitys` are generalized by `ExecutableEntitys`.

4.2.2.4 RTE Events

The meta model describes the following RTE events:

Abbreviation	Name
T	<code>TimingEvent</code>
BG	<code>BackgroundEvent</code>
DR	<code>DataReceivedEvent</code> (S/R Communication only)
DRE	<code>DataReceiveErrorEvent</code> (S/R Communication only)
DSC	<code>DataSendCompletedEvent</code> (explicit S/R Communication only)
DWC	<code>DataWriteCompletedEvent</code> (implicit S/R Communication only)
OI	<code>OperationInvokedEvent</code> (C/S Communication only)
ASCR	<code>AsynchronousServerCallReturnsEvent</code> (C/S communication only)
MS	<code>SwcModeSwitchEvent</code>
MSA	<code>ModeSwitchedAckEvent</code>
MME	<code>SwcModeManagerErrorEvent</code>
ETO	<code>ExternalTriggerOccurredEvent</code>
ITO	<code>InternalTriggerOccurredEvent</code>
I	<code>InitEvent</code>
THE	<code>TransformerHardErrorEvent</code>
TEE	<code>OsTaskExecutionEvent</code>

Table 4.1: Abbreviations of RTEEvents

According to the meta model each kind of `RTEEvent` can either

ACT activate a `RunnableEntity`, or

WUP wakeup a `RunnableEntity` at its `WaitPoints`

The meta model makes no restrictions which kind of `RTEEvents` are referred by `WaitPoints`. As a consequence RTE API functions would be necessary to set up the `WaitPoints` for each kind of `RTEEvent`.

Nevertheless in some cases it seems to make no sense to implement all possible combinations of the general meta model. E.g. setting up a `WaitPoint`, which should be resolved by a cyclic `TimingEvent`. Therefore the RTE SWS defines some restrictions, which are also described in section A.

The meta model also allows, that the same `RunnableEntity` can be triggered by several `RTEEvents`. For the current approach of the RTE and restrictions see section 4.2.7.

	T	BG	DR	DRE	DSC	DWC	OI	ASCR
--	---	----	----	-----	-----	-----	----	------

ACT	X	X	X	X	X	X	X	X
WUP			X		X			X
	MS	MSA	MME	ETO	ITO	I	THE	TEE
ACT	X	X	X	X	X	X	X	X
WUP		X						

Table 4.2: activation of *RunnableEntity* depended on the kind of *RTEEvent*

The table 4.2 shows, that *activation of RunnableEntity* is possible for each kind of *RTEEvent*. For *RunnableEntity* activation, no explicit RTE API in the to be activated *RunnableEntity* is necessary. The RTE itself is responsible for the activation of the *RunnableEntity* depending on the configuration in the SW-C Description.

If the *RunnableEntity* contains a *WaitPoint*, it can be resolved by the assigned *RTEEvent*(s). Entering the *WaitPoint* requires an explicit call of a RTE API function. The RTE (together with the OS) has to implement the *WaitPoint* inside this RTE API.

The following list shows which RTE API function has to be called to set up *WaitPoints*.

- *DataReceivedEvent*: *Rte_Receive()*
- *DataSendCompletedEvent*: *Rte_Feedback()*
- *ModeSwitchedAckEvent*: *Rte_SwitchAck()*
- *AsynchronousServerCallReturnsEvent*: *Rte_Result()*

[SWS_Rte_01292] [When a *DataReceivedEvent* references a *RunnableEntity* and a required *VariableDataPrototype* and no *WaitPoint* references the *DataReceivedEvent*, the *RunnableEntity* shall be activated when the data is received. **[SWS_Rte_01135].**] (*SRS_Rte_00072*)

Requirement **[SWS_Rte_01292]** merely affects when the runnable is activated – an API call should still be created, according to requirement **[SWS_Rte_01288]**, **[SWS_Rte_01289]**, and **[SWS_Rte_07395]** as appropriate, to actually read the data.

4.2.2.5 BswEvents

The meta model describes the following *BswEvents*.

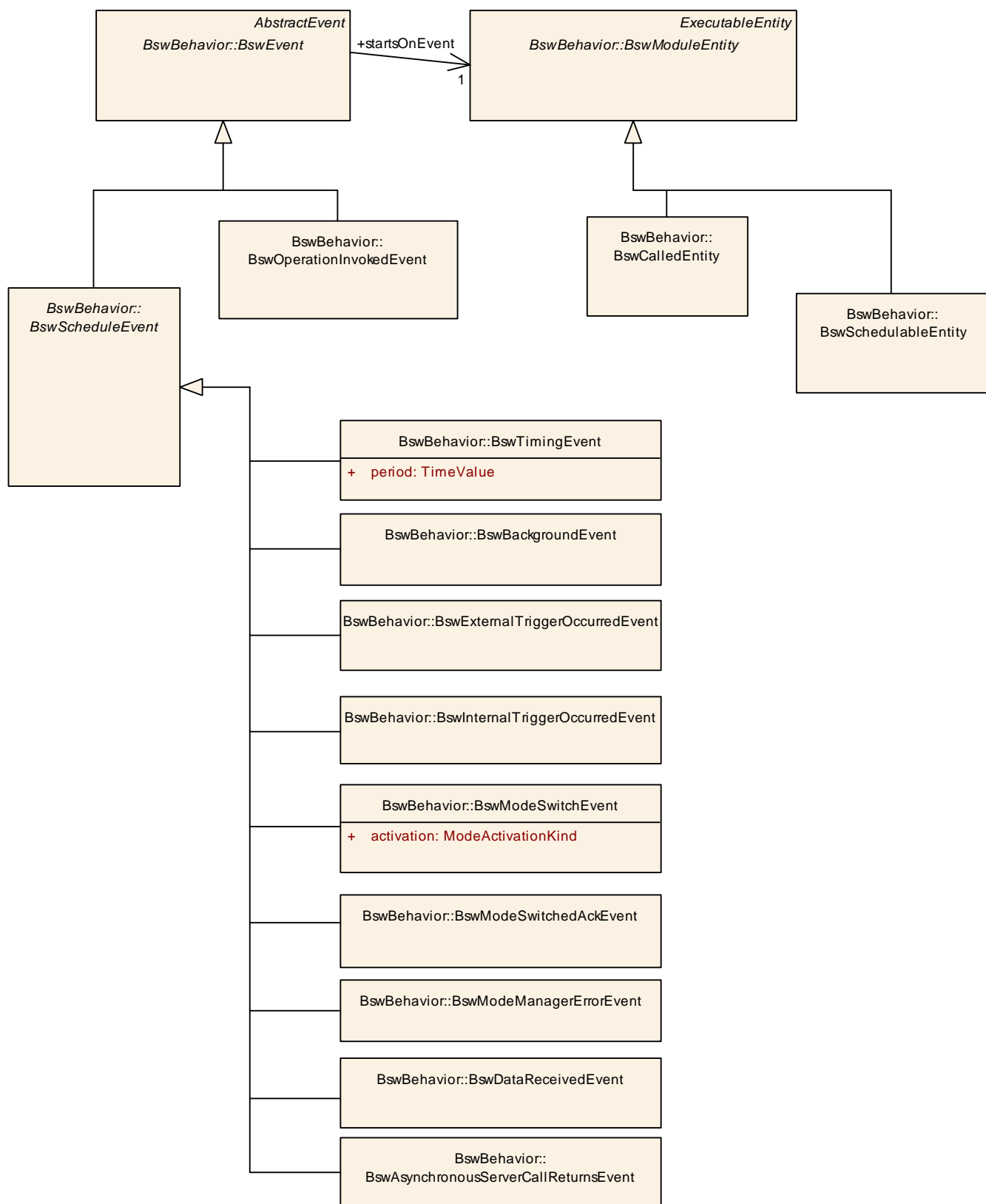


Figure 4.11: Different kinds of BswEvents

Similar to [RTEEvents](#) the *activation of Basic Software Schedulable Entities* is possible for each kind of [BswEvent](#). For of [BswSchedulableEntity](#)s activation, no explicit *Basic Software Scheduler* API in the to be activated [BswSchedulableEntity](#) is necessary. The *Basic Software Scheduler* itself is responsible for the activation of the [BswSchedulableEntity](#) depending on the configuration in the *Basic Software Module Description*. In difference to [RTEEvents](#), none of the [BswEvents](#) support [WaitPoints](#). For more details see document [9].

4.2.2.6 Mapping of Runnable Entities and Basic Software Schedulable Entities to tasks (informative)

One of the main requirements of the RTE generator is "Construction of task/ISR2 bodies" [SRS_Rte_00049]. The necessary input information e.g. the mapping of [RunnableEntity](#)s and [BswSchedulableEntity](#) to tasks/ISR2s must be provided by the ECU configuration description.

The ECU configuration description (or an extract of it) is the input for the RTE Generator (see Figure 3.4). It is also the purpose of this document to define the necessary input information. Therefore the following scenarios may help to derive requirements for the ECU Configuration Template as well as for the RTE-generator itself.

Note: The scenarios do not cover all possible combinations.

The RTE-Configurator uses parts of the ECU Configuration of other BSW Modules, e.g. the mapping of [RunnableEntity](#)s to [OsTasks](#). In this configuration process the RTE-Configurator expects OS objects (e.g. Tasks, Events, Alarms...) which are used in the generated RTE and *Basic Software Scheduler*.

Some figures for better understanding use the following conventions:

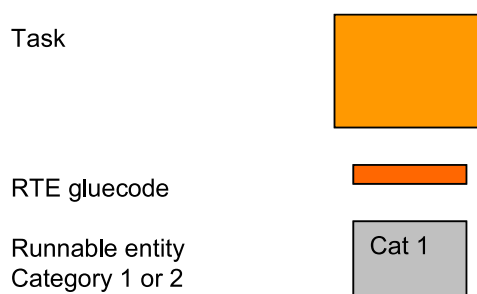


Figure 4.12: Element description

Note: The following examples are only showing [RunnableEntity](#)s. But taking the categorization of [BswSchedulableEntity](#)s defined in section 4.2.2.2 into account, the scenarios are applicable for [BswSchedulableEntity](#)s as well.

Note: The implementations described in this section are *examples only* and are presented for information only. The examples **must not be viewed as specification of**

implementation. The intention is to serve as examples of one possible implementation and not as specification of the only permitted implementation.

4.2.2.6.1 Scenario for mapping of `RunnableEntity`s to tasks

The different properties of `RunnableEntity`s with respect to data access and termination have to be taken into account when discussing possible scenarios of mapping `RunnableEntity`s to tasks.

- `RunnableEntity`s using `VariableAccesses` in the `dataReadAccess` or `dataWriteAccess` roles (implicit read and send) have to terminate.
- `RunnableEntity`s of category 1 can be mapped either to basic or extended tasks. (see next subsection).
- `RunnableEntity`s using at least one `WaitPoint` are of category 2.
- `RunnableEntity`s of category 2 that contain `WaitPoints` will be typically mapped to extended tasks.
- `RunnableEntity`s that contain a `SynchronousServerCallPoint` generally have to be mapped to extended tasks.
- `RunnableEntity`s that contain a `SynchronousServerCallPoint` can be mapped to basic tasks if no timeout monitoring is required and the server runnable is on the same partition.
- `RunnableEntity`s that contain a `SynchronousServerCallPoint` can be mapped to basic tasks if the server runnable is invoked directly and is itself of category 1.

Note that the runnable to task mapping scenarios supported by a particular RTE implementation might be restricted.

4.2.2.6.1.1 Scenario 1

Runnable entity category 1A: "runnable1"

- Ports: only S/R with `VariableAccesses` in the `dataReadAccess` or `dataWriteAccess` role
- `RTEEvents`: `TimingEvent`
- no sequence of `RunnableEntity`s specified
- no `VariableAccess` in the `dataSendPoint` role
- no `WaitPoint`

Possible mappings of "runnable1" to tasks:

Basic Task

If only one of those kinds of [RunnableEntity](#) is mapped to a task (task contains only one [RunnableEntity](#)), or if multiple [RunnableEntity](#)s with the same activation period are mapped to the same task, a basic task can be used. In this case, the execution order of the [RunnableEntity](#)s within the task is necessary. In case the [RunnableEntity](#)s have different activation periods, the RTE has to provide the glue-code to guarantee the correct call cycle of each [RunnableEntity](#).

The ECU Configuration-Template has to provide the sequence of [RunnableEntity](#)s mapped to the same task, see [RtePositionInTask](#).

Figure 4.13 shows the possible mappings of [RunnableEntity](#)s into a basic task. If and only if a sequence order is specified, more than one [RunnableEntity](#) can be mapped into a basic task.

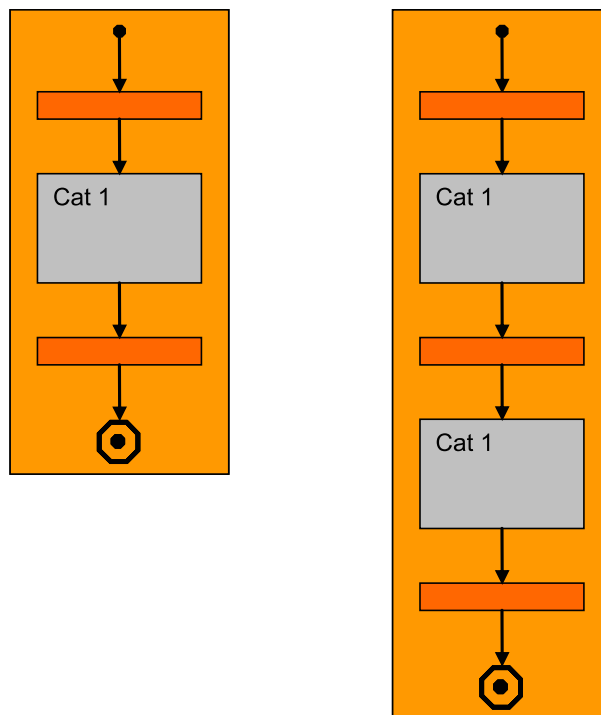


Figure 4.13: Mapping of Category 1 [RunnableEntity](#)s to Basic Tasks

Extended Task

If more than one [RunnableEntity](#) is mapped to the same task and the special condition (same activation period) does not fit, an extended task is used.

If an extended task is used, the entry points to the different [RunnableEntity](#)s might be distinguished by evaluation of different OS events. In the scenario above, the different activation periods may be provided by different OS alarms. The corresponding OS events have to be handled inside the task body. Therefore the RTE-generator needs for each task the number of assigned OS Events and their names.

The ECU Configuration has to provide the OS events assigned to the [RTEEvents](#) triggering the [RunnableEntity](#)s that are mapped to an extended task, see [RteUsedOsEventRef](#).

Figure 4.14 shows the possible mapping of the multiple [RunnableEntity](#)s of category 1 into an Extended Task. Note: The Task does not terminate.

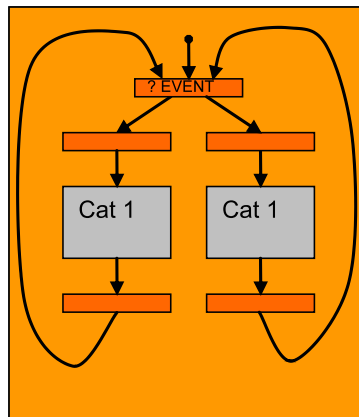


Figure 4.14: Mapping of Category 1 [RunnableEntity](#)s to Extended Tasks

For both, basic tasks and extended tasks, the ECU Configuration must provide the name of the task.

The ECU Configuration has to provide the name of the task, see [OsTask](#).

The ECU Configuration has to provide the task type (BASIC or EXTENDED), which can be determined from the presence or absence of OS Events associated with that task, see [OsTask](#).

4.2.2.6.1.2 Scenario 2

Runnable entity category 1B: "runnable2"

- Ports: S/R with [VariableAccesses](#) in the [dataSendPoint](#) role.
- [RTEEvents](#): TimingEvent
- no [WaitPoint](#)

Possible mappings of "runnable2" to tasks:

The following figure shows the different mappings:

- One category 1B runnable
- More than one category 1B runnable mapped to the same basic task with a specified sequence order
- More than one category 1B runnable mapped into an extended task

The gluecode to realize the `VariableAccess` in the `dataReadAccess` and `dataWriteAccess` roles respectively before entering the runnable and after exiting is not necessary.

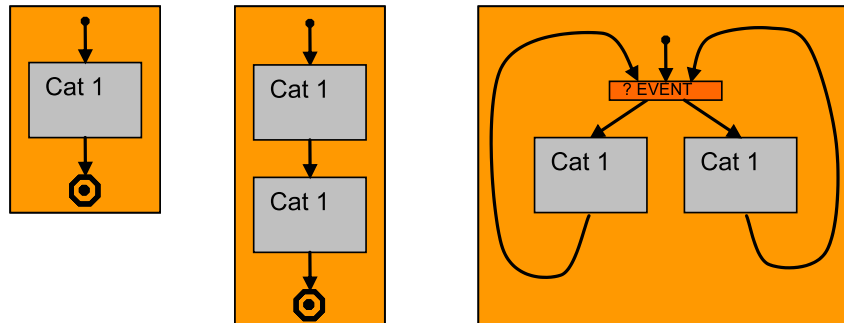


Figure 4.15: Mapping of Category 1 RunnableEntities using no VariableAccesses in the `dataReadAccess` or `dataWriteAccess` role

4.2.2.6.1.3 Scenario 3

Runnable entity category 1A: "runnable3"

- Ports: S/R with `VariableAccesses` in the `dataReadAccess` or `dataWriteAccess` role
- RTEEvents: Runnable is activated by a `DataReceivedEvent`
- no `VariableAccess` in the `dataSendPoint` role
- no `WaitPoint`

There is no difference between Scenario 1 and 3. Only the `RTEEvent` that activates the `RunnableEntity` is different.

4.2.2.6.1.4 Scenario 4

Runnable entity category 2: "runnable4"

- Ports: S/R with `VariableAccesses` in the `dataReceivePointByValue` or `dataReceivePointByArgument` role and `WaitPoint` (blocking read)
- RTEEvents: `WaitPoint` referencing a `DataReceivedEvent`

Runnable is activated by an arbitrary `RTEEvent` (e.g. by a `TimingEvent`). When the `RunnableEntity` has entered the `WaitPoint` and the `DataReceivedEvent` occurs, the `RunnableEntity` resumes execution.

The runnable has to be mapped to an extended task. Normally each category 2 runnable has to be mapped to its own task. Nevertheless it is not forbidden to map multiple category 2 `RunnableEntities` to the same task, though this might be restricted by an

RTE generator. Mapping multiple category 2 `RunnableEntity`s to the same task can lead to big delay times if e.g. a `WaitPoint` is resolved by the incoming `RTEEvent`, but the task is still waiting at a different `WaitPoint`.

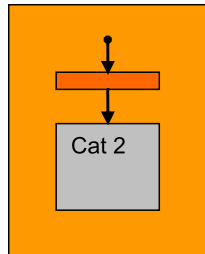


Figure 4.16: Mapping of Category 2 `RunnableEntity`s to Extended Tasks

4.2.2.6.1.5 Scenario 5

There are two `RunnableEntity`s implementing a client (category 2) and a server for synchronous C/S communication and the `timeout` attribute of the `ServerCallPoint` is 0.

On a single core, there are two ways to invoke a server synchronously:

- Simple function call for intra-partition C/S communication if the `canBeInvokedConcurrently` attribute of the server runnable is set and if the server runnable is of category 1. In that case the server runnable is executed in the same task context (same stack) as the client runnable that has invoked the server. The client runnable can be mapped to a basic task.
- The server runnable is mapped to its own task. If the `canBeInvokedConcurrently` attribute is not set, the server runnable must be mapped to a task.

If the implementation of the synchronous server invocation does not use OS events, the client runnable can be mapped to a basic task and the task of the server runnable must have higher priority than the task of the client runnable. Furthermore, the task to which the client runnable is mapped must be preemptable. This has to be checked by the RTE generator. Activation of the server runnable can be done by `ActivateTask()` for a basic task or by `SetEvent()` for an extended task. In both cases, the task to be activated must have higher priority than the task of the client runnable to enforce a task switch (necessary, because the server invocation is synchronous).

4.2.2.6.1.6 Scenario 6

There are two `RunnableEntity`s implementing a client (category 2) and a server for synchronous C/S communication and the `timeout` attribute of the `ServerCallPoint` is greater than 0.

There are again two ways to invoke a server synchronously:

- Simple function call for intra-partition C/S communication if the `canBeInvokedConcurrently` attribute of the server runnable is set and the server is of category 1. In that case the server runnable is executed in the same task context (same stack) as the client runnable that has invoked the server and no timeout monitoring is performed (see [SWS_Rte_03768]). In this case the client runnable can be mapped to a basic task.
- The server runnable is mapped to its own task. If the `canBeInvokedConcurrently` attribute is not set, the server runnable must be mapped to a task.

If the implementation of the timeout monitoring uses OS events, the task of the server runnable must have lower priority than the task of the client runnable and the client runnable must be mapped to an extended task. Furthermore, both tasks must be preemptable¹. This has to be checked by the RTE generator. The notification that a timeout occurred is then notified to the client runnable by using an OS Event. In order for the client runnable to immediately react to the timeout, a task switch to the client task must be possible when the timeout occurs.

4.2.2.6.1.7 Scenario 7

Runnable entity category 2: "runnable7"

- Ports: only C/S with `AsynchronousServerCallPoint` and `WaitPoint`
- RTEEvents: `AsynchronousServerCallReturnsEvent` (C/S communication only)

The mapping scenario for "runnable7", the client runnable that collects the result of the asynchronous server invocation, is similar to Scenario 4.

4.2.2.6.1.8 Scenario 8

Runnable entity category 1: "runnable8"

- Ports: only `trigger port` connected to a `trigger source` with a synchronized `Trigger` defining a *triggertDirectImplementation*
- no `VariableAccess` in the `dataSendPoint` role
- RTEEvents: Runnable is activated by a `ExternalTriggerOccurredEvent`
- no `WaitPoint`

¹Strictly speaking, this restriction is not necessary for the task to which the client runnable is mapped. If OS events are used to implement the timeout monitoring and the notification that the server is finished, the RTE API implementation generally uses the OS service `WaitEvent`, which is a point of rescheduling.

4.2.2.6.1.9 Scenario 9

Runnable entity category 1: "runnable9"

- **RTEEvents**: Runnable is activated by a **TimingEvent**
- no **WaitPoint**

The mapping scenario for "runnable8" and "runnable9" is similar to Scenario 1 for basic tasks whereas an ISR2 is used instead of a task.

4.2.2.7 Monitoring of runnable execution time

This section describes how the monitoring of **RunnableEntity** execution time can be done.

The RTE doesn't directly support monitoring of **RunnableEntity**s execution time but the AUTOSAR OS support for monitoring of **OsTasks** execution time can be used for this purpose.

If execution time monitoring of a **RunnableEntity** is required a possible solution is to map the **RunnableEntity** alone to an **OsTask** and to configure the OS to monitor the execution time of the **OsTask**.

This solution can lead to dispatch to individual **OsTasks** **RunnableEntity**s that should be initially mapped to the same **OsTask** because of for example:

- requirements on execution order of the **RunnableEntity**s and/or
- requirements on evaluation order of the **RTEEvents** that activate the **RunnableEntity**s and
- constraints to have no preemption between the **RunnableEntity**s

In order to keep the control on the execution order of the **RunnableEntity**s, the evaluation order of the **RTEEvents** and the non-preemption between the **RunnableEntity**s when then **RunnableEntity**s are individually mapped to several **OsTasks** for the purpose of monitoring, a possible solution is to replace the calls to the C-functions of the **RunnableEntity**s by activations of the **OsTasks** to which the monitored **RunnableEntity**s are mapped.

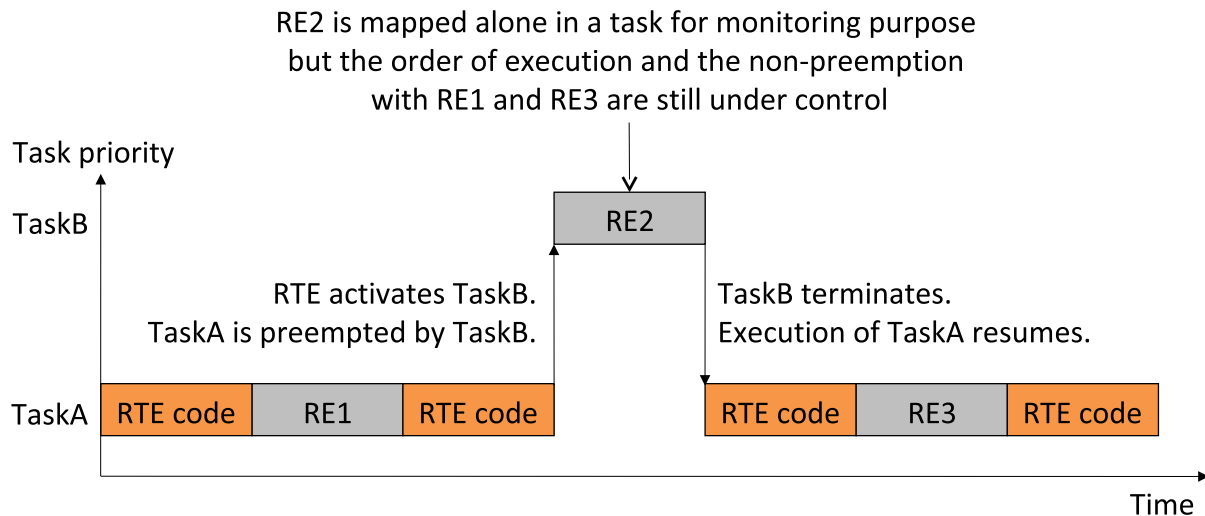


Figure 4.17: Inter task activation and mapping of runnable to individual task for monitoring purpose

This behavior of the RTE can be configured with the attributes `RteVirtuallyMappedToTaskRef` of the `RteEventToTaskMapping`. `RteVirtuallyMappedToTaskRef` references the `OsTask` in which the execution order of the `RunnableEntities` and/or the evaluation order of the `RTEEvents` are controlled. `RteMappedToTaskRef` references the individual `OsTasks` to which the `RunnableEntities` are mapped for the purpose of monitoring.

[SWS_Rte_07800] [The RTE Generator shall respect the configured virtual runnable to task mapping (`RteVirtuallyMappedToTaskRef`) in the RTE configuration.] (*SRS_Rte_00193*)

Of course this solution requires that the task priorities and scheduling properties are well configured in the OS to allow immediate preemption by the `OsTasks` to which the monitored `RunnableEntities` are mapped. A possible solution is:

- Priority of the `OsTask` to which the `RunnableEntity` is mapped is higher than the priority of the `OsTask` to which the `RunnableEntity` is virtually mapped and
- the `OsTask` to which the `RunnableEntity` is virtually mapped have a full preemptive scheduling or
- the RTE call the OS service `Schedule()` just after activation of the `OsTask` to which the `RunnableEntity` is mapped

Example 1: Without `OsEvent`

Description of the example:

`RunnableEntity` RE1 is activated by `TimingEvent` 100ms T1.

`RunnableEntity` RE2 is activated by `TimingEvent` 100ms T2.

`RunnableEntity` RE3 is activated by `TimingEvent` 100ms T3.

Execution order of the `RunnableEntity`s shall be R1, R2 then R3.
RE2 shall be monitored.

Possible RTE configuration:

RE1/T1 is mapped to `OsTask` TaskA with `RtePositionInTask` equal to 1.
RE2/T2 is mapped to `OsTask` TaskB but virtually mapped to TaskA with `RtePositionInTask` equal to 2.
RE3/T3 is mapped to `OsTask` TaskA with `RtePositionInTask` equal to 3.

Possible RTE implementation:

RTE starts cyclic `OsAlarm` with 100ms period.
This `OsAlarm` is configured to activate TaskA.
Non preemptive scheduling is configured for Task A.
TaskB priority = TaskA priority + 1

```

1 void TaskA(void)
2 {
3     RE1();
4     ActivateTask(TaskB);
5     Schedule();
6     RE3();
7     TerminateTask();
8 }
9
10 void TaskB(void)
11 {
12     RE2();
13     TerminateTask();
14 }
```

Example 2: With `OsEvent`

Description of the example:

`RunnableEntity` RE1 is activated by `DataReceivedEvent` DR1.
`RunnableEntity` RE2 is activated by `DataReceivedEvent` DR2.
`RunnableEntity` RE3 is activated by `DataReceivedEvent` DR3.
Evaluation order of the `RTEEvents` shall be DR1, DR2 then DR3.
All the runnables shall be monitored.

Possible RTE configuration:

RE1 is mapped to `OsTask` TaskB but virtually mapped to TaskA with a reference to `OsEvent` EvtA and `RtePositionInTask` equal to 1.
RE2 is mapped to `OsTask` TaskC but virtually mapped to TaskA with a reference to `OsEvent` EvtB and `RtePositionInTask` equal to 2.
RE3 is mapped to `OsTask` TaskD but virtually mapped to TaskA with a reference to `OsEvent` EvtC and `RtePositionInTask` equal to 3.

Possible RTE implementation:

RTE set EvtA, EvtB and EvtC according to the callbacks from COM.
Full preemptive scheduling is configured for Task A.
TaskB priority = TaskC priority = TaskD priority = TaskA priority + 1

```

1 void TaskA(void)
```

```

2  {
3      EventMaskType Event;
4
5      while(1)
6      {
7          WaitEvent(EvtA | EvtB | EvtC);
8          GetEvent(TaskA, &Event);
9          if (Event & EvtA)
10         {
11             ClearEvent(EvtA);
12             ActivateTask(TaskB);
13         }
14         else if (Event & EvtB)
15         {
16             ClearEvent(EvtB);
17             ActivateTask(TaskC);
18         }
19         else if (Event & EvtC)
20         {
21             ClearEvent(EvtC);
22             ActivateTask(TaskD);
23         }
24     }
25 }
26
27 void TaskB(void)
28 {
29     RE1();
30     TerminateTask();
31 }
32
33 void TaskC(void)
34 {
35     RE2();
36     TerminateTask();
37 }
38
39 void TaskD(void)
40 {
41     RE3();
42     TerminateTask();
43 }

```

It is also possible to configure the RTE for the monitoring of group of runnable = monitoring of the sum of the runnable execution times.

Example 3: Monitoring of group of runnables

Description of the example:

[RunnableEntity](#) RE1 is activated by [TimingEvent](#) 100ms T1.

[RunnableEntity](#) RE2 is activated by [TimingEvent](#) 100ms T2.

[RunnableEntity](#) RE3 is activated by [TimingEvent](#) 100ms T3.

[RunnableEntity](#) RE4 is activated by [DataReceivedEvent](#) DR1.

[RunnableEntity](#) RE5 is activated by [DataReceivedEvent](#) DR2.

RunnableEntity RE6 is activated by DataReceivedEvent DR3.
RunnableEntity RE7 is activated by DataReceivedEvent DR4.
DataReceivedEvent DR2, DR3 and DR4 references the same dataElement. Evaluation order of the RTEEvents shall be T1, T2, T3, DR1, DR2, DR3 then DR4.
RE2 and RE3 shall be monitored as a group.
RE6 and RE7 shall be monitored as a group.

Possible RTE configuration:

RE1 is mapped to OsTask TaskA with a reference to OsEvent EvtA and RtePositionInTask equal to 1.

RE2 is mapped to OsTask TaskB but virtually mapped to TaskA with a reference to OsEvent EvtA and RtePositionInTask equal to 2.

RE3 is mapped to OsTask TaskB but virtually mapped to TaskA with a reference to OsEvent EvtA and RtePositionInTask equal to 3.

RE4 is mapped to OsTask TaskA with a reference to OsEvent EvtB and RtePositionInTask equal to 4.

RE5 is mapped to OsTask TaskA with a reference to OsEvent EvtC and RtePositionInTask equal to 5.

RE6 is mapped to OsTask TaskC but virtually mapped to TaskA with a reference to OsEvent EvtC and RtePositionInTask equal to 6.

RE7 is mapped to OsTask TaskC but virtually mapped to TaskA with a reference to OsEvent EvtC and RtePositionInTask equal to 7.

Possible RTE implementation:

RTE starts cyclic OsAlarm with 100ms period.

This OsAlarm is configured to set EvtA.

RTE set EvtB and EvtC according to the callbacks from COM.

Full preemptive scheduling is configured for Task A.

TaskB priority = TaskC priority = TaskA priority + 1

```
1 void TaskA(void)
2 {
3     EventMaskType Event;
4
5     while(1)
6     {
7         WaitEvent(EvtA | EvtB | EvtC);
8         GetEvent(TaskA, &Event);
9         if (Event & EvtA)
10        {
11            ClearEvent(EvtA);
12            RE1();
13            ActivateTask(TaskB);
14        }
15        else if (Event & EvtB)
16        {
17            ClearEvent(EvtB);
18            RE4();
19        }
20        else if (Event & EvtC)
21        {
22            ClearEvent(EvtC);
```

```

23         RE5();
24         ActivateTask(TaskC);
25     }
26 }
27 }
28
29 void TaskB(void)
30 {
31     RE2();
32     RE3();
33     TerminateTask();
34 }
35
36 void TaskC(void)
37 {
38     RE6();
39     RE7():
40     TerminateTask();
41 }

```

4.2.2.8 TimingEvent activated runnables

A [TimingEvent](#) / [BswTimingEvent](#) is a recurring [RTEEvent](#) / [BswEvent](#) which is used to perform recurrent activities in [RunnableEntitys](#) or [BswSchedulableEntitys](#).

[SWS_Rte_06728] [The RTE shall activate [RunnableEntitys](#) triggered by a [TimingEvent](#) recurring with the effective period time of an [TimingEvent](#) for the component instance.]([SRS_Rte_00237](#))

[SWS_Rte_06729] [The RTE Generator shall determine the effective period time of a [TimingEvent](#) from the [period](#) attribute of the [TimingEvent](#) if no [InstantiationRTEEventProps](#) are defined for the [TimingEvent](#) of the component instance.]([SRS_Rte_00237](#))

[SWS_Rte_06730] [The RTE Generator shall determine the effective period time of a [TimingEvent](#) from the [period](#) attribute of the [InstantiationRTEEventProps](#) if [InstantiationRTEEventProps](#) are defined for the [TimingEvent](#) of the component instance.]([SRS_Rte_00237](#))

Please note the component instance is defined by [RteSoftwareComponentInstanceRef](#) of [RteSwComponentInstance](#) referring to the [SwComponentPrototype](#). See figure 8.2.

[SWS_Rte_CONSTR_09121] [The RTE Generator shall reject configurations where an [ExternalTriggerOccurredEvent](#) or [BswExternalTriggerOccurredEvent](#) is mapped to an [ISR2](#) and no [BswTriggerDirectImplementation](#) exists in the connected [trigger source](#)]([SRS_Rte_00237](#))

[SWS_Rte_04563] [The RTE shall activate an `ExecutableEntity` if its `TimingEvent` or `BswTimingEvent` is mapped to an ISR2 (via an `RteEventToIsrMapping`).] (*SRS_Rte_00237*)

[SWS_Rte_CONSTR_09122] [The RTE Generator shall reject configurations where a `TimingEvent` or `BswTimingEvent` is mapped to an ISR2 and either no `OsIsrPeriod` exists for the `OsIsr` referenced in the event mapping or the period value is not an integer multiple of the `OsIsrPeriod` value.] ()

[SWS_Rte_CONSTR_09123] [The RTE Generator shall reject configurations where a `TimingEvent` or `BswTimingEvent` is mapped to an `OsTask` and the `OsTaskPeriod` exists for this `OsTask` and the period value is not an integer multiple of the `OsTaskPeriod` value.] ()

[SWS_Rte_CONSTR_09124] [The RTE Generator shall reject configurations where a `TimingEvent` or `BswTimingEvent` is mapped to an `OsTask` and no `OsTaskPeriod` exists for this `OsTask` and when the `strictConfigurationCheck` is set to true.] ()

4.2.2.9 Synchronization of `TimingEvent` activated runnables

This section describes how the synchronization of `TimingEvent` activated `RunnableEntities` can be done.

The following cases have to be distinguished:

- the `RunnableEntities` are mapped to the same `OsTask`
- the `RunnableEntities` are mapped to different `OsTasks` in the same `OsApplication`
- the `RunnableEntities` are mapped to different `OsTasks` in different `OsApplications` on the same core
- the `RunnableEntities` are mapped to different `OsTasks` in different `OsApplications` on different cores on the same microcontroller
- the `RunnableEntities` are mapped to different `OsTasks` in different `OsApplications` on different microcontrollers within the same ECU
- the `RunnableEntities` are mapped to different `OsTasks` in different `OsApplications` on different microcontrollers within different ECUs

As `OsAlarms` and `OsScheduleTableExpiryPoints` are used to implement `TimingEvents` the following different possible solutions exist to synchronize the `RunnableEntities` according to the different cases:

- use the same `OsAlarm` or `OsScheduleTableExpiryPoint` to implement all the `TimingEvents`

- use different `OsAlarms` or `OsScheduleTableExpiryPoints` in different `OsScheduleTables` based on the same `OsCounter` and start them with absolute start offset to control the synchronization between them
- use different `OsScheduleTableExpiryPoints` in different explicitly synchronized `OsScheduleTables` based on different `OsCounters` but with same period and max value

The choice of the `OsAlarms` or `OsScheduleTableExpiryPoints` used to implement the `TimingEvents` can be configured in the RTE with `RteUsedOsAlarmRef` or `RteUsedOsSchTblExpiryPointRef` in the `RteEventToTaskMapping`.

[SWS_Rte_07804] [The RTE Generator shall respect the configured `OsAlarms` (`RteUsedOsAlarmRef`) and `OsScheduleTableExpiryPoints` (`RteUsedOsSchTblExpiryPointRef`) for the implementation of the `TimingEvents`.] ([SRS_Rte_00232](#))

The choice of the absolute start offset of the `OsAlarms` and `OsScheduleTables` can be configured in the RTE with `RteExpectedActivationOffset` in the `RteUsedOsActivation`.

[SWS_Rte_07805] [The RTE Generator shall respect the configured absolute start offset (`RteExpectedActivationOffset`) when it starts the `OsAlarms` and `OsScheduleTables` used for the implementation of the `TimingEvents`.] ([SRS_Rte_00232](#))

The RTE / *Basic Software Scheduler* is not responsible to synchronize/desynchronize the explicitly synchronized `OsScheduleTables`. The RTE / *Basic Software Scheduler* is only responsible to start the explicitly synchronized `OsScheduleTables`. In this case no `RteExpectedActivationOffset` has to be configured.

4.2.2.10 BackgroundEvent activated Runnable Entities and BasicSoftware Schedulable Entities

A `BackgroundEvent` is a recurring `RTEEvent` / `BswEvent` which is used to perform background activities in `RunnableEntitys` or `BswSchedulableEntitys`. It is similar to a `TimingEvent` but has no fixed time period and is typically activated only with lowest priority.

A `BackgroundEvent` triggering can be implemented in two principle ways by the RTE Generator. Either the background activation is done by a real background OS task; or the `BackgroundEvents` are activated like `TimingEvents` on a fixed recurrence which is defined by the ECU integrator (see [\[SWS_Rte_07179\]](#) and [\[SWS_Rte_07180\]](#)). The second way might be required to overcome the limitation of a single real background OS task if `BackgroundEvents` are used in several partitions.

If the background activation is done by a real background OS task, the OS Task has to have the lowest priority on the CPU core (see [\[SWS_Rte_07181\]](#)). If a implementation is used where the OS Task terminates (*BasicTask*) the background OS Task is

immediately reactivated after its termination, e.g. by usage of `ChainTask` call of the OS.

4.2.2.11 InitEvent activated Runnable Entities

An `InitEvent` which is used to activate `RunnableEntity`s for initialization purpose in case of start of the RTE or restart of a partition.

[SWS_Rte_06761] [The RTE shall activate `RunnableEntity`s triggered by an `InitEvent` once when `Rte_Start` is executed.](*SRS_Rte_00240*)

[SWS_Rte_06762] [The RTE shall activate `RunnableEntity`s triggered by an `InitEvent` once when `Rte_RestartPartition` is executed for those `RunnableEntity`s belonging to the restarted partition.](*SRS_Rte_00240*)

The activation of `RunnableEntity`s for initialization purpose can basically implemented in two ways. Either the `InitEvent` is mapped to an `OsTask` or the `InitEvent` is mapped to an `RteInitializationRunnableBatch`.

In case of an `OsTask` the `RunnableEntity`s are scheduled once when the related task gets active. In this case the `RtePositionInTask` decides in which order the `RunnableEntity`s are scheduled in the whole task. For instance if the `InitEvent` is mapped after an `TimingEvent` and the `TimingEvent` is already triggered when the `OsTask` gets active the initialization runnable is called after time periodic runnable. Therefore its in the responsibility of the ECU integrator to ensure the correct and intended order.

In the case the `InitEvent` is mapped to an `RteInitializationRunnableBatch` the `RunnableEntity`s are scheduled when the related `Rte_Init` function is called. In this case the `RtePositionInTask` decides in which order the `RunnableEntity`s are scheduled in the same `Rte_Init` function.

The triggering of the recurrent `RTEEvents` is released with the call of `Rte_Start-Timing`.

4.2.2.12 OsTaskExecutionEvent activated Runnable Entities

An `OsTaskExecutionEvent/BswOsTaskExecutionEvent` is an `RTEEvent/Bsw-Event` which gets activated due to the activation of an OS Task. The `ExecutableEntity` triggered by an `OsTaskExecutionEvent/BswOsTaskExecutionEvent` gets activated whenever the OS Task on which the `OsTaskExecutionEvent` is mapped is running and reaches the position of the `ExecutableEntity`. In opposite the VFB tracing (e.g. `Rte_Task_Dispatch`) a `RunnableEntity` triggered by `OsTaskExecutionEvent` has access to AUTOSAR interfaces. In addition, the `RtePositionInTask` and `RteBswPositionInTask` allows an arbitrary position between `ExecutableEntity`s mapped by other `RTEEvents/BswEvents`.

For instance:

1. 'RunA', triggered by `SwcModeSwitchEvent`, `RtePositionInTask` = 10
2. 'RunB', triggered by `OsTaskExecutionEvent`, `RtePositionInTask` = 15
3. 'RunC', triggered by `SwcModeSwitchEvent`, `RtePositionInTask` = 20
4. 'RunD', triggered by `SwcModeSwitchEvent`, `RtePositionInTask` = 25
5. 'RunE', triggered by `OsTaskExecutionEvent`, `RtePositionInTask` = 30

In addition, the `OsTaskExecutionEvent` can be combined with `mode disabling dependency`s like other `RTEEvents`

[SWS_Rte_82006]{DRAFT} [The RTE shall activate `RunnableEntity`s triggered by an `OsTaskExecutionEvent` when the OS Task - on which the `OsTaskExecutionEvent` is mapped - is running and reaches the position of this `RunnableEntity`.]
()

[SWS_Rte_82007]{DRAFT} [The RTE shall activate `BswSchedulableEntity`s triggered by an `BswOsTaskExecutionEvent` when the OS Task - on which the `BswOsTaskExecutionEvent` is mapped - is running and reaches the position of this `BswSchedulableEntity`.]
()

4.2.3 Activation and Start of ExecutableEntitys

This section defines the activation of ExecutableEntity execution-instances by using a state machine (Fig. 4.18).

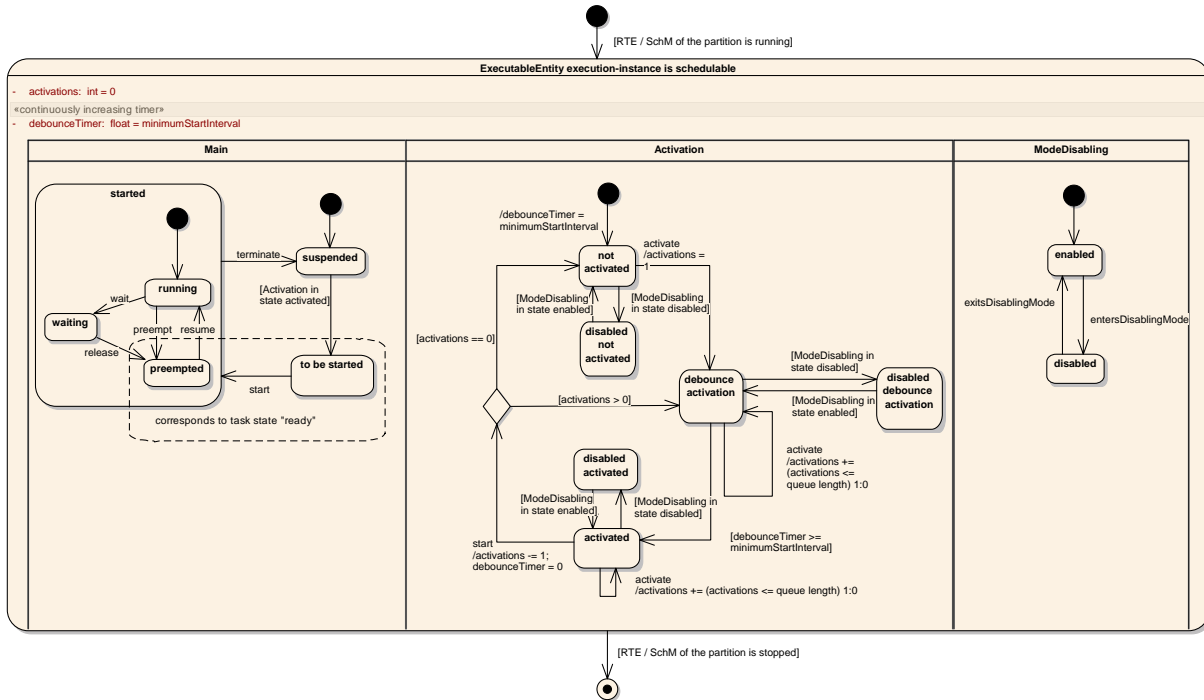


Figure 4.18: General state machine of an ExecutableEntity execution-instance.

An ExecutableEntity execution-instance is one execution-instance of an ExecutableEntity (RunnableEntity or BswSchedulableEntity) with respect to concurrent execution.

For a RunnableEntity with canBeInvokedConcurrently = false or for a BswSchedulableEntity whose referenced BswModuleEntry in the role implementedEntry has a isReentrant attribute set to false, there is only one execution-instance. For a RunnableEntity with canBeInvokedConcurrently = true or for a BswSchedulableEntity whose referenced BswModuleEntry in the role implementedEntry has its isReentrant attribute set to true, there is a well defined number of execution-instances.

E.g., for a server runnable that is executed as direct function call, each Server-CallPoint relates to exactly one ExecutableEntity execution-instance.

The main principles for the activation of runnables are:

- RunnableEntitys are activated by RTEEvents
- BswSchedulableEntitys are activated by BswEvents
- only server runnables (RunnableEntitys activated by an OperationInvokedEvent) are queued. All other ExecutableEntitys are unqueued.

If a `RunnableEntity` is activated due to several `DataReceivedEvents` of `dataElements` with `swImplPolicy = queued`, it is the responsibility of the `RunnableEntity` to dequeue all queued data.

- A `minimumStartInterval` will delay the activation of `RunnableEntity`s and `BswSchedulableEntity`s to prevent that a `RunnableEntity` or a `BswSchedulableEntity` is started more than once within the `minimumStartInterval`.

Each `ExecutableEntity execution-instance` has its own state machine. The full state machine is shown in Fig. 4.18.

Note on Figure 4.18: the debounce timer `debounceTimer` is an increasing timer. It is local to the `ExecutableEntity execution-instance`. The activation counter `activations` is a local integer to count the pending activations. The runnable debounce timer and the activation counter are like the whole state machine just concepts for the specification of the behavior, not for the implementation.

The pending activations are only counted for [server runnables](#) when RTE implements a call serialization of their invocation. In all other cases, RTE does not queue activations and the state machine for the activation of [ExecutableEntity execution-instances](#) simplifies as shown in Figure 4.19.

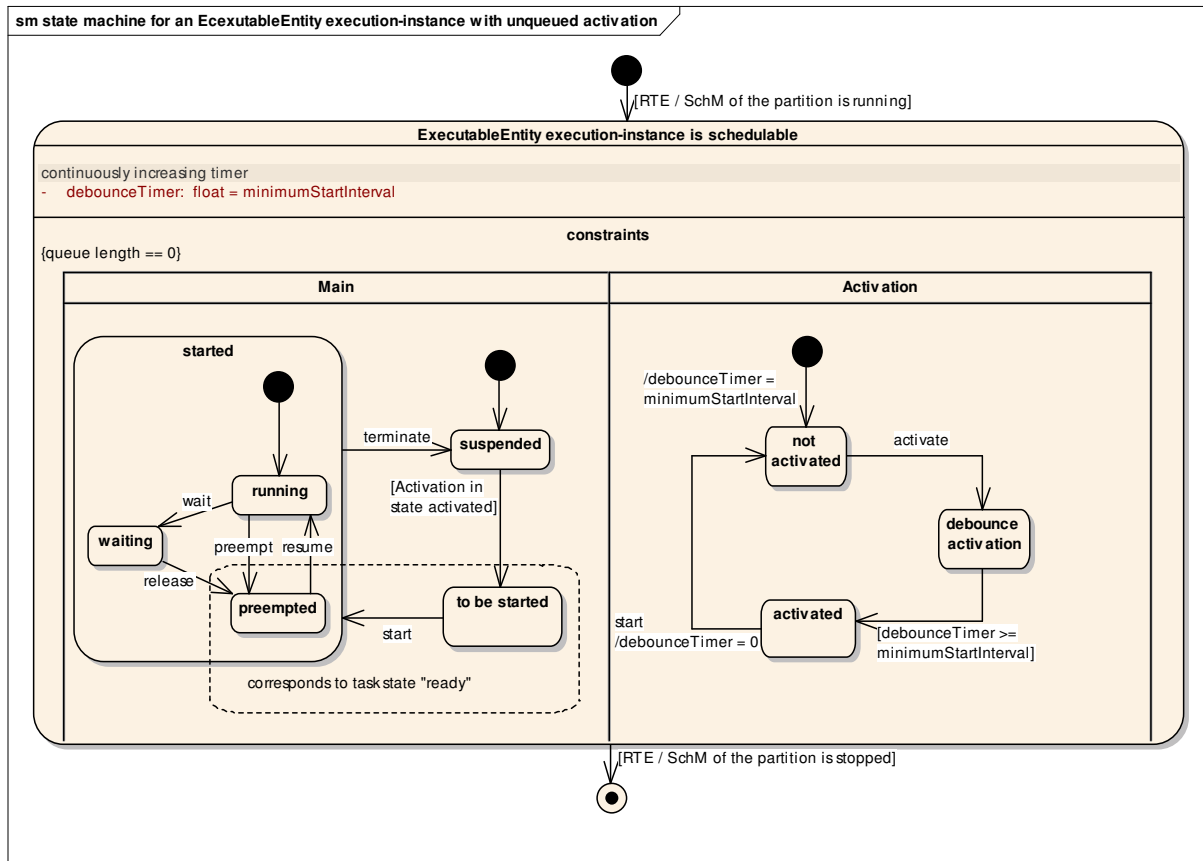


Figure 4.19: Statemachine of an unqueued execution-instance (not a server runnable)

If RTE implements an [ExecutableEntity execution-instance](#) by direct or trusted function call, as described in section 4.2.3.1, the simplified state machine is shown in Figure 4.22.

The state machine of an [ExecutableEntity execution-instance](#) is not identical to that of the task containing the [ExecutableEntity execution-instance](#), but there are dependencies between them. E.g., the [ExecutableEntity execution-instance](#) can only be 'running' when the corresponding task is 'running'.

Table 4.3 describes all [ExecutableEntity execution-instance](#) states in detail. The [ExecutableEntity execution-instance](#) state machine is split in two threads. The Main states describe the real state of the [ExecutableEntity execution-instance](#) and the transitions between a suspended and a running [ExecutableEntity execution-instance](#), while the supporting Activation states describe the state of the pending activations by [RTEEvents](#) or [BswEvents](#).

ExecutableEntity execution-instance state	description
ExecutableEntity execution-instance is schedulable	This super state describes the life time of the state machine. Only when RTE or the SchM that runs the ExecutableEntity execution-instance is started in the corresponding partition, this state machine is active.
ExecutableEntity execution-instance Main states	
suspended	The ExecutableEntity execution-instance is not started and there is no pending request to start the ExecutableEntity execution-instance.
to be started	The ExecutableEntity execution-instance is activated but not yet started. Entering the to be started state, usually implies the activation of a task/ISR2 that starts the ExecutableEntity execution-instance. The ExecutableEntity execution-instance stays in the 'to be started' state, when the task/ISR2 is already running until the gluecode of the task/ISR2 actually calls the function implementing the ExecutableEntity.
running	The function, implementing the ExecutableEntity code is being executed. The task/ISR2 that contains the ExecutableEntity execution-instance is running.
waiting	A task containing the ExecutableEntity execution-instance is waiting at a WaitPoint within the ExecutableEntity.
preempted	A task/ISR2 containing the ExecutableEntity execution-instance is preempted from executing the function that implements the ExecutableEntity.
started	'started' is the super state of 'running', 'waiting' and 'preempted' between start and termination of the ExecutableEntity execution-instance.
ExecutableEntity execution-instance Activation states	
not activated	No RTEEvent / BswEvent requires the activation of the ExecutableEntity execution-instance.
debounce activation	One or more RTEEvents with a startOnEvent relation to the ExecutableEntity execution-instance have occurred ² , but the debounce timer has not yet exceeded the minimumStartInterval. The activation will automatically advance to activated, when the debounce timer reaches the minimumStartInterval.
activated	One or more RTEEvents or BswEvents with a startOnEvent relation to the ExecutableEntity have occurred, and the debounce timer has exceeded the minimumStartInterval. While the activated state is active, the Main state of the ExecutableEntity execution-instance automatically advances from the suspended to the 'to be started' state. For a server runnable where RTE implements a serialization of server calls, an activation counter counts the number of activations. When the ExecutableEntity execution-instance starts, the activation counter will be decremented. When there is still a pending activation, the Activation state will turn to debounce activation and otherwise to no activation.

²Note that, e.g., the same OperationInvokedEvent may lead to the activation of different ExecutableEntity execution-instances, depending on the client that caused the event.

Table 4.3: States defined for each `ExecutableEntity` execution-instance.

Note: For tasks, the equivalent state machine does not distinguish between preempted and to be started. They are subsumed as ‘ready’.

<code>ExecutableEntity</code> execution-instance transition	description of event and actions
initial transition to ‘ExecutableEntity execution-instance is schedulable’	RTE or the SchM that runs the <code>ExecutableEntity</code> execution-instance is being started in the corresponding partition.
termination transition from ‘ExecutableEntity execution-instance is schedulable’	RTE or the SchM that runs the <code>ExecutableEntity</code> execution-instance gets stopped in the corresponding partition.
transitions to <code>ExecutableEntity</code> execution-instance Main states	
initial transition to suspended	the suspended state is the initial state of the <code>ExecutableEntity</code> execution-instance Main states.
from started to suspended	The <code>ExecutableEntity</code> execution-instance has run to completion.
from suspended to ‘to be started’	This transition is automatically executed, while the Activation state is ‘activated’.
from ‘to be started’ to running	The function implementing the <code>ExecutableEntity</code> is called from the context of this execution-instance.
from preempted to running	A task that is preempted from executing the <code>ExecutableEntity</code> execution-instance changes state from preempted to running.
from running to waiting	The runnable enters a <code>WaitPoint</code> .
from waiting to preempted	The task that contains a runnable waiting at a wait point changes from waiting to preempted.
from running to preempted	A task containing the <code>ExecutableEntity</code> execution-instance gets preempted from executing the function that implements the <code>ExecutableEntity</code> .
transitions to <code>ExecutableEntity</code> execution-instance Activation states	
initial transition to ‘not activated’	The ‘not activated’ state is the initial state of the <code>ExecutableEntity</code> execution-instance Activation states. The debounce timer is set to the <code>minimumStartInterval</code> value, to prevent a delay for the first activation of the <code>ExecutableEntity</code> execution-instance.
from activated to ‘not activated’	The function implementing the <code>ExecutableEntity</code> is called from the context of this execution-instance and no further activations are pending. The debounce timer is reset to 0.
from ‘not activated’ to ‘debounce activation’	The occurrence of an <code>RTEEvent</code> or <code>BswEvent</code> requires the activation of the <code>ExecutableEntity</code> execution-instance. A local activation counter is set to 1. If no <code>minimumStartInterval</code> is configured, or the debounce timer has already exceeded the <code>minimumStartInterval</code> , the ‘debounce activation’ state will be omitted and the transition leads directly to the activated state.

from activated to 'debounce activation'	The function implementing the <code>ExecutableEntity</code> is called from the context of this execution-instance (start), and another activation is pending (only for <code>server runnable</code>). The activation counter is decremented and the debounce timer reset to 0. If no <code>minimumStartInterval</code> is configured, the 'debounce activation' state will be omitted and the transition returns directly at the activated state.
from 'debounce activation' to 'debounce activation'	If RTE implements server call serialization for a <code>server runnable</code> , and an <code>OperationInvokedEvent</code> occurs for the server runnable. The activation counter is incremented (at most to the queue length).
from 'debounce activation' to activated	The debounce timer is expired, <code>debounce timer > minimumStartInterval</code> .
from activated to activated	If RTE implements server call serialization for a <code>server runnable</code> , and an <code>OperationInvokedEvent</code> occurs for the server runnable. The activation counter is incremented (at most to the queue length).

Table 4.4: States defined for each `ExecutableEntity` execution-instance.

[SWS_Rte_02697] [The activation of `ExecutableEntity` execution-instances shall behave as described by the state machine in Fig. 4.18, Table 4.3, and Table 4.4.] (*SRS_Rte_00072, SRS_Rte_00160, SRS_Rte_00133, SRS_Rte_00211, SRS_Rte_00214, SRS_Rte_00217, SRS_Rte_00219*)

The RTE will not activate, start or release `ExecutableEntity` execution-instances of a terminated or restarting partition (see [SWS_Rte_07604]), or when RTE is stopped in that partition (see [SWS_Rte_02538]).

The following examples in Fig. 4.20 and Fig. 4.21 show the different timing situations of the `ExecutableEntity` execution-instances with or without a `minimumStartInterval`. The `minimumStartInterval` can reduce the number of activations by collecting more activating `RTEEvents` / `BswEvents` within that interval. No activation will be lost. The activations are just delayed and combined to keep the `minimumStartInterval`. The started state of the `ExecutableEntity` execution-instance Main states and the activated state of the Activation states are shown in the figures. Each flash indicates the occurrence of an `RTEEvent` or `BswEvent`.

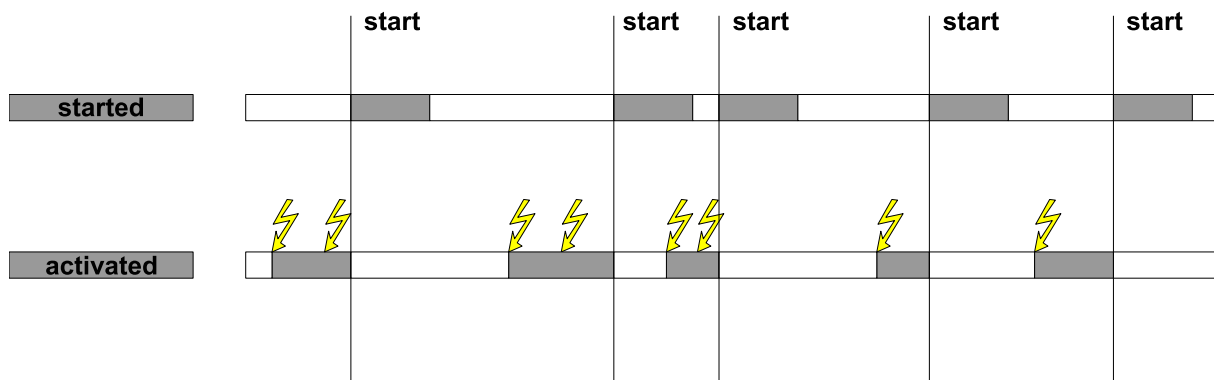


Figure 4.20: Activation of an `ExecutableEntity` execution-instance without `minimum-StartInterval`

Figure 4.20 illustrates the activation of an `ExecutableEntity` execution-instance without `minimumStartInterval`. The execution-instance can only be activated once (does not apply for `server runnables`). The activation is not queued. The execution-instance can already be activated again when it is still started (see Figure 4.18).

With configuration of the `RteEventToTaskMapping` such activation can even be used for an immediately restart of the `ExecutableEntity` before other `ExecutableEntity`s which are mapped subsequently in the task are getting started.

[SWS_Rte_07061] [When the parameter `RteImmediateRestart` / `RteBswImmediateRestart` is `TRUE` the RTE shall immediately restart the `ExecutableEntity` after termination if the `ExecutableEntity` was activated by this `RTEEvent` / `BswEvent` while it was already started.]([SRS_Rte_00072](#))

This can be utilized to spread a long-lasting calculation in several smaller slices with the aim to reduce the maximum blocking time of Tasks in a Cooperative Environment. Typically between each iteration one Schedule Point has to be placed and the number of iteration might depend on operating conditions of the ECU. Further on in a calculation chain the long-lasting calculation shall be completed before consecutive `ExecutableEntity`s are called.

Example 4.4

Example of `RunnableEntity` code:

```

1 LongLastingRunnable()
2 {
3     /* the very long calculation */
4     if(!finished)
5     {
6         /* further call is required to complete the calculation*/
7         Rte_IrTrigger_LongLastingCalculation_ProceedCalculation();
8     }
9 }
```

Therefore the `ExecutableEntity` with a long lasting calculation issues a trigger as long as the calculation is not finished. These trigger activates the `ExecutableEntity` again. The first activation of the `ExecutableEntity` might be triggered by another `RTEEvent` / `BswEvent`.

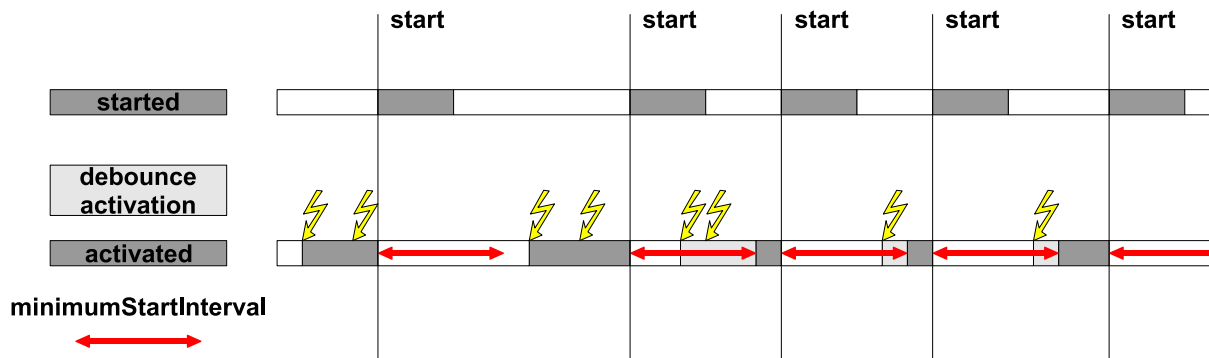


Figure 4.21: Activation of an `ExecutableEntity` with a `minimumStartInterval`

Figure 4.21 illustrates the activation of an `ExecutableEntity` with a `minimumStartInterval`. (Here no `execution-instances` have to be distinguished, there is only one.) The red arrows in this figure indicate the `minimumStartInterval` after each start of the `ExecutableEntity`. An `RTEEvent` or `BswEvent` within this `minimumStartInterval` leads to the debounce activation state. When the `minimumStartInterval` ends, the debounce activation state changes to the activated state.

When a data received event activates a runnable when it is still running, it might be that the data is already dequeued during the current execution of the runnable. Still, the runnable will be started again. So, it is possible that a runnable that is activated by a data received event finds an empty receive queue.

4.2.3.1 Activation by direct function call

In many cases, `ExecutableEntity execution-instances` can be implemented by RTE by a direct or trusted function call if allowed by the `canBeInvokedConcurrently`. In these cases, the activation and start of the `ExecutableEntity execution-instance` collapse to one event. The states 'to be started', 'debounce activation', and 'activated' are passed immediately.

Obviously, debounce activation is not possible (see meta model restriction [SWS_Rte_02733]).

There is one `ExecutableEntity execution-instance` per call point, trigger point, mode switch point, etc.. The state chart simplifies as shown in Figure 4.22.

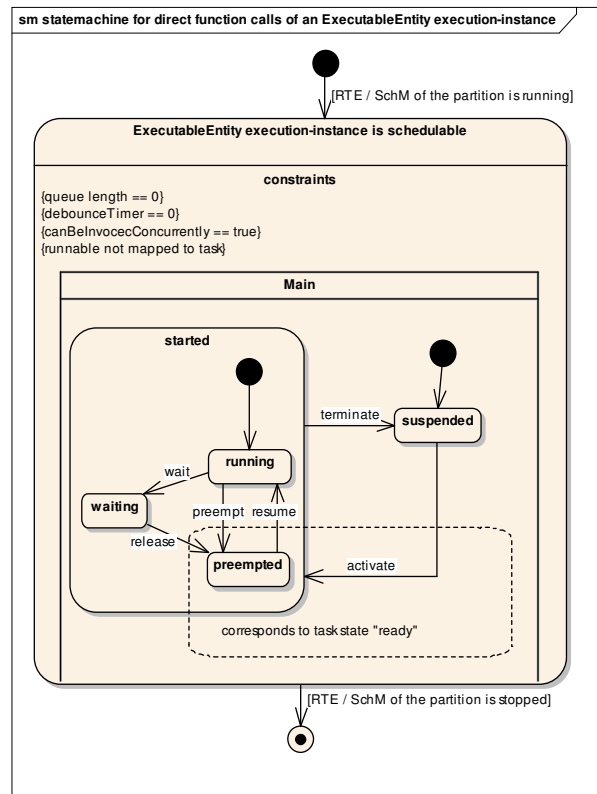


Figure 4.22: State machine of an **ExecutableEntity execution-instance that is implemented by direct or trusted function calls.**

A **triggered ExecutableEntity** is activated at least by one **ExternalTriggerOccurredEvent** or **InternalTriggerOccurredEvent**. In some cases, the *Trigger Event Communication* or the *Inter Runnable Triggering* is implemented by RTE generator as a direct or trusted function call of the **triggered ExecutableEntity** by the triggering **ExecutableEntity**.

An **on-entry ExecutableEntity**, **on-transition ExecutableEntity**, **on-exit ExecutableEntity** or a **ModeSwitchAck ExecutableEntity** might be executed in the context of the **Rte_Switch** API if an asynchronous mode switch procedure is implemented.

A **server runnable** is exclusively activated by **OperationInvokedEvents** and implements the server in client server communication. In some cases, the client server communication is implemented by RTE as a direct or trusted function call of the server by the client.

4.2.3.2 Activation Offset for [RunnableEntity](#)s and [BswSchedulableEntity](#)s

In order to allow optimizations (smooth cpu load, mapping of [RunnableEntity](#)s and [BswSchedulableEntity](#)s with different periods in the same task to avoid data sharing, etc.), the RTE has to handle the activation offset information from a task shared reference point only for time trigger [RunnableEntity](#)s and [BswSchedulableEntity](#)s. The maximum period of a task can be calculated automatically as the greatest common divisor (GCD) of all runnables period and offset. It is assumed that the runnables worst case execution is less than the GCD. In case of the worst case execution is greater than the GCD, the behavior becomes undefined.

[SWS_Rte_07000] [The RTE shall respect the configured activation offset of [RunnableEntity](#)s mapped within one OS task.] ([SRS_Rte_00161](#))

[SWS_Rte_07520] [The *Basic Software Scheduler* shall respect the configured activation offset of [BswSchedulableEntity](#)s mapped within one OS task.] ([SRS_Rte_00212](#))

[SWS_Rte_CONSTR_09010] Worst case execution time shall be less than the GCD [The [RunnableEntity](#)s or [BswSchedulableEntity](#)s worst case execution time shall be less than the GCD of all [BswSchedulableEntity](#)s and [RunnableEntity](#)s period and offset in activation offset context for [RunnableEntity](#)s and [BswSchedulableEntity](#)s.]()

Note: The following examples are showing [RunnableEntity](#)s only. Nevertheless it is applicable for [BswSchedulableEntity](#)s or a mixture of [RunnableEntity](#)s and [BswSchedulableEntity](#)s as well.

Example 1:

This example describes 3 runnables mapped in one task with an activation offset defined for each runnables.

Runnable	Period	Activation Offset
R1	100ms	20ms
R2	100ms	60ms
R3	100ms	100ms

Table 4.5: Runnables timings

The runnables R1, R2 and R3 are mapped in the task T1 at 20 ms which is the GCD of all runnables period and activation offset.

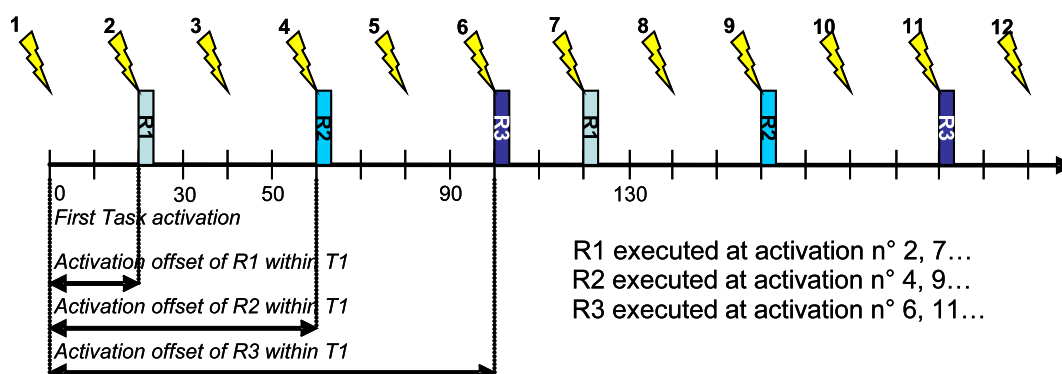


Figure 4.23: Example of activation offset for runnables

Example 2:

This example describes 4 runnables mapped in one task with an activation offset and position in task defined for each runnables.

Runnable	Period	Position in task	Activation Offset
R1	50ms	1	0ms
R2	100ms	2	0ms
R3	100ms	3	70ms
R4	50ms	4	20ms

Table 4.6: Runnables timings with position in task

The runnables R1, R2, R3 and R4 are mapped in the task T1 at 10 ms which is the GCD of all runnables period and activation offset.

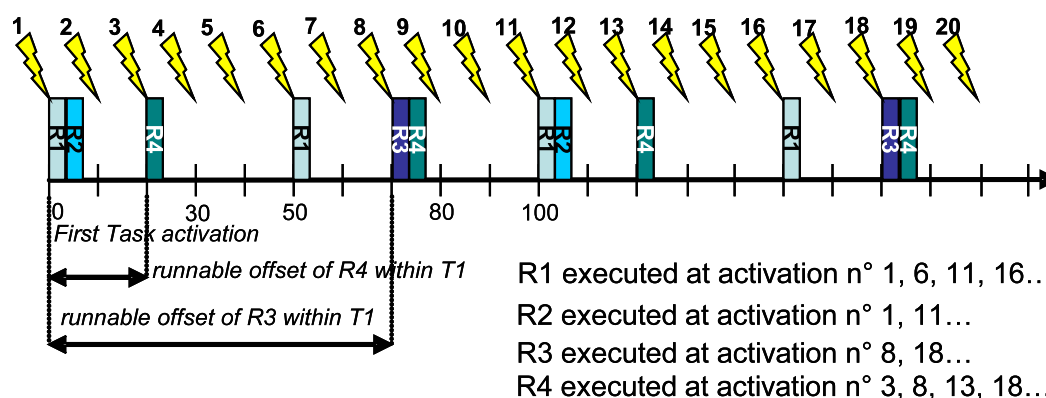


Figure 4.24: Example of activation offset for runnables with position in task

4.2.3.3 Provide activating RTE event

It is possible to define the activation of one runnable entity by several RTE events. But when the runnable entity is invoked by the RTE it shall be possible to query which of the RTE events actually triggered the execution of this runnable entity run.

Contract Phase:

The provide activating event feature is enabled if the runnable entity has at least one `activationReason` defined.

[SWS_Rte_08051] [If the provide activating event feature is enabled, the RTE generator in contract phase shall generate the runnable entity signature according to [\[SWS_Rte_01126\]](#) and [\[SWS_Rte_08071\]](#).] ([SRS_Rte_00238](#))

[SWS_Rte_08052] [If the provide activating event feature is enabled, the RTE generator in contract phase shall generate the type `Rte_ActivatingEvent_<name>` (activation vector), where `<name>` is the `symbol` describing the runnable entity's entry point, to store the activation bits. Based on the highest value of `ExecutableEntityActivationReason.bitPosition` for this runnable entity the type shall be either `uint8`, `uint16`, or `uint32` so that the highest value of `bitPosition` fits into the data type.] ([SRS_Rte_00238](#))

Note that it is considered an invalid configuration if `ExecutableEntityActivationReason.bitPosition` has a value higher than 31 (see [\[constr_1226\]](#) in software component template [\[2\]](#))

[SWS_Rte_08053] [If the provide activating RTE event feature is enabled, the RTE generator in contract phase shall generate for each `ExecutableEntityActivationReason` of one executable entity a definition to provide the specific bit position in the `Rte_ActivatingEvent_<name>` data type:

```
#define Rte_ActivatingEvent_<name>_<activation> xxU
```

The value of `xx` is defined by the `bitPosition` $xx = 2^{\text{bitPosition}}$.] ([SRS_Rte_00238](#))

Example: runnable entity symbol = "greek" and has 3 `ExecutableEntityActivationReasons` aggregated. Those are referenced by 4 RTE events:

- RTEEvent: "alpha" symbol: aleph
- RTEEvent: "beta" symbol: beth
- RTEEvent: "gamma" symbol: gimel
- RTEEvent: "delta" symbol: gimel

This will result in a `uint8 Rte_ActivatingEvent_<name>` data type: typedef `uint8 Rte_ActivatingEvent_greek` and 3 definitions:

- `#define Rte_ActivatingEvent_greek_aleph 01U`
- `#define Rte_ActivatingEvent_greek_beth 02U`
- `#define Rte_ActivatingEvent_greek_gimel 04U`

Generation Phase:

[SWS_Rte_08054] [If the provide activating RTE event feature is enabled, the RTE shall collect the activating RTE events, which have the `activationReasonRepresentation` reference defined, in the context of the OS task the runnable entity is mapped to in an activation vector at the corresponding bit position as defined in [\[SWS_Rte_08053\]](#).] ([SRS_Rte_00238](#))

[SWS_Rte_08055] [If the provide activating RTE event feature is enabled, the RTE shall provide the collected activating RTE events (activation vector) to the runnable entity API when the runnable entity is "started". The activation vector shall be reset immediately after it has been provided.] ([SRS_Rte_00238](#))

Since it is possible that there is a time gap between the activation and the execution (start) of a runnable entity the subsequent activations are summed up and provided with the start of the runnable entity.

Activations during the execution of a runnable entity are collected for the next start of that runnable entity.

4.2.4 Cyclic execution of `ExecutableEntity`s

Between activation and start of an `ExecutableEntity` there is usually a direct causal relationship. Either the `ExecutableEntity` is executed by a direct function call in the activating RTE API or *Basic Software Scheduler* API (e.g. `SchM_Trigger` or `Rte_Switch`) or the activating RTE API or *Basic Software Scheduler* API activates a task which then executes the `ExecutableEntity`. A special case are `TimingEvents` and `BackgroundEvents` where the activation is not provided by an RTE API or *Basic Software Scheduler* API but by the OS.

There are cases where this direct causal relationship of activation and execution is not desired. Reasons can be a better control over the dynamic behavior of the system (e.g. execution of `ExecutableEntity`s at well defined points) or just reduction of resource consumption (e.g. due to reduced number of task activations in burst situations). To achieve this the causal relationship will be relaxed by separating the activation of the `ExecutableEntity` and its execution completely. That is, the activation of an `ExecutableEntity` only delivers the information that it has to be executed while the execution context (i.e. the `OsTask`) is triggered elsewhere in the desired moment.

This section concentrates on a cyclic execution of `ExecutableEntity`s. Triggering the execution context is therefore done outside the RTE or *Basic Software Scheduler* via the OS. The `OsTask` representing the execution context of the `ExecutableEntity` will in this case have a configured `OsTaskPeriod`.

[SWS_Rte_04569] [The RTE shall execute `RunnableEntity`s referenced by an `RTEEvent` being mapped to an `OsTask` with configured `OsTaskPeriod` when the task is executed (See [\[SWS_Rte_04571\]](#)) and the `RunnableEntity` was activated by the `RTEEvent`.] ([SRS_Rte_00237](#))

[SWS_Rte_04570] [The *Basic Software Scheduler* shall execute [BswModuleEntity](#)s referenced by a [BswEvent](#) being mapped to an [OsTask](#) with configured [OsTaskPeriod](#) when the task is executed (See [\[SWS_Rte_04571\]](#)) and the [BswModuleEntity](#) was activated by the [BswEvent](#).] ([SRS_Rte_00237](#))

[SWS_Rte_04571] [The *Basic Software Scheduler* / RTE shall assume the execution of an [OsTask](#) with the recurrence defined in [OsTaskPeriod](#), if the [OsTask](#) has one. It shall not perform additional task activations for this [OsTask](#).] ([SRS_Rte_00237](#))

The following two examples will demonstrate the meaning of the requirements. The first one is very primitive and focuses on [TimingEvents](#). The second one shows the case of an [ExternalTriggerOccurredEvent](#).

Example 1:

A [TimingEvent](#) having period 0.02 (20ms) and starting [RunnableEntity](#) [RunnA](#) is mapped to [OsTask](#) [Task10ms](#) having [OsTaskPeriod](#) set to 0.01 (10ms). [\[SWS_Rte_04569\]](#) (and [\[SWS_Rte_04571\]](#)) applies and forces the RTE to implement a prescaler to scale down the 10ms of the [OsTask](#) to the 20ms requested by the [TimingEvent](#). The code (optimized for readability, not CPU resources) might then look as follows:

```

1  uint8 RunnA_Task10ms_prescaler = 0;
2
3  TASK(Task10ms)
4  {
5      if (RunnA_Task10ms_prescaler == 0)
6      {
7          RunnA();
8          RunnA_Task10ms_prescaler = 2;
9      }
10     RunnA_Task10ms_prescaler--;
11 }
```

Example 2:

An [ExternalTriggerOccurredEvent](#) starts [RunnableEntity](#) [RunnB](#) and is mapped to [OsTask](#) [Task10ms](#) having [OsTaskPeriod](#) set to 0.01 (10ms). Again [\[SWS_Rte_04569\]](#) but especially also [\[SWS_Rte_04571\]](#) apply. The code (without defensive code preventing e.g. activation queue overflow) might then look as follows:

```

1  uint8 RunnA_Task10ms_activation_count = 0;
2
3  Std_ReturnType Rte_Trigger_myTriggerComponent_myTriggerPort_myTrigger(
4      void)
5  {
6      RunnA_Task10ms_activation_count++;
7      /* SWS_Rte_04571 prevents the activation of Task10ms here */
8      return RTE_E_OK;
9  }
10 TASK(Task10ms)
11 {
```

```

12  /* the RTE is forced to examine if there was an activation of RunnA,
    as Task10ms is executed independently of a possible activation of
    RunnA */
13  if (RunnA_Task10ms_activation_count != 0)
14  {
15      RunnA_Task10ms_activation_count--;
16      RunnA();
17  }
18  }

```

4.2.5 Interrupt decoupling and notifications

4.2.5.1 Basic notification principles

Several BSW modules exist which contain functionality which is not directly activated, triggered or called by AUTOSAR software-components but by other circumstances, like digital input port level changes, complex driver actions, CAN signal reception, etc. In most cases interrupts are a result of those circumstances. For a definition of interrupts, see the VFB [1].

Several of these BSW functionalities create situations, signalled by an interrupt, when AUTOSAR SW-Cs have to be involved. To inform AUTOSAR software components of those situations, runnables in AUTOSAR software components are activated by notifications. So interrupts that occur in the basic software have to be transformed into notifications of the AUTOSAR software components. Such a transformation has to take place at RTE level **at the latest!** Which interrupt is connected to which notification is decided either during system configuration/generation time or as part of the design of Complex Device Drivers or the Microcontroller Abstraction Layer.

This means that runnables in AUTOSAR SW-Cs have to be activated or "waiting" cat2 runnables in extended tasks have to be set to "ready to run" again. In addition some event specific data may have to be passed.

There are two different mechanisms to implement these notifications, depending on the kind of BSW interfaces.

1. **BSW with Standardized interface.** Used with COM and OS.
 Basic-SW modules with Standardized interfaces cannot create RTEEvents. So another mechanism must be chosen: **"callbacks"**
 The typical callback realization in a C/C++ environment is a function call.
2. **BSW with AUTOSAR interface:** Used in all the other BSW modules.
 Basic-SW modules with AUTOSAR-Interfaces have their interface specified in an AUTOSAR BSW description XML file which contains signal specifications according to the AUTOSAR specification. The BSW modules can employ RTE API calls like `Rte_Send` – see 5.6.5). `RTEEvents` may be connected with the RTE API calls, so realizing AUTOSAR SW-C activation.

Note that an AUTOSAR software component can send a notification to another AUTOSAR software component or a BSW module only via an AUTOSAR interface.

4.2.5.2 Interrupts

The AUTOSAR concept as stated in the VFB specification [1] does not allow AUTOSAR software components to run in interrupt context. Only the Microcontroller Abstraction Layer, Complex Device Drivers and the OS are allowed to directly interact with interrupts and implement interrupt service routines (see Requirement [SRS_BSW_00164]. This ensures hardware independence and determinism.

If AUTOSAR software components were allowed to run in interrupt context, one AUTOSAR software component could block the entire system schedule for an unacceptably long period of time. But the main reason is that AUTOSAR software components are supposed to be independent of the underlying hardware so that exchangeability between ECUs can be ensured. The schedule of an ECU is more predictable and better testable if the timing effects of interrupts are restricted to the basic software of that ECU.

Furthermore, AUTOSAR software components are not allowed to explicitly block interrupts as a means to ensure data consistency. They have to use RTE functions for this purpose instead, see Section 4.2.6.

4.2.5.3 Decoupling interrupts on RTE level

Runnables in AUTOSAR SW-Cs may be running as a consequence of an interrupt but **not** in interrupt context, which means not within an interrupt service routine! Between the interrupt service routine and an AUTOSAR SW-C activation there must always be a decoupling instance. AUTOSAR SW-C runnables are only executed in the context of tasks.

The decoupling instance is latest in the RTE. For the RTE there are several options to realize the decoupling of interrupts. Which option is the best depends on the configuration and implementation of the RTE, so only examples are given here.

Example 1:

Situation:

- An interrupt routine calls an RTE callback function

Intention:

- Start a runnable

RTE job:

- RTE starts a task containing the runnable activation code by using the `ActivateTask()` OS service call.
- Other more sophisticated solutions are possible, e.g. if the task containing the runnable is activated periodically.

Example 2:

Situation:

- An interrupt routine calls an RTE callback function

Intention:

- Make a runnable wake up from a wait point

RTE job:

- RTE sets an OS event

These scenarios described in the examples above not only hold for RTE callback functions but for other RTE API functions as well.

[SWS_Rte_03600] [The RTE shall prevent runnable entities of AUTOSAR software-components to run in interrupt context.]([SRS_Rte_00099](#))

4.2.5.4 RTE and interrupt categories

Since category 1 interrupts are not under OS control the RTE has absolutely no possibility to influence their execution behavior. So no category 1 interrupt is allowed to reach RTE. This is different for interrupt of category 2.

[SWS_Rte_03594] [The RTE Generator shall reject the configuration if a `SwcBswRunnableMapping` associates a `BswInterruptEntity` with a `RunnableEntity` and the attribute `interruptCategory` of the `BswInterruptEntity` is equal to `cat 1`.]([SRS_Rte_00018](#), [SRS_Rte_00099](#))

[SWS_Rte_CONSTR_09012] **Category 1 interrupts shall not access the RTE.**
[Category 1 interrupts shall not access the RTE.]()

Most of the OS services can also be called from a category 2 interrupt service routine (see [4]). The main difference to tasks is that ISRs cannot have a wait state and are always activated from an external source (never by the Rte). In addition, ISRs always have a higher priority than a task. Thus, the Rte shall allow to run ExecutableEntities under certain circumstances. The activation of the ISR2 is not in the scope of the Rte.

[SWS_Rte_04564] [The RTE shall activate an `ExecutableEntity` if its `ExternalTriggerOccurredEvent` or `BswExternalTriggerOccurredEvent` is mapped to an ISR2 (via an `RteEventToIsrMapping`).]([SRS_Rte_00237](#))

[SWS_Rte_CONSTR_09120] [The RTE Generator shall reject configurations where an event that triggers a category 2 [ExecutableEntity](#) is mapped to an ISR2.]()

Note: [ExecutableEntity](#) of category 2 requires a wait point but an ISR2 is not allowed to enter a wait state. For time based activation of [ExecutableEntities](#) please refer to section 4.2.2.8.

SWS Item	[ECUC_Rte_09151]
Container Name	RteEventTolSrMapping
Parent Container	RteSwComponentInstance
Description	Maps a RunnableEntity onto one OsIsr based on the activating ExternalTriggerOccurredEvent.
Configuration Parameters	

Name	RtePositionInIsr [ECUC_Rte_09152]		
Parent Container	RteEventTolSrMapping		
Description	Each RunnableEntity mapped to an OsIsr has a specific position within the ISR2 execution. For event driven activation this is the order of evaluation which actual RunnableEntity has to be executed.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RtelSrEventRef [ECUC_Rte_09153]		
Parent Container	RteEventTolSrMapping		
Description	Reference to the description of the ExternalTriggerOccurredEvent or TimingEvent which is pointing to the RunnableEntity being mapped. This allows a fine grained mapping of RunnableEntites based on the activating RTEEvent.		
Multiplicity	1		
Type	Foreign reference to RTE-EVENT		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteMappedTolsrRef [ECUC_Rte_09154]		
Parent Container	RteEventTolsrMapping		
Description	Reference to the OsISR the RunnableEntity activated by the RteEventRef is mapped to.		
Multiplicity	1		
Type	Reference to OsIsr		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsFillRoutineRef [ECUC_Rte_09155]		
Parent Container	RteEventTolsrMapping		
Description	Reference to a Buffer-Fill Routine implemented by an RTE Implementation Plug-In. This routine gets invoked directly before the ExecutableEntity is started. Attributes: requiresIndex=true		
Multiplicity	0..*		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPluginFillFlush Routine]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsFlushRoutineRef [ECUC_Rte_09156]		
Parent Container	RteEventToIsrMapping		
Description	Reference to a Buffer-Flush Routine implemented by an RTE Implementation Plug-In. This routine gets invoked directly after the ExecutableEntity has terminated. Attributes: requiresIndex=true		
Multiplicity	0..*		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPluginFillFlushRoutine]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

4.2.5.5 RTE and Basic Software Scheduler and [BswExecutionContext](#)

The RTE and *Basic Software Scheduler* do support the invocation [triggered ExecutableEntity](#) via direct or trusted function call in some special cases. Nevertheless, it shall be prevented that an [ExecutableEntity](#) from a particular execution context calls a [triggered ExecutableEntity](#) which requires an execution context with more permissions.

The constraint [constr_4086] in document [9] describes the possible invocation of [ExecutableEntities](#) by direct or trusted function call dependent from [BswExecutionContext](#).

This applies to the invocation of a [triggered ExecutableEntity](#) by the [SchM_Trigger](#), [SchM_ActMain](#) or [Rte_Trigger](#) APIs, or to the invocation of an [on-entry ExecutableEntity](#), [on-transition ExecutableEntity](#), [on-exit ExecutableEntity](#) or [ModeSwitchAck ExecutableEntity](#) by the [SchM_Switch](#) or [Rte_Switch](#) APIs.

4.2.5.5.1 Interrupt decoupling for COM

COM callbacks are used to inform the RTE about something that happened independently of any RTE action. This is often interrupt driven, e.g. when a data item has been received from another ECU or when a S/R transmission is completed. It is the RTE's job e.g. to create [RTEEvents](#) from the interrupt.

[SWS_Rte_03530] [The RTE shall provide callback functions to allow COM to signal COM events to the RTE.] ([SRS_Rte_00072](#), [SRS_Rte_00099](#))

[SWS_Rte_03531] [The RTE shall support runnable activation by COM callbacks.] ([SRS_Rte_00072](#), [SRS_Rte_00099](#))

[SWS_Rte_03532] [The RTE shall support category 2 runnables to wake up from a wait point as a result of COM callbacks.] ([SRS_Rte_00072](#), [SRS_Rte_00099](#))

See RTE callback API in chapter [5.9](#).

4.2.6 Data Consistency

4.2.6.1 General

Concurrent accesses to shared data memory can cause data inconsistencies. In general this must be taken into account when several code entities accessing the same data memory are running in different contexts - in other words when systems using parallel (multicore) or concurrent (singlecore) execution of code are designed. More general: Whenever task context-switches occur and data is shared between tasks or ISR2s, data consistency is an issue.

AUTOSAR systems use operating systems according to the AUTOSAR-OS specification which is derived from the OSEK-OS specification. The Autosar OS specification defines a priority based scheduling to allow event driven systems. This means that tasks with higher priority levels or ISR2s are able to interrupt (preempt) tasks with lower priority level.

The "lost update" example in Figure [4.25](#) illustrates the problem for concurrent read-modify-write accesses:

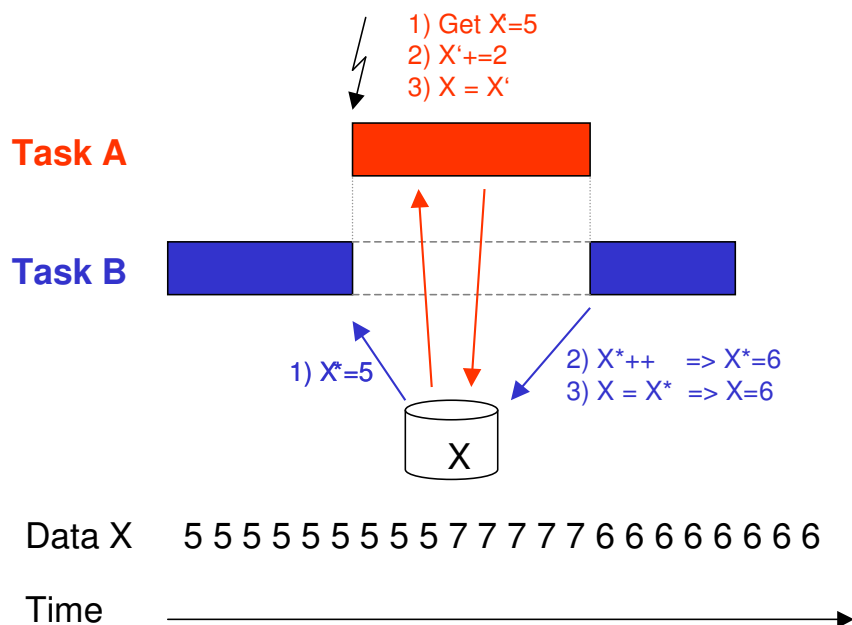


Figure 4.25: Data inconsistency example - lost update

There are two tasks. Task A has higher priority than task B. A increments the commonly accessed counter X by 2, B increments X by 1. So in both tasks there is a read (step1) – modify (step2) – write (step3) sequence. If there are no atomic accesses (fully completed read-modify-write accesses without interruption) the following can happen:

1. Assume $X=5$.
2. B makes read (step1) access to X and stores value 5 in an intermediate store (e.g. on stack or in a CPU register).
3. B cannot continue because it is preempted by A.
4. A does its read (step1) – modify (step2) – write (step3) sequence, which means that A reads the actual value of X, which is 5, increments it by 2 and writes the new value for X, which is 7. ($X=5+2$)
5. A is suspended again.
6. B continues where it has been preempted: with its modify (step2) and write (step3) job. This means that it takes the value 5 from its internal store, increments it by one to 6 and writes the value 6 to X ($X=5+1$).
7. B is suspended again.

The correct result after both Tasks A and B are completed should be $X=8$, but the update of X performed by task A has been lost.

4.2.6.2 Communication Patterns

In AUTOSAR systems the RTE has to take care that a lot of the communication is not corrupted by data consistency problems. RTE Generator has to apply suitable means if required.

The following communication mechanisms can be distinguished:

- Communication within one atomic AUTOSAR SW-C:
Communication between Runnables of one atomic AUTOSAR SW-C running in different task/ISR2 contexts where communication between these Runnables takes place via commonly accessed data. If the need to support data consistency by the RTE exists, it must be specified by using the concepts of "ExclusiveAreas" or "InterRunnableVariables" only.
- Intra-partition communication between AUTOSAR SW-Cs:
Sender/Receiver (S/R) communication between Runnables of different AUTOSAR SW-Cs using *implicit* or *explicit* data exchange can be realized by the RTE through commonly accessed RAM memory areas. Data consistency in Client/Server (C/S) communication can be put down to the same concepts as S/R communication. Data access collisions must be avoided. The RTE is responsible for guaranteeing data consistency.
- Inter-Partition communication
The RTE has to guarantee data consistency. The different possibilities provided to the RTE for the communication between partitions are discussed in section [4.3.4](#).
- Intra-ECU communication between AUTOSAR SW-Cs and BSW modules with AUTOSAR interfaces:
This is a special case of the above two.
- Inter ECU communication
COM has to guarantee data consistency for communication between ECUs on complete path between the COM modules of different ECUs. The RTE on each ECU has to guarantee that no data inconsistency might occur when it invokes COM send respectively receive calls supplying respectively receiving data items which are concurrently accessed by application via RTE API call, especially when queueing is used since the queues are provided by the RTE and not by COM.

[SWS_Rte_03514] [The RTE has to guarantee data consistency for communication via AUTOSAR interfaces.] ([SRS_Rte_00032](#))

4.2.6.3 Concepts

In the AUTOSAR SW-C Template [\[2\]](#) chapter "Interaction between runnables within one component", the concepts of

1. ExclusiveAreas (see section [4.2.6.5](#) below)

2. InterRunnableVariables (see section 4.2.6.6 below)

are introduced to allow the user (SW-Designer) to specify where the RTE shall guarantee data consistency for AUTOSAR SW-C internal communication and execution circumstances. This is discussed in more detail in next sections.

Additionally exclusive areas are also available for *Basic Software Modules* to protect access to module internal data. See [9]. The exclusive areas for *Basic Software Modules* are handled by the *Basic Software Scheduler*.

The AUTOSAR SW-C template specification [2] also states that AUTOSAR SW-Cs may define `PerInstanceMemory` or `arTypedPerInstanceMemory`, allowing reservation of static (permanent) need of global RAM for the SW-C. Nothing is specified about the way Runnables might access this memory. RTE only provides a reference to this memory (see section 5.6) but doesn't guarantee data consistency for it.

The implementer of an AUTOSAR SW-C has to take care by himself that accesses to RAM reserved as `PerInstanceMemory` out of Runnables running in different task/ISR2 contexts don't cause data inconsistencies. On the other hand this provides more freedom in using the memory.

4.2.6.4 Mechanisms to guarantee data consistency

`ExclusiveAreas` and `InterRunnableVariables` are only mentioned in association with AUTOSAR SW-C internal communication. Nevertheless the data consistency mechanisms behind can be applied to communication between AUTOSAR SW-Cs or between AUTOSAR SW-Cs and BSW modules too. Everywhere where the RTE has to guarantee data consistency.

The data consistency guaranteeing mechanisms listed here are derived from AUTOSAR SW-C Template and from further discussions. There might be more (see section 4.3.4 for the mechanisms involved for `inter-partition` communication).

The RTE has the responsibility to apply such mechanisms if required. The details how to apply the mechanisms are left open to the RTE supplier.

Mechanisms:

- **Sequential scheduling strategy**

The activation code of Runnables is sequentially placed in one task/ISR2 so that no interference between them is possible because one Runnable is only activated after the termination of the other. Data consistency is guaranteed.

- **Interrupt blocking strategy**

Interrupt blocking can be an appropriate means if collision avoidance is required for a very short amount of time. This might be done by disabling respectively suspending all interrupts, Os interrupts only or - if hardware supports it - only of some interrupt levels. In general this mechanism must be applied with care

because it might influence SW in tasks with higher priority too and the timing of the complete system.

- **Usage of OS resources**

Usage of OS resources. Advantage in comparison to Interrupt blocking strategy is that less SW parts with higher priority are blocked. Disadvantage is that implementation might consume more resources (code, runtime) due to the more sophisticated mechanism. Appropriateness of this mechanism may vary depending on the number of OSs/cores and/or the number of available resources.

- **Task blocking strategy**

Mutual task preemption is prohibited. This might be reached e.g. by assigning same priorities to affected tasks, by assigning same internal OS resource to affected tasks or by configuring the tasks to be non-preemptive. This mechanism may be inappropriate in multi-partitioned systems.

- **Copy strategy**

Idea: The RTE creates copies of data items so that concurrent accesses in different task/ISR2 contexts cannot collide because some of the accesses are redirected to the copies.

How it can work:

- Application for **read conflicts**:

For all readers with lower priority than the writer a *read copy* is provided.

Example:

There exist Runnable R1, Runnable R2, data item X and a copy data item X*. When Runnable R1 is running in higher priority task context than R2, and R1 is the only one writing X and R2 is reading X it is possible to guarantee data consistency by making a copy of data item X to variable X* **before** activation of R2 and redirecting write access from X to X* or the read access from X to X* for R2.

- Application for **write conflicts**:

If one or more data item receiver with a higher priority than the sender exist, a *write copy* for the sender is provided.

Example:

There exist Runnable R1, Runnable R2, data item X and copy data item X*. When Runnable R1 (running in lower priority task context than R2) is writing X and R2 is reading X, it is possible to guarantee data consistency by making a copy of data item X to data item X* **before** activation of R1 together with redirecting the write access from X to X* for R1 or the read access from X to X* for R2.

Usage of this copy mechanism may make sense if one or more of the following conditions hold:

- This copy mechanism can handle those cases when only one instance does the data write access.
- R2 is accessing X several times.
- More than one Runnable R2 has read (resp. write) access to X.
- To save runtime is more important than to save code and RAM.
- Additional RAM requirements to hold the copies is acceptable.

Further issues to be taken into account:

- AUTOSAR SW-Cs provided as source code and AUTOSAR SW-Cs provided as object code may or have to be handled in different ways. The redirecting mechanism for source code could use macros for C and C++ very efficiently whereas object-code AUTOSAR SW-Cs most likely are forced to use references.

Note that the copy strategy is used to guarantee data consistency for implicit sender-receiver communication ([VariableAccesses](#) in the [dataReadAccess](#) or [dataWriteAccess](#) role) and for AUTOSAR SW-C internal communication using [InterRunnableVariables](#) with implicit behavior.

4.2.6.5 Exclusive Areas

The concept of [ExclusiveArea](#) is more a working model. It's not a concrete implementation approach, although concrete possible mechanisms are listed in AUTOSAR SW-C template specification [2].

Focus of the [ExclusiveArea](#) concept is to block potential concurrent accesses to get data consistency. [ExclusiveAreas](#) implement critical section

ExclusiveAreas are associated with [RunnableEntity](#)s. The RTE is forced to guarantee data consistency when the [RunnableEntity](#) runs in an [ExclusiveArea](#). A [RunnableEntity](#) can run inside one or several [ExclusiveAreas](#) completely or can enter one or several [ExclusiveAreas](#) during their execution for one or several times

- If an AUTOSAR SW-C requests the RTE to look for data consistency for its internally used data (for a part of it or the complete one) using the [ExclusiveArea](#) concept, the SW designer can use the API calls "Rte_Enter()" in [5.6.30](#) and "Rte_Exit()" in [5.6.31](#) to specify where he wants to have the protection by RTE applied.
"Rte_Enter()" defines the begin and "Rte_Exit()" defines the end of the code sequence containing data accesses the RTE has to guarantee data consistency for.

- If the SW designer wants to have the mutual exclusion for complete `RunnableEntity`s he can specify this by using the `ExclusiveArea` in the role `"runsInsideExclusiveArea"` in the AUTOSAR SW-C description.

In principle the `ExclusiveArea` concept can handle the access to single data items as well as the access to several data items realized by a group of instructions. It also doesn't matter if one Runnable is completely running in an `ExclusiveArea` and another Runnable only temporarily enters the same `ExclusiveArea`. The RTE has to guarantee data consistency.

[SWS_Rte_03500] [The RTE has to guarantee data consistency for arbitrary accesses to data items accessed by Runtables marked with the same `ExclusiveArea`.] (*SRS_Rte_00032*, *SRS_Rte_00046*)

[SWS_Rte_03515] [RTE has to provide an API enabling the SW-Cs to access and leave `ExclusiveAreas`.] (*SRS_Rte_00046*)

If Runtables accessing same `ExclusiveArea` are assigned to be executing in different task/ISR2 contexts, the RTE can apply suitable mechanisms, e.g. task/ISR2 blocking, to guarantee data consistency for data accesses in the common `ExclusiveArea`. However, special attributes can be set that require certain data consistency mechanisms in which case the RTE generator is forced to apply the selected mechanism.

The *Basic Software Scheduler* provides `ExclusiveAreas` for the *Basic Software Modules*. *Basic Software Modules* have to use the API calls `SchM_Enter()` in 6.5.1 and `SchM_Exit()` in 6.5.2 to specify where the protection by Basic Software Scheduler has to be applied.

[SWS_Rte_07522] [The *Basic Software Scheduler* has to guarantee data consistency for arbitrary accesses to data items accessed by `BswModuleEntity`s marked with the same `ExclusiveArea`.] (*SRS_Rte_00222*, *SRS_Rte_00046*)

[SWS_Rte_07523] [*Basic Software Scheduler* has to provide an API enabling the *Basic Software Module* to access and leave `ExclusiveAreas`.] (*SRS_Rte_00222*, *SRS_Rte_00046*)

It is not supported, that a `BswModuleEntity` which is not a `BswSchedulableEntity` uses an `ExclusiveArea` in the role `runsInsideExclusiveArea`. This is not possible, because such `BswSchedulableEntity` might be called directly by other *Basic Software Modules* and therefore the *Basic Software Scheduler* is not able to enter and exit the `ExclusiveArea` automatically.

[SWS_Rte_07524] [The RTE generator shall reject a configuration where a `BswModuleEntity` which is not a `BswSchedulableEntity` uses an `ExclusiveArea` in the role `runsInsideExclusiveArea`.] (*SRS_Rte_00222*, *SRS_Rte_00046*, *SRS_Rte_00018*)

4.2.6.5.1 Assignment of data consistency mechanisms

The data consistency mechanism that has to be applied to an [ExclusiveArea](#) might be domain, ECU or even project specific. The decision which mechanism has to be applied by RTE / *Basic Software Scheduler* is taken during ECU integration by setting the [ExclusiveArea](#) configuration parameter [RteExclusiveAreaImplMechanism](#). This parameter is an input for RTE generator.

As stated in section [4.2.6.4](#) there might be more mechanisms to realize [ExclusiveAreas](#) as mentioned in this specification. So RTE implementations might provide other mechanisms in plus by a vendor specific solutions. This allows further optimizations.

Actually following values for configuration parameter [RteExclusiveAreaImplMechanism](#) must be supported:

- [ALL_INTERRUPT_BLOCKING](#)
This value requests enabling and disabling of all Interrupts and is based on the *Interrupt blocking strategy*.
- [OS_INTERRUPT_BLOCKING](#)
This value requests enabling and disabling of Os Interrupts and is based on the *Interrupt blocking strategy*.
- [OS_RESOURCE](#)
This value requests to apply the *Usage of OS resources* mechanism.
- [OS_SPINLOCK](#)
This value is used to co-ordinate concurrent access by TASKs/ISR2s on different cores to a shared resource.
- [NONE](#)
RTE generator shall not apply any mechanisms for data consistency. Data consistency will be ensured by methods outside of RTE implementation control.
- [RTE_PLUGIN](#)
This value requests to apply the [RTE Implementation Plug-In](#) mechanism.

The strategies / mechanisms are described in general in section [4.2.6.4](#).

[SWS_Rte_03504] [If the configuration parameter [RteExclusiveAreaImplMechanism](#) of an [ExclusiveArea](#) is set to value [ALL_INTERRUPT_BLOCKING](#) the RTE generator shall use the mechanism of *Interrupt blocking* (blocking all interrupts) to guarantee data consistency if data inconsistency could occur.]([SRS_Rte_00032](#))

[SWS_Rte_05164] [If the configuration parameter [RteExclusiveAreaImplMechanism](#) of an [ExclusiveArea](#) is set to value [OS_INTERRUPT_BLOCKING](#) the RTE generator shall use the mechanism of *Interrupt blocking* (blocking Os interrupts only) to guarantee data consistency if data inconsistency could occur.]([SRS_Rte_00032](#))

[SWS_Rte_03595] [If the configuration parameter [RteExclusiveAreaImplMechanism](#) of an [ExclusiveArea](#) is set to value `OS_RESOURCE` the RTE generator shall use OS resources to guarantee data consistency if data inconsistency could occur.] ([SRS_Rte_00032](#))

The requirements above have the limitation "if data inconsistency could occur" because it makes no sense to apply a data consistency mechanism if no potential data inconsistency can occur. This can be relevant if e.g. the "Sequential scheduling strategy" (described in section [4.2.6.4](#)) still has solved the item by the ECU integrator defining an appropriate runnable-to-task mapping.

[SWS_Rte_08419] [If the configuration parameter [RteExclusiveAreaImplMechanism](#) of an [ExclusiveArea](#) is set to value `OS_SPINLOCK` the RTE generator shall use OS spinlocks to guarantee data consistency if data inconsistency could occur.] ([SRS_Rte_00032](#))

[SWS_Rte_03999] [If the configuration parameter [RteExclusiveAreaImplMechanism](#) of an [ExclusiveArea](#) is set to value `NONE` then the RTE generator shall create functionally empty implementations for all required APIs.] ([SRS_Rte_00032](#))

Note: The implementation of [ExclusiveAreas](#) via [RTE Implementation Plug-In](#) mechanism ([RteExclusiveAreaImplMechanism](#) set to `RTE_PLUGIN`) is described in section [7.3.5](#). Note:

The configuration parameter [RteExclusiveAreaImplMechanism](#) can be specified for each SWC instance and therefore the implementation for each API may differ. The description "functionally empty" implies no code to lock/unlock the exclusive area however other code, such as VFB trace, may be present. If all SWC instances result in identical implementations, e.g. empty, then an RTE generator can provide a function-like macro within the RTE API mappings to further optimize the generated API. Such optimization is not possible when implementations differ since the API mappings are generated per-type.

In a SWC code, it is not allowed to use [WaitPoints](#) inside an [ExclusiveArea](#): The RTE generator might use OSEK services to implement [ExclusiveAreas](#) and waiting for an OS event is not allowed when an OSEK resource has been taken for example. For [RunnableEntityEntersExclusiveArea](#), the RTE generator cannot check if [WaitPoints](#) are inside an [ExclusiveArea](#). Therefore, it is the responsibility of the SWC Code writer to ensure that no [WaitPoints](#) are used inside an exclusive area. But for [RunnableEntities](#) running inside an [ExclusiveArea](#), the RTE generator is able to do the following check.

[SWS_Rte_07005] [The RTE generator shall reject a configuration with a [WaitPoint](#) applied to a [RunnableEntity](#) which is using the [ExclusiveArea](#) in the role `run-sInsideExclusiveArea`] ([SRS_Rte_00032](#), [SRS_Rte_00018](#))

4.2.6.6 InterRunnableVariables

AtomicSwComponents (except for NvBlockComponents) can reserve InterRunnableVariables which can be accessed by the Runnables of this one AtomicSwComponent (also see section 4.3.3.1). Read and write accesses are possible. There is a separate set of those variables per AUTOSAR SW-C instance.

Again the RTE has to guarantee data consistency. Appropriate means will depend on Runnable placement decisions which are taken during ECU configuration.

[SWS_Rte_03516] [The RTE has to guarantee data consistency for communication between Runnables of one AUTOSAR software-component instance using the same InterRunnableVariable.] ([SRS_Rte_00142](#), [SRS_Rte_00032](#))

Next the two kinds of InterRunnableVariables are treated:

1. InterRunnableVariables with **implicit** behavior

`(implicitInterRunnableVariable)`

2. InterRunnableVariables with **explicit** behavior

`(explicitInterRunnableVariable)`

4.2.6.6.1 InterRunnableVariables with implicit behavior

In applications with very high SW-C communication needs and much real time constraints (like in powertrain domain) the usage of a copy mechanism to get data consistency might be a good choice because during `RunnableEntity` execution no data consistency overhead in form of concurrent access blocking code and runtime during its execution exists - independent of the number of data item accesses.

Costs are code overhead in the `RunnableEntity` prologue and epilogue which is often be minimal compared to other solutions. Additional RAM need for the copies comes in plus.

When *InterRunnableVariables with implicit behavior* are used the RTE is required to make the data available to the Runnable using the `semantics of a copy` operation but is not necessarily required to use a unique copy for each `RunnableEntity`.

Focus of *InterRunnableVariable with implicit behavior* is to avoid concurrent accesses by redirecting second, third, .. accesses to data item copies.

[SWS_Rte_03517] [The RTE shall guarantee data consistency for *InterRunnableVariables with implicit behavior* by avoiding concurrent accesses to data items specified by `implicitInterRunnableVariable` using one or more copies and redirecting accesses to the copies.

] ([SRS_Rte_00142](#), [SRS_Rte_00032](#))

Compared with Sender/Receiver communication

- Like with `VariableAccesses` in the `dataReadAccess` and `dataWriteAccess` roles, the Runnable IN data is stable during Runnable execution, which means that during an Runnable execution several read accesses to an `implicitInterRunnableVariable` always deliver the same data item value.
- Like with `VariableAccesses` in the `dataReadAccess` and `dataWriteAccess` roles, the Runnable OUT data is forwarded to other Runnables not before Runnable execution has terminated, which means that during an Runnable execution write accesses to `implicitInterRunnableVariable` are not visible to other Runnables.

This behavior requires that Runnable execution terminates.

[SWS_Rte_03582] [The value of several read accesses to `implicitInterRunnableVariable` during a `RunnableEntity` execution shall only change for write accesses performed within this `RunnableEntity` to the `implicitInterRunnableVariable`]([SRS_Rte_00142](#))

[SWS_Rte_03583] [Several write accesses to `implicitInterRunnableVariable` during a `RunnableEntity` execution shall result in only one update of the `implicitInterRunnableVariable` content visible to other `RunnableEntities` with the last written value.
]([SRS_Rte_00142](#))

[SWS_Rte_03584] [The update of `implicitInterRunnableVariable` done during a `RunnableEntity` execution shall be made available to other `RunnableEntities` after the `RunnableEntity` execution has terminated.
]([SRS_Rte_00142](#))

[SWS_Rte_07022] [If a `RunnableEntity` has both read and write access to an `implicitInterRunnableVariable` the result of the write access shall be immediately visible to subsequent read accesses from within the same runnable entity.]([SRS_Rte_00142](#))

The usage of `implicitInterRunnableVariables` is permitted for all categories of runnable entities. For runnable entities of category 2, the behavior is guaranteed only if it has a finite execution time. A category 2 runnable that runs forever will not have its data updated.

For API of `implicitInterRunnableVariable` see sections [5.6.24](#) and [5.6.26](#).

For more details how this mechanism could work see "Copy strategy" in section [4.2.6.4](#).

4.2.6.6.2 InterRunnableVariables with explicit behavior

In many applications saving RAM is more important than saving runtime. Also some application require to have access to the newest data item value without any delay, even several times during execution of a Runnable.

Both requirements can be fulfilled when RTE supports data consistency by blocking second/third/.. concurrent accesses to a signal buffer if data consistency is jeopardized. (Most likely RTE has nothing to do if SW is running on a 16bit machine and making an access to an 16bit value when a 16bit data bus is present.)

Focus of *InterRunnableVariables with explicit behavior* is to block potential concurrent accesses to get data consistency.

The mechanism behind is the same as in the [ExclusiveArea](#) concept (see section 4.2.6.5). But although ExclusiveAreas can handle single data item accesses too, their API is made to make the RTE to apply data consistency means for a group of instructions accessing several data items as well. So when using an ExclusiveArea to protect accesses to one single common used data item each time two RTE API calls grouped around are needed. This is very inconvenient and might lead to faults if the calls grouped around might be forgotten.

The solution is to support *InterRunnableVariables with explicit behavior*.

[SWS_Rte_03519] [The RTE shall guarantee data consistency for *InterRunnableVariables with explicit behavior* by blocking concurrent accesses to data items specified by `explicitInterRunnableVariable`.]
([SRS_Rte_00142](#), [SRS_Rte_00032](#))

The RTE generator is not free to select on it's own if implicit or explicit behavior shall be applied. Behavior must be known at AUTOSAR SW-C design time because in case of *InterRunnableVariables with implicit behavior* the AUTOSAR SW-C designer might rely on the fact that several read accesses always deliver same data item value.

[SWS_Rte_03580] [The RTE shall supply different APIs for *InterRunnableVariables with implicit behavior* and *InterRunnableVariables with explicit behavior*.]
([SRS_Rte_00142](#))

For API of *InterRunnableVariables with explicit behavior* see sections [5.6.28](#) and [5.6.29](#).

4.2.7 Multiple trigger of Runnable Entities and Basic Software Schedulable Entities

Concurrent activation

The AUTOSAR SW-C template specification [2] states that runnable entities (further called "runnables") might be invoked concurrently several times if the Runnables attribute `canBeInvokedConcurrently` is set. It's then in the responsibility of the AUTOSAR SW-C designer that no data might be corrupted when the Runnable is activated several times in parallel.

If a SW-C has multiple instances, they have distinct runnables. Two runnables that use the same `RunnableEntity` description of the same `SwcInternalBehavior` description but are instantiated with two different SW-C instances are treated as two distinct runnables in the following. This kind of concurrency is always allowed between

SW-Cs, even if the runnables have their `canBeInvokedConcurrently` attribute set to false.

[SWS_Rte_03523] [The RTE shall support concurrent activation of the same instance of a runnable entity if the associative attribute `canBeInvokedConcurrently` is set to `TRUE`. This includes concurrent activation in several tasks/ISR2s. If the attribute is not set resp. set to `FALSE`, concurrent activation of the runnable entity is forbidden. (see requirement [SWS_Rte_05083])] (*SRS_Rte_00072*, *SRS_Rte_00133*)

The *Basic Software Module Description Template* [9] specifies the possible concurrent activation of `BswModuleEntity`s by the attribute `isReentrant`.

[SWS_Rte_07525] [The *Basic Software Scheduler* shall support concurrent activation of the same instance of a `BswSchedulableEntity` if the attribute `isReentrant` of the referenced `BswModuleEntry` in the role `implementedEntry` is set to `true`. This includes concurrent activation in several tasks/ISR2s. If the attribute is set to `false` concurrent activation of the `BswSchedulableEntity` is forbidden. (see requirement [SWS_Rte_07588])] ()

Concurrent activation of the same instance of an `ExecutableEntity` results in multiple `ExecutableEntity execution-instances`. One for each context of activation.

Activation by several RTEEvents and BswEvents

Nevertheless a Runnable whose attribute `canBeInvokedConcurrently` is NOT set might be still activated by several `RTEEvents` if activation configuration guarantees that concurrent activation can never occur and the `minimumStartInterval` condition is kept. This includes activation in different tasks. In this case, the runnable is still considered to have only one `ExecutableEntity execution-instances`. A standard use case is the activation of same instance of a runnable in different modes.

[SWS_Rte_03520] [The RTE shall support activation of same instance of a runnable entity by multiple `RTEEvents`.] (*SRS_Rte_00072*)

`RTEEvents` are triggering runnable activation and may supply 0..several role parameters, see section 5.7.3. Role parameters are not visible in the runnables signature - except in those triggered by an `OperationInvokedEvent`. With the exception of the `RTEEvent OperationInvokedEvent` all role parameters can be accessed by user with implicit or explicit Receiver API.

[SWS_Rte_03524] [The RTE shall support activation of same instance of a runnable entity by `RTEEvents` of different kinds.] (*SRS_Rte_00072*)

The RTE does NOT support a runnable entity triggered by an `RTEEvent OperationInvokedEvent` to be triggered by any other `RTEEvent` except for other `OperationInvokedEvents` of compatible operations. This limitation is stated in appendix in section A.2 ([SWS_Rte_03526]).

The similar configuration as mentioned for the `RunnableEntity`s might be used for `BswSchedulableEntity`s. Therefore even a `BswSchedulableEntity` whose referenced `BswModuleEntry` in the role `implementedEntry` has its `isReentrant` attribute set to `false` can be activated by several `BswEvents`.

[SWS_Rte_07526] [The *Basic Software Scheduler* shall support activation of same instance of a `BswSchedulableEntity` by multiple `BswEvents`.]()

[SWS_Rte_07527] [The *Basic Software Scheduler* shall support activation of same instance of a `BswSchedulableEntity` by `BswEvents` of different kinds.]()

4.2.8 Implementation of Parameter and Data Elements

4.2.8.1 General

A SWC communicates with other SWCs through ports. A port is characterized by a `PortInterface` and there are several kinds of `PortInterfaces`. In this section, we focus on the `ParameterInterface`, the `SenderReceiverInterface`, and the `NvDataInterface`. These three kinds of `PortInterfaces` aggregate some specific interface elements. For example, a `ParameterInterface` aggregates 0..* `ParameterDataPrototypes`.

4.2.8.2 Compatibility rules

A receiver port can only be connected to a compatible provider port. The compatibility rules are explained in the AUTOSAR Software Component Template [2]. The compatibility mainly depends on the attribute `swImplPolicy` attached to the element of the interface. The table 4.13 below gives an overview of compatibility rules.

Provide Port			Require Port					
Port Interface			Prm			S/R		NvD
Interface Element			PDP			VDP		VDP
swImplPolicy			fixed	const	standard	standard	queued	standard
Prm	PDP	fixed	yes	yes	yes	yes	no	yes
		const	no	yes	yes	yes	no	yes
		standard	no	no	yes	yes	no	yes
S/R	VDP	standard	no	no	no	yes	no	yes
		queued	no	no	no	no	yes	no
NvD	VDP	standard	no	no	no	yes	no	yes

Table 4.13: Overview of compatibility of `ParameterDataPrototype` and `VariableDataPrototypes`

Interface Element
PDP : `ParameterDataPrototype`
VDP : `VariableDataPrototype`

Port Interface	
Prm	: ParameterInterface
S/R	: SenderReceiverInterface
NvD	: NvDataInterface

Table 4.14: Key to table 4.13

For examples, a Require Port that expects a fixed parameter - i.e produced by a macro `#define` - can only be connected to a Port that provides a fixed Parameter. This is because this fixed data may be used in a compilation directive like `#IF` and only macro `#define` (fixed data) can be compiled in this case. On the other hand, this provided fixed parameter can be connected to almost every require port, except a queued Sender/receiver interface.

The RTE doesn't have to check the compatibility between ports since this task is performed at the VFB level. But it shall provide the right implementation of interface element and API according the attribute [swImplPolicy](#) attached to the interface element.

4.2.8.3 Implementation of an interface element

The implementation of an interface element depends on the attribute [swImplPolicy](#). The attribute [swCalibrationAccess](#) determines how the interface element can be accessed by e.g. an external calibration tool. The table 4.15 defines the supported combinations of [swImplPolicy](#) and [swCalibrationAccess](#) attribute setting and gives the corresponding implementation by the RTE.

swImplPolicy	SwCalibrationAccess			Implementation
	not Accessible	readOnly	readWrite	
fixed	yes	not supported	not supported	macro definition or c const declaration dependent from RTE optimization
const	yes	yes	not supported	c const declaration
standard	yes	yes	yes	standard implementation i.e. a variable for Variable-DataPrototype in RAM or a calibration parameter in ROM ³

³calibration parameter have to be allocated in RAM if data emulation with SW support is required, see 4.2.9.3.5

queued	yes	not supported	not supported	FIFO Queue
measurement Point	not supported	yes	not supported	Variable

Table 4.15: Data implementation according `swImplPolicy`

4.2.8.4 Initialization of `VariableDataPrototypes`

Basically the need for initialization of any `VariableDataPrototypes` is specified by the Software Component Descriptions defining the `VariableDataPrototypes`. This information is basically defined by the existence of an `initValue`, the `sectionInitializationPolicy` of the related `SwAddrMethod`. As described in section 8.12 additionally the initialization strategy can be adjusted by the integrator of the RTE to adjust the behavior to the start-up code.

[SWS_Rte_07046] [Variables implementing `VariableDataPrototypes` shall be initialized if

- an `initValue` is defined
- AND
- no `SwAddrMethod` is defined for `VariableDataPrototype`.

]([SRS_Rte_00052](#), [SRS_Rte_00068](#), [SRS_Rte_00116](#))

[SWS_Rte_03852] [Variables implementing `VariableDataPrototypes` shall be initialized if

- an `initValue` is defined
- AND
- a `SwAddrMethod` is defined for `VariableDataPrototype`
- AND
- the `RteInitializationStrategy` for the `sectionInitializationPolicy` of the related `SwAddrMethod` is NOT configured to `RTE_INITIALIZATION_STRATEGY_NONE`.

]([SRS_Rte_00052](#), [SRS_Rte_00068](#), [SRS_Rte_00116](#))

4.2.8.5 Initialization of optional Elements

The existence of optional elements in a given `AutosarDataType` needs to be specifically considered for the definition of initial values.

4.2.8.5.1 ApplicationDataType

In case the initial value is provided for a given `DataPrototype` typed by an `ApplicationRecordDataType` where at least one `ApplicationRecordElement` has the attribute `isOptional` set to `TRUE`, there is no means to relate to the `availabilityBitfield` of such a `DataPrototype` (as the `availabilityBitfield` is introduced at the `ImplementationDataType` level).

Each `ApplicationRecordElement` (including those where the attribute `isOptional` is set to `TRUE`) may be either initialized by an `ApplicationValueSpecification` or `NotAvailableValueSpecification`. The usage of a `NotAvailableValueSpecification` defines that this record element is to be considered not available already during initialization. The not available record element will also be initialized with a default pattern (see [TPS_SWCT_01823]). The alternative usage of `ApplicationValueSpecification` and `NotAvailableValueSpecification` is used to derive the initial value for the `availabilityBitfield`.

[SWS_Rte_08911] [If the initial value is provided for a `DataPrototype` typed by an `ApplicationRecordDataType` where at least one `ApplicationRecordElement` has the attribute `isOptional` set to `TRUE`, then the initial value for the corresponding `availabilityBitfield` shall be derived from the existence of `ApplicationValueSpecification` and `NotAvailableValueSpecification`:

- if an `ApplicationRecordElement` is initialized using an `ApplicationValueSpecification`, then the corresponding bit in the `availabilityBitfield` shall be set to `TRUE` (available)
- if an `ApplicationRecordElement` is initialized using an `NotAvailableValueSpecification`, then the corresponding bit in the `availabilityBitfield` shall be set to `FALSE` (not available)

](*SRS_Rte_00052, SRS_Rte_00068, SRS_Rte_00116, SRS_Rte_00261*)

4.2.8.5.2 ImplementationDataType

In case the initial value is provided for a `DataPrototype` typed by an `ImplementationDataType` of category `STRUCTURE` where `isStructWithOptionalElement` set to the value `TRUE`, then the [2] defines the initialization strategy in [TPS_SWCT_01785]. This results in an explicit initial value definition for all structure members, including the `availabilityBitfield` as defined in [TPS_SWCT_01786].

[SWS_Rte_08912] [If the initial value is provided for a `DataPrototype` typed by an `ImplementationDataType` of category `STRUCTURE` where `isStructWithOptionalElement` set to the value `TRUE`, then the initial value for the `availabilityBitfield` shall be taken from the initial value for the `ImplementationDataTypeElement` where the `shortName` is set to the value "availabilityBitfield".](*SRS_Rte_00052, SRS_Rte_00068, SRS_Rte_00116, SRS_Rte_00261*)

4.2.8.6 Initial value calculation

Basically the Meta Model defines two different flavors of rule based value specifications:

- [ApplicationRuleBasedValueSpecification](#)
- [NumericalRuleBasedValueSpecification](#)

The [ApplicationRuleBasedValueSpecification](#) defines the values in the physical representation whereas the [NumericalRuleBasedValueSpecification](#) defines the values in the numerical representation. (See document [2], section *Data Description*) But both are using the [RuleBasedValueSpecification](#) to define a set of values based on a [rule](#) and [arguments](#) for the rule.

Especially in case of large arrays an high amount of initial values are required. But many arrays are initialized with identical values or at least filled up to the end with identical values. For such use case the [RuleBasedValueSpecification](#) of category `FILL_UNTIL_END` can be used to avoid the creation and maintenance of redundant [ValueSpecifications](#).

[SWS_Rte_06764] [The RTE Generator shall support [ApplicationRuleBasedValueSpecifications](#) for [DataPrototypes](#) typed by [ApplicationArrayDataTypes](#).] ([SRS_Rte_00239](#))

[SWS_Rte_06765] [The RTE Generator shall support [NumericalRuleBasedValueSpecifications](#) for [DataPrototypes](#) typed by [ImplementationDataTypes](#) of category `ARRAY` and for Compound Primitive Data Types which are mapped to [ImplementationDataTypes](#) of category `ARRAY`.] ([SRS_Rte_00239](#))

[SWS_Rte_06733] [The RTE Generator shall support [RuleBasedValueSpecifications](#) with the [rule](#) `FILL_UNTIL_END`.] ([SRS_Rte_00239](#))

[SWS_Rte_08542] [The RTE Generator shall support [RuleBasedValueSpecifications](#) with the [rule](#) `FILL_UNTIL_MAX_SIZE`.] ([SRS_Rte_00239](#))

[SWS_Rte_06734] [The RTE shall initialize the elements of the array according the values defined by [RuleBasedValueSpecification.arguments](#) if a [RuleBasedValueSpecification](#) with the [rule](#) `FILL_UNTIL_END` or `FILL_UNTIL_MAX_SIZE` is applicable.

Thereby the order of arguments corresponds to the order of elements in the array, i.e. the first argument corresponds to the first element of the array, the second argument corresponds to the second element of the array, and so on.] ([SRS_Rte_00239](#))

AUTOSAR defines a standardized behavior of [RuleBasedValueSpecifications](#) only for the rules `FILL_UNTIL_END` and `FILL_UNTIL_MAX_SIZE`. RTE vendors are free to add additional, non-standardized rules (see [TPS_SWCT_01495]).

[SWS_Rte_06735] [The RTE Generator shall apply the value of the last [RuleBasedValueSpecification](#) argument to any following element of the array until the last

element of the array if the `rule` is set to `FILL_UNTIL_END` and the number of arguments is smaller than the number of elements of the array to which it is applied.]([SRS_Rte_00239](#))

[SWS_Rte_08792] [The RTE Generator shall apply the value of the last `RuleBasedValueSpecification` argument to so many following elements of the array until first `maxSizeToFill` elements of the array are filled if the `rule` is set to `FILL_UNTIL_MAX_SIZE` and the number of arguments is smaller than the number of elements of the array to which it is applied.]([SRS_Rte_00239](#))

[SWS_Rte_06736] [The RTE Generator shall ignore arguments that go beyond the last element of the array if the number of arguments exceeds the number of elements of the array to which it is applied.]([SRS_Rte_00239](#))

4.2.9 Measurement and Calibration

4.2.9.1 General

Calibration is the process of adjusting an ECU SW to fulfill its tasks to control physical processes respectively to fit it to special project needs or environments. To do this two different mechanisms are required and have to be distinguished:

1. Measurement

Measure what's going on in the ECU e.g. by monitoring communication data (Inter-ECU, Inter-Partition, Intra-partition, Intra-SWC). There are several ways to get the monitor data out of the ECU onto external visualization and interpretation tools.

2. Calibration

Based on the measurement data the ECU behavior is modified by changing parameters like runtime SW switches, process controlling data of primitive or composite data type, interpolation curves or interpolation fields. In the following for such parameters the term calibration parameter is used.

With AUTOSAR, a calibration parameter is instantiated with a `ParameterDataPrototype` class that aggregates a `SwDataDefProps` with properties `swCalibrationAccess = readWrite` and `swImplPolicy = standard`.

Nevertheless it is supported, that `VariableDataPrototype` is instantiated that aggregates a `SwDataDefProps` with properties `swCalibrationAccess = readWrite` and `swImplPolicy = standard`. But in this case the implementation of such `VariableDataPrototype` is treated identical to `swCalibrationAccess = readOnly` and the RTE Generator has not to implement further measures (for instance "Data emulation with SW support" [4.2.9.3.5](#)).

It's possible that different `SwDataDefProps` settings are specified for a `VariableDataPrototype` and its referenced `AutosarDataType`. In this case the rules specified in the SWC-T shall be applied. See as well [SWS_Rte_07196].

`SwDataDefProps` contain more information how measurement values or characteristics are to be interpreted and presented by external calibration tools. This information is needed for the ASAM2 respectively A2L file generation. Afterwards the A2L file is used by ECU-external measurement and calibration tools so that these tools know e.g. how to interpret raw data received from ECU and how to get them.

4.2.9.1.1 Definition of Calibration Parameters

Calibration parameters can be defined in AUTOSAR SW as well as in Basic-SW. In the *AUTOSAR Architecture* there are two possibilities to define calibration parameters. Which one to choose is not in the focus of this RTE specification.

1. RTE provides the calibration parameter access if they are specified via a `ParameterSwComponentType`. A `ParameterSwComponentType` can be defined in order to provide `ParameterDataPrototypes` (via ports) to other Software Components.
2. Calibration parameter access invisible for RTE
 Since multiple instantiation with code sharing is not allowed for Basic-SW and multiple instantiation is not always required for software components it's possible for these software to define own methods how calibration parameters are allocated. Nevertheless these calibration parameters shall be described in the belonging *Basic Software Module Description* respectively *Software Component Description*. In case data emulation with SW-support is used, the whole software and tool chain for calibration and measurement, e.g. Basic-SW (respectively XCP driver) which handles emulation details and data exchange with external calibration tools then has to deal with several emulation methods at once: The one the RTE uses and the other ones each Basic-SW or SWC using local calibration parameters practices.

4.2.9.1.2 Online and offline calibration

The way how measurement and calibration is performed is company, domain and project specific. Nevertheless two different basic situations can be distinguished and are important for understanding:

1. Offline calibration
 Measure when ECU is running, change calibration data when ECU is off.
 Process might look like this:
 - (a) Flash the ECU with current program file
 - (b) PowerUp ECU in target (actual or emulated) environment

- (c) Measure running ECU behavior - log or monitor via external tooling
- (d) Switch off ECU
- (e) Change calibration parameters and create a new flashable program file (hex-file) e.g. by performing a new SW make run
- (f) Back to (a).

Do loop as long as a need for calibration parameter change exists or the Flash survives.

2. Online calibration

Do measurement and calibration in parallel.

In this case in principle all steps mentioned in "Offline calibration" above have to be performed in parallel. So other mechanisms are introduced avoiding ECU flashing when modifying ECU parameters. ECU works temporarily with changed data and when the calibration process is over the result is an updated set of calibration data. In next step this new data set might be merged into the existing program file or the new data set might be an input for a new SW make run. In both cases the output is a new program file to flash into the ECU.

Process might look like this:

- (a) Flash the ECU with current program file
- (b) PowerUp ECU in target environment
- (c) Measure running ECU behavior and temporarily modify calibration parameters. Store set of updated calibration parameters (not on the ECU but on the calibration tool computer). Actions in step c) may be done iteratively.
- (d) Switch off ECU
- (e) Create a new flashable program file (hex-file) containing the new calibration parameters

Procedure over

4.2.9.2 Measurement

4.2.9.2.1 What can be measured

The AUTOSAR SW-C template specification [2] explains to which AUTOSAR prototypes a measurement pattern can be applied.

RTE provides measurement support for

1. communication between Ports
Measurable are

- `VariableDataPrototypes` of a `SenderReceiverInterface` used in a `PortPrototype` (of a `SwComponentPrototype`) to capture sender-receiver communication or between `SwComponentPrototypes`
 - `VariableDataPrototypes` of a `NvDataInterface` used in a `PortPrototype` (of a `SwComponentPrototype`) to capture non volatile data communication or between `SwComponentPrototypes`
 - `ArgumentDataPrototypes` of an `ClientServerOperation` in a `ClientServerInterface` to capture client-server communication between `SwComponentPrototypes`
2. communication inside of AUTOSAR SW-Cs
Measurable are `implicitInterRunnableVariable`, `explicitInterRunnableVariable` or `arTypedPerInstanceMemory`
 3. data structures inside a AUTOSAR `NvBlockSwComponent`
Measurable are `ramBlocks` and `romBlocks` of a `NvBlockSwComponent`'s `NvBlock`
 4. Communication inside of AUTOSAR Basic Software Modules
Measurable are `VariableDataPrototypes` defined in role of `arTypedPerInstanceMemory`.

Further on AUTOSAR SW-Cs and *Basic Software Modules* can define measurables which are not instantiated by RTE. These are described by `VariableDataPrototypes` in the role `staticMemory`. Hence those kind of measurables are not described in the generated `McSupportData` of the RTE (see 4.2.9.4).

4.2.9.2.2 RTE support for Measurement

The way how measurement data is read out of the ECU is not focus of the RTE specification. But the RTE structure and behavior must be specified in that way that measurement values can be provided by RTE during ECU program execution.

To avoid synchronization effort it shall be possible to read out measurement data asynchronously to RTE code execution. For this the measurement data must be stable. As a consequence this might forbid direct reuse of RAM locations for implementation of several AUTOSAR communications which are independent of each other but occurring sequentially in time (e.g. usage of same RAM cell to store uint8 data sender receiver communication data between Runnables at positions 3 and 7 and later the same RAM cell for the communication between Runnables at positions 9 and 14 of same periodically triggered task). So applying measurable elements might lead to less optimizations in the generated RTE's code and to increased RAM need.

There are circumstances when RTE will store same communication data in different RAM locations, e.g. when realizing implicit sender receiver communication or InterRunnable Variables with implicit behavior. In these cases there is only the need to

have the content of one of these stores made accessible from outside.

Please note: In case the Rte implements Inter partition data communication with IOC the measurement support may become vendor specific since the IOC does not provide standardized support for measurement of IOC channels. But on the other hand the creation of distinct measurement buffers in the Rte in addition to the needed buffers in IOC is also not a worthwhile in any case due to the additional RAM need.

The information that measurement shall be supported by RTE is defined in applied `SwDataDefProps`:

The value `readOnly` or `readWrite` of the property `swCalibrationAccess` defines that measurement shall be supported, any other value of the property `swCalibrationAccess` is to be ignored for measurement.

Please note that the definition of `[SWS_Rte_03900]` and `[SWS_Rte_03902]` do not have further conditions when the location in memory has to be provided to support the usage of `VariableDataPrototype` with the `swImplPolicy = measurementPoint`. In case that the MCD system is permitted to access such a `VariableDataPrototype` the RTE is not allowed to do optimization which would prevent such measurement even if there is no consuming software component in the input configuration.

The memory locations containing measurement values are initialized according to `[SWS_Rte_07046]` and `[SWS_Rte_03852]`.

[SWS_Rte_07044] [The RTE generator shall reject input configurations in which a `RunnableEntity` defines a read access (`VariableAccess` in the role `readLocalVariable`, `dataReadAccess`, `dataReceivePointByValue` or `dataReceivePointByArgument`) to an `VariableDataPrototype` with a `swImplPolicy` set to `measurementPoint`.] (`SRS_Rte_00018`)

For sender-receiver resp. client-server communication same or compatible interfaces are used to specified connected ports. So very often measurement will be demanded two times for same or compatible `VariableDataPrototype` on provide and require side of a 1:1 communication resp. multiple times in case of 1:N or M:1 communication. In that case providing more than one measurement value for a `VariableDataPrototype` doesn't make sense and would increase ECU resources need excessively. Instead only one measurement value shall be provided.

Sender-receiver communication

[SWS_Rte_03900] [If the `swCalibrationAccess` of a `VariableDataPrototype` used in an interface of a sender-receiver port of a `SwComponentPrototype` is set to `readOnly` or `readWrite` the RTE generator has to provide one reference to a location

in memory where the actual content of the instance specific data of the corresponding `VariableDataPrototype` of the communication can be accessed.]([SRS_Rte_00153](#))

To prohibit multiple measurement values for same communication:
(Note that affected `VariableDataPrototypes` might be specified in same or compatible port interfaces.)

[SWS_Rte_03972] [For 1:1 and 1:N sender-receiver communication the RTE shall provide measurement values taken from sender side if measurement is demanded in provide and require port.]([SRS_Rte_00153](#))

[SWS_Rte_03973] [For N:1 intra-ECU sender-receiver communication the RTE shall provide measurement values taken from receiver side if measurement is demanded in provide and require ports.]([SRS_Rte_00153](#))

Note:

See further below for support of queued communication.

[SWS_Rte_03974] [For a `VariableDataPrototype` with measurement demand associated with received data of inter-ECU sender-receiver communication the RTE shall provide only one measurement store reference containing the actual received data even if several receiver ports demand measurement.]([SRS_Rte_00153](#))

[SWS_Rte_07344] [For a `VariableDataPrototype` with measurement demand associated with received data of inter-Partition sender-receiver communication the RTE shall provide only one measurement store reference per partition containing the actual received data even if several receiver ports demand measurement in the Partition.]([SRS_Rte_00153](#))

Client-Server communication

[SWS_Rte_03901] [If the `swCalibrationAccess` of an `ArgumentDataPrototype` used in an interface of a client-server port of a `SwComponentPrototype` is set to `readOnly` the RTE generator has to provide one reference to a location in memory where the actual content of the instance specific argument data of the communication can be read.]([SRS_Rte_00153](#))

To prohibit multiple measurement values for same communication:
(Note that affected `ArgumentDataPrototypes` might be specified in same or compatible port interfaces.)

[SWS_Rte_03975] [For intra-ECU client-server communication the RTE shall provide measurement values taken from client side if measurement of an `ArgumentDataPrototypes` is demanded by provide and require ports.]([SRS_Rte_00153](#))

[SWS_Rte_03976] [For inter-ECU client-server communication with the client being present on same ECU as the RTE, the RTE shall provide measurement values taken from client side.]([SRS_Rte_00153](#))

[SWS_Rte_03977] [For inter-ECU client-server communication with the server being present on same ECU as the RTE, the RTE shall provide measurement values taken from server if no client present on same ECU as the server is connected with that server too.]([SRS_Rte_00153](#))

[SWS_Rte_07349] [For inter-Partition client-server communication with the server being present on the same ECU as the RTE, the RTE shall provide measurement values taken from server if no client present on the same Partition as the server is connected with that server too.]([SRS_Rte_00153](#))

Note:

When a measurement is applied to a client-server call additional copy code might be produced so that a zero overhead direct server invocation is no longer possible for this call.

Mode Switch Communication

[SWS_Rte_06700] [If the `swCalibrationAccess` of a `ModeDeclarationGroupPrototype` used in an interface of a `mode switch port` of a `SwComponentPrototype` is set to `readOnly` the RTE generator has to provide three references to locations in memory where the *current mode*, the *previous mode* and the *next mode* of the related `mode machine instance` can be accessed.]([SRS_Rte_00153](#))

The affected `ModeDeclarationGroupPrototypes` might be used at different ports with the same or compatible port interfaces. **[SWS_Rte_06701]** prohibits the occurrence of multiple measurement values for the same communication:

[SWS_Rte_06701] [For 1:1 and 1:N mode switch communication the RTE shall provide measurement values taken from `mode manager` side if measurement is demanded in provide and require port.]([SRS_Rte_00153](#))

Inter Runnable Variables

[SWS_Rte_03902] [If the `swCalibrationAccess` of a `VariableDataPrototype` in the role `implicitInterRunnableVariable` or `explicitInterRunnableVariable` is set to `readOnly` or `readWrite` the RTE generator has to provide one reference to a location in memory where the actual content of the *Inter Runnable Variable* can be accessed for a specific instantiation of the AUTOSAR SWC.]([SRS_Rte_00153](#))

PerInstanceMemory

[SWS_Rte_07160] [If the `swCalibrationAccess` of a `VariableDataPrototype` in the role `arTypedPerInstanceMemory` is set to `readOnly` or `readWrite` the RTE generator has to provide one reference to a location in memory where the actual content of the `arTypedPerInstanceMemory` can be accessed for a specific instantiation of the AUTOSAR SWC.]([SRS_Rte_00153](#))

[SWS_Rte_06206] [If the `swCalibrationAccess` of a `VariableDataPrototype` in the role `arTypedPerInstanceMemory` is set to `readOnly` or `readWrite` the RTE Generator has to provide exactly one reference to a location in memory where the actual content of the `arTypedPerInstanceMemory` can be accessed for a specific instantiation of the Basic Software Module.

]([SRS_Rte_00153](#))

Nv RAM Block

[SWS_Rte_07174] [If the `swCalibrationAccess` of a `VariableDataPrototype` in the role `ramBlock` of a `NvBlockSwComponentType`'s `NvBlockDescriptor` is set to `readOnly` or `readWrite` the RTE generator has to provide one reference to a location in memory where the actual content of the *Nv RAM Block* can be accessed for a specific instantiation of the AUTOSAR `NvBlockSwComponentType`.

]([SRS_Rte_00153](#))

Non Volatile Data communication

[SWS_Rte_07197] [If the `swCalibrationAccess` of a `VariableDataPrototype` used in an `NvDataInterface` of a non volatile data port of a `SwComponentPrototype` is set to `readOnly` or `readWrite` the RTE generator has to provide one reference to a location in memory where the actual content of the instance specific data of the corresponding `VariableDataPrototype` of the communication can be accessed.]([SRS_Rte_00153](#))

To prohibit multiple measurement values for same communication:

(Note that affected `VariableDataPrototypes` might be specified in same or compatible port interfaces.)

[SWS_Rte_07198] [For 1:1 and 1:N non volatile data communication the RTE shall provide measurement values taken from `ramBlock` if measurement is demanded either in provide port, any require port ([\[SWS_Rte_07197\]](#) or `ramBlock` ([\[SWS_Rte_07174\]](#))).]([SRS_Rte_00153](#))

Unconnected ports or compatible interfaces

As stated in section [5.2.7](#) RTE supports handling of unconnected ports.

Measurement support for unconnected sender-receiver provide ports makes sense since a port might be intentionally added for monitoring purposes only.

Measurement support for unconnected sender-receiver require ports makes sense since the measurement is specified on the type level of the Software Component and therefore independent of the individual usage of the Software Component. In case of unconnected sender-receiver require ports the measurement shall return the initial value.

Support for unconnected client-server provide port does not make sense since the server cannot be called and with this no data can be passed there.

Support for unconnected client-server require port makes sense since the measurement is specified on the type level of the Software Component and therefore independent of the individual usage of the Software Component. In case of unconnected client-server require ports the measurement shall return the actually provided and returned values.

[SWS_Rte_03978] [For sender-receiver communication the RTE generator shall respect measurement demands enclosed in unconnected provide ports.]([SRS_Rte_00139](#), [SRS_Rte_00153](#))

[SWS_Rte_05101] [For sender-receiver communication the RTE generator shall respect measurement demands enclosed in unconnected require ports and deliver the initial value.]([SRS_Rte_00139](#), [SRS_Rte_00153](#))

[SWS_Rte_03980] [For client-server communication the RTE generator shall ignore measurement demands enclosed in unconnected provide ports.]([SRS_Rte_00139](#), [SRS_Rte_00153](#))

[SWS_Rte_05102] [For client-server communication the RTE generator shall respect measurement demands enclosed in unconnected require ports. The behavior shall be similar as if the require port would be connected and the server does not respond.]([SRS_Rte_00139](#), [SRS_Rte_00153](#))

[SWS_Rte_05170] [For client-server communication the RTE generator shall ignore measurement requests for queued client-server communication.]([SRS_Rte_00139](#), [SRS_Rte_00153](#))

In case the measurement of client-server communication is not possible due to requirement [\[SWS_Rte_05170\]](#) the [McSupportData](#) need to reflect this (see [\[SWS_Rte_05172\]](#)).

In principle the same thoughts as above are applied to unused [VariableDataPrototypes](#) for sender-receiver communication where ports with compatible but not same interfaces are connected. It's no issue for client-server due to compatibility rules for client-server interfaces since in compatible client-server interfaces all [ClientServerOperations](#) have to be present in provide and require port (see AUTOSAR SW-C Template [\[2\]](#)).

[SWS_Rte_03979] [For sender-receiver communication the RTE generator shall respect measurement demands of those [VariableDataPrototypes](#) in connected ports when provide and require port interfaces are not the same (but only compatible) even when a [VariableDataPrototype](#) in the provide port has no assigned [VariableDataPrototype](#) in the require port.]([SRS_Rte_00153](#))

General measurement disabling switch

To support saving of ECU resources for projects where measurement isn't required at all whereas enclosed AUTOSAR SW-Cs contain [SwDataDefProps](#) requiring it, it shall be possible to switch off support for measurement. This shall not influence support for calibration (see [4.2.9.3](#)).

[SWS_Rte_03903] [The RTE generator shall have the option to switch off support for measurement for generated RTE code. This option shall influence complete RTE code at once.] ([SRS_Rte_00153](#))

There also might be projects in which monitoring of ECU internal behavior is required but calibration is not.

[SWS_Rte_03904] [The enabling of RTE support for measurement shall be independent of the enabling of the RTE support for calibration.] ([SRS_Rte_00153](#))

Queued communication

Measurement of queued communication is not supported yet. Reasons are:

- A queue can be empty. What's to measure then?
- Which of the queue entries is the one to take the data from might differ out of user view?
- Only quite inefficient solutions possible because implementation of queues entails storage of information dynamically at different memory locations. So always additional copies are required.

[SWS_Rte_03950] [RTE generator shall reject configurations where measurement for queued sender-receiver communication is configured.] ([SRS_Rte_00153](#), [SRS_Rte_00018](#))

4.2.9.3 Calibration

The RTE and *Basic Software Scheduler* has to support the allocation of calibration parameters and the access to them for SW using them. As seen later on for some calibration methods the RTE and *Basic Software Scheduler* must contain support SW too (see [4.2.9.3.5](#)). But in general the RTE and *Basic Software Scheduler* is not responsible for the exchange of the calibration data values or the transportation of them between the ECU and external calibration tools.

The following sections are mentioning only the RTE but this has to be understood in the context that the support for *Calibration* is a functionality which affects the Basic Software Scheduler part of the RTE as well. In case of the *Basic Software Scheduler Generation Phase* (see [3.4.1](#)) this functionality might even be provided with out any other software component related RTE functionality.

With AUTOSAR, a calibration parameter (which the AUTOSAR SW-C template specification [2] calls `ParameterSwComponentType`) is instantiated with a `ParameterDataPrototype` that aggregates a `SwDataDefProps` with properties `swCalibrationAccess = readWrite` and `swImplPolicy = standard`. This chapter applies to this kind of `ParameterSwComponentTypes`. For other combinations of these properties, consult the section [4.2.8](#)

4.2.9.3.1 Calibration parameters

Calibration parameters can be defined in [ParameterSwComponentTypes](#), in AUTOSAR SW-Cs, [NvBlockSwComponentTypes](#) and in *Basic Software Modules*.

1. [ParameterSwComponentTypes](#) don't have an internal behavior but contain [ParameterDataPrototypes](#) and serve to provide calibration parameters used commonly by several AUTOSAR SW-Cs. The use case that one or several of the user SW-Cs are instantiated on different ECUs is supported by instantiation of the [ParameterSwComponentType](#) on the affected ECUs too.
Of course several AUTOSAR SW-Cs allocated on one ECU can commonly access the calibration parameters of [ParameterSwComponentTypes](#) too. Also several instances of an AUTOSAR SW-Cs can share the same calibration parameters of a [ParameterSwComponentType](#).
2. Calibration parameters defined in AUTOSAR SW-Cs can only be used inside the SW-C and are not visible to other SW-Cs. Instance individual and common calibration parameters accessible by all instances of an AUTOSAR SW-C are possible.
3. For [NvBlockSwComponentTypes](#) it is supported to provide calibration access to the [ParameterDataPrototype](#) defining the [romBlock](#). These values can not be directly accessed by AUTOSAR SW-Cs but are used to serve as default values for the NVRAM Block applied via [InitBlockCallbackFunction](#).
4. Calibration parameters defined in *Basic Software Modules* can only be used inside the defining *Basic Software Module* and are not visible to other *Basic Software Modules*. In contrast to AUTOSAR SW-Cs, *Basic Software Modules* can only define instance specific calibration parameters.

[SWS_Rte_03958] [Several AUTOSAR SW-Cs (and also several instances of AUTOSAR SW-Cs) shall be able to share same calibration parameters defined in [ParameterSwComponentTypes](#).] ([SRS_Rte_00154](#), [SRS_Rte_00159](#))

[SWS_Rte_07186] [The generated RTE shall initialize the memory objects implementing [ParameterDataPrototypes](#) in *p-ports* of [ParameterSwComponentTypes](#) according the [ValueSpecification](#) of the [ParameterProvideComSpec](#) referring the [ParameterDataPrototype](#) in the *p-port*,

- if such [ParameterProvideComSpec](#) exists and
- if no [CalibrationParameterValue](#) refers to the [FlatInstanceDescriptor](#) associated to the [ParameterDataPrototype](#)

This is also applicable if the [swImplPolicy](#) = *fixed* and if the related [ParameterDataPrototype](#) is implemented as preprocessor define which does not immediately allocate a memory object.] ([SRS_Rte_00154](#), [SRS_Rte_00159](#))

[SWS_Rte_07029] [The generated RTE shall initialize the memory objects implementing `ParameterDataPrototypes` in *p-ports* of `ParameterSwComponentTypes` according the `ValueSpecification` in the role `implInitValue` of the `CalibrationParameterValue` referring the `FlatInstanceDescriptor` associated to the `ParameterDataPrototype` if such `CalibrationParameterValue` is defined.] (*SRS_Rte_00154*)

Note: the initialization according [\[SWS_Rte_07029\]](#) and [\[SWS_Rte_07030\]](#) precedes the initialization values defined in the context of an component type and used in [\[SWS_Rte_07185\]](#) and [\[SWS_Rte_07186\]](#). This enables to provide initial values for calibration parameter instances to:

- predefine start values for the calibration process
- utilizes the result of the calibration process
- take calibration parameter values from previous projects

[SWS_Rte_03959] [If the `SwcInternalBehavior` aggregates an `ParameterDataPrototype` in the role `perInstanceParameter` the RTE shall support the access to instance specific calibration parameters of the AUTOSAR SW-C.] (*SRS_Rte_00154*, *SRS_Rte_00158*)

[SWS_Rte_05112] [If the `SwcInternalBehavior` aggregates an `ParameterDataPrototype` in the role `sharedParameter` the RTE shall create a common access to the shared calibration parameter.] (*SRS_Rte_00154*, *SRS_Rte_00159*)

[SWS_Rte_07096] [If the `BswInternalBehavior` aggregates an `ParameterDataPrototype` in the role `perInstanceParameter` the *Basic Software Scheduler* shall support the access to instance specific calibration parameters of the *Basic Software Module*.] (*SRS_Rte_00154*, *SRS_Rte_00158*)

[SWS_Rte_07185] [The generated RTE and *Basic Software Scheduler* shall initialize the memory objects implementing `ParameterDataPrototype` in the role `perInstanceParameter` or `sharedParameter`

- if it has a `ValueSpecification` in the role `initValue` according to this `ValueSpecification` and
- if no `CalibrationParameterValue` refer to the `FlatInstanceDescriptor` associated to the `ParameterDataPrototype`

This is also applicable if the `swImplPolicy` = `fixed` and if the related `ParameterDataPrototype` is implemented as preprocessor define which does not immediately allocate a memory object.] (*SRS_Rte_00154*)

[SWS_Rte_07030] [The generated RTE and *Basic Software Scheduler* shall initialize the memory objects implementing `ParameterDataPrototypes` in the role `perInstanceParameter` or `sharedParameter` according the `ValueSpecification` in the role the `implInitValue` of the `CalibrationParameterValue` referring the `FlatInstanceDescriptor` associated to the `ParameterDataPrototype` if such `CalibrationParameterValue` is defined.] (*SRS_Rte_00154*)

It might be project specific or even project phase specific which calibration parameters have to be calibrated and which are assumed to be stable. So it shall be selectable on [ParameterSwComponentTypes](#) and AUTOSAR SW-C granularity level for which calibration parameters RTE shall support calibration.

If an r-port contains a [ParameterDataPrototype](#), the following requirements specify its behavior if the port is unconnected.

[SWS_Rte_02749] [In case of an unconnected parameter r-port, the RTE shall set the values of the [ParameterDataPrototypes](#) of the r-port according to the `initValue` of the r-port's [ParameterRequireComSpec](#) referring to the [ParameterDataPrototype](#).]([SRS_Rte_00139](#), [SRS_Rte_00159](#))

If the port is unconnected, RTE expects an init value, see [[SWS_Rte_02750](#)].

ParameterDataPrototypes in role `romBlock`

[SWS_Rte_07033] [If the [swCalibrationAccess](#) of a [ParameterDataPrototype](#) in the role `romBlock` is set to `readWrite` the RTE generator has to provide one reference to a location in memory where the actual content of the *romBlock* can be accessed.]([SRS_Rte_00154](#))

[SWS_Rte_07034] [The generated RTE shall initialize any [ParameterDataPrototype](#) in the role `romBlock`

- if it has a [ValueSpecification](#) in the role `initValue` according to this [ValueSpecification](#) and
- if no [CalibrationParameterValue](#) refer to the [FlatInstanceDescriptor](#) associated to the [ParameterDataPrototype](#)

]([SRS_Rte_00154](#))

[SWS_Rte_07035] [The generated RTE shall initialize the memory objects implementing [ParameterDataPrototypes](#) in the role `romBlock` according the [ValueSpecification](#) in the role the `implInitValue` of the [CalibrationParameterValue](#) referring the [FlatInstanceDescriptor](#) associated to the [ParameterDataPrototype](#) if such [CalibrationParameterValue](#) is defined.]([SRS_Rte_00154](#))

[ParameterDataPrototype](#) used as `romBlock` are instantiated according to [[SWS_Rte_07693](#)].

Configuration of calibration support

[SWS_Rte_03905] [It shall be configurable for each [ParameterSwComponentType](#) if RTE calibration support for the enclosed [ParameterDataPrototypes](#) is enabled or not.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

[SWS_Rte_03906] [It shall be configurable for each AUTOSAR SW-C if RTE calibration support for the enclosed [ParameterDataPrototypes](#) is enabled or not.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

RTE calibration support means the creation of SW as specified in section 4.2.9.3.5 "Data emulation with SW support".

Require ports on `ParameterSwComponentTypes` don't make sense. `ParameterSwComponentTypes` only have to provide calibration parameters to other Component types. So the RTE generator shall reject configurations containing require ports attached to `ParameterSwComponentTypes`. (see section A.14)

4.2.9.3.1.1 Separation of calibration parameters

Sometimes it is required that one or more calibration parameters out of the mass of calibration parameters of an `ParameterSwComponentType` respectively an AUTOSAR SW-C shall be placed in another memory location than the other parameters of the `ParameterSwComponentType` respectively the AUTOSAR SW-C. This might be due to security reasons (separate normal operation from monitoring calibration data in memory) or the possibility to change calibration data during a diagnosis session (which the calibration parameter located in NVRAM).

[SWS_Rte_03907] [The RTE generator shall support separation of calibration parameters from `ParameterSwComponentTypes`, AUTOSAR SW-Cs and *Basic Software Modules* depending on the `ParameterDataPrototype` property `swAddrMethod`.] (*SRS_Rte_00154*, *SRS_Rte_00158*)

4.2.9.3.2 Support for offline calibration

As described in section 4.2.9.1 when using an offline calibration process measurement is decoupled from providing new calibration parameters to the ECUs SW. During measurement phase information is collected needed to define to which values the calibration parameters are to be set best. Afterwards the new calibration parameter set is brought into the ECU e.g. by using a bootloader.

[SWS_Rte_03971] [The RTE generator shall have the option to switch off all *data emulation* support for generated RTE code. This option shall influence complete RTE code at once.] (*SRS_Rte_00154*, *SRS_Rte_00156*)

The term *data emulation* is related to mechanisms described in section 4.2.9.3.3.

Out of view of RTE the situation is same as when *data emulation without SW support* (described in section 4.2.9.3.4) is used:

The RTE is only responsible to provide access to the calibration parameters via the RTE API as specified in section 5.6. Exchange of `ParameterDataPrototype` content is done invisibly for ECU program flow and with this for RTE too.

When no *data emulation support* is required calibration parameter accesses to parameters stored in FLASH could be performed by direct memory read accesses without any indirection for those cases when accesses are coming out of single instantiated

AUTOSAR SW-Cs or from *Basic Software Modules*. Nevertheless it's not goal of this specification to require direct accesses since this touches implementation. It might be ECU HW dependent or even be project dependent if other accesses are more efficient or provide other significant advantages or not.

4.2.9.3.3 Support for online calibration: Data emulation

To allow **online calibration** it must be possible to provide alternative calibration parameters invisible for application. The mechanisms behind are described here. We talk of *data emulation*.

In the following several calibration methods are described:

1. Data emulation without SW support and
2. several methods of data emulation with SW-support.

The term **data emulation** is used because the change of calibration parameters is emulated for the ECU SW which uses the calibration data. This change is invisible for the user-SW in the ECU.

RTE is significantly involved when SW support is required and has to create calibration method specific SW. Different calibration methods means different support in Basic SW which typically is ECU integrator specific. So it does not make sense to support DIFFERENT data emulation with SW support methods in ANY one RTE build. But it makes sense that the RTE supports direct access (see section 4.2.9.3.4) for some AUTOSAR SW-Cs resp. [ParameterSwComponentTypes](#) resp. *Basic Software Modules* and one of the data emulation with SW support methods (see section 4.2.9.3.5) for all the other AUTOSAR SW-Cs resp. [ParameterSwComponentTypes](#) resp. *Basic Software Modules* at the same time.

[SWS_Rte_03909] [The RTE shall support only one of the data emulation with SW support methods at once.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

4.2.9.3.4 Data emulation without SW support (direct access)

For "online calibration" (see section 4.2.9.1) the ECU is provided with additional hardware which consists of control logic and memory to store modified calibration parameters in. During ECU execution the brought in control logic redirects memory accesses to new bought in memory whose content is modified by external tooling without disturbing normal ECU program flow. Some microcontrollers contain features supporting this. A lot of smaller microcontrollers don't. So this methods is highly HW dependent.

To support these cases the RTE doesn't have to provide e.g. a reference table like described in section 4.2.9.3.5. Exchange of `ParameterDataPrototype` content is done invisibly for program flow and for RTE too.

[SWS_Rte_03942] [The RTE generator shall have the option to switch off *data emulation with SW support* for generated RTE code. This option shall influence complete RTE code at once.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

4.2.9.3.5 Data emulation with SW support

In case "online calibration" (see section 4.2.9.1) is required, quite often data emulation without support by special SW constructs isn't possible. Several methods exist, all have the consequence that additional need of ECU resources like RAM, ROM/FLASH and runtime is required.

Data emulation with SW support is possible in different manners. During calibration process in each of these methods modified calibration data values are kept typically in RAM. Modification is controlled by ECU external tooling and supported by ECU internal SW located in AUTOSAR basic SW or in complex driver.

If calibration process isn't active the accessed calibration data is originated in ROM/FLASH respectively in NVRAM in special circumstances (as seen later on).

Since multiple instantiation is to be supported several instances of the same `ParameterDataPrototypes` have to be allocated. Because the RTE is the only one SW in an AUTOSAR ECU able to handle the different instances the access to these calibration parameters can only be handled by the RTE. So the RTE has to provide additional SW constructs required for data emulation with SW support for calibration.

However the RTE doesn't know which of the ECU functionality shall be calibrated during a calibration session. To allow expensive RAM to be reused to calibrate different ECU functionalities in one or several online calibration sessions (see 4.2.9.1) in case of the single and double pointered methods for data emulation with SW support described below the RTE has only to provide the access to `ParameterDataPrototypes` during runtime but allowing other SW (a BSW module or a complex driver) to redirect the access to alternative calibration parameter values (e.g. located in RAM) invisibly for application.

The RTE is neither the instance to supply the alternative values for `ParameterDataPrototypes` nor in case of the pointered methods for data emulation with SW support to do the redirection to the alternative values.

[SWS_Rte_03910] [The RTE shall support *data emulation with SW support* for calibration.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

[SWS_Rte_03943] [The RTE shall support these data emulation methods with SW support:

- Single pointered calibration parameter access further called "single pointered method"

- Double pointered calibration parameter access further called "double pointered method"
- Initialized RAM parameters further called "initRAM parameter method"

]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

Please note that the support data emulation methods is applicable for calibration parameters provided for software components as well as calibration parameters provided for basic software modules.

ParameterElementGroup

To save RAM/ROM/FLASH resources in single pointered method and double pointered method [ParameterDataPrototype](#) allocation is done in groups. One entry of the calibration reference table references the begin of a group of [ParameterDataPrototypes](#). For better understanding of the following, this group is called [ParameterElementGroup](#) (which is no term out of the AUTOSAR SW-C template specification [2]). One [ParameterElementGroup](#) can contain one or several [ParameterDataPrototypes](#).

[SWS_Rte_03911] [If data emulation with SW support is enabled, the RTE generator shall allocate all [ParameterDataPrototypes](#) marked with same property [swAddrMethod](#) of one instance of a [ParameterSwComponentType](#) consecutively. Together they build a separate [ParameterElementGroup](#).]([SRS_Rte_00154](#), [SRS_Rte_00156](#), [SRS_Rte_00158](#))

[SWS_Rte_03912] [If data emulation with SW support is enabled, the RTE shall guarantee that all non-shared [ParameterDataPrototypes](#) marked with same property [swAddrMethod](#) of an AUTOSAR SWC instance are allocated consecutively. Together they build a separate [ParameterElementGroup](#).]([SRS_Rte_00154](#), [SRS_Rte_00158](#))

[SWS_Rte_05194] [If data emulation with SW support is enabled, the RTE shall guarantee that all shared [ParameterDataPrototypes](#) marked with same property [swAddrMethod](#) of an AUTOSAR SWC type are allocated consecutively. Together they build a separate [ParameterElementGroup](#).]([SRS_Rte_00154](#), [SRS_Rte_00158](#))

It is not possible to access same calibration parameter inside of a [ParameterSwComponentType](#) via several ports. This is a consequence of the need to support the use case that a [ParameterSwComponentType](#) shall be able to contain several calibration parameters derived from one [ParameterDataPrototype](#) which is contained in one interface applied to several ports of the [ParameterSwComponentType](#). Using only the [ParameterDataPrototype](#) names for the names of the elements of a [ParameterElementGroup](#) would lead to a name clash since then several elements with same name would have to be created. So port prototype and [ParameterDataPrototype](#) name are concatenated to specify the [ParameterElementGroup](#) member names.

This use case cannot be applied to AUTOSAR SW-C internal calibration parameters since they cannot be accessed via AUTOSAR ports.

[SWS_Rte_03968] [The names of the elements of a [ParameterElementGroup](#) derived from a [ParameterSwComponentType](#) shall be <port>_<element> where <port> is the short-name of the provided AUTOSAR port prototype and <element> the short-name of the [ParameterDataPrototype](#) within the [ParameterInterface](#) categorizing the PPort.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

4.2.9.3.5.1 Single pointered method

There is one calibration reference table in RAM with references to one or several [ParameterElementGroups](#). Accesses to calibration parameters are indirectly performed via this reference table.

Action during calibration procedure e.g. calibration parameter value exchange is not focus of this specification. Nevertheless an example is given for better understanding.

Example how the exchange of calibration parameters could be done for single pointered method:

1. Fill a RAM buffer with the modified calibration parameter values for complete [ParameterElementGroup](#)
2. Modify the corresponding entry in the calibration reference table so that a redirection to new [ParameterElementGroup](#) is setup

Now calibration parameter accesses deliver the modified values.

Figure 4.26 illustrates the method.

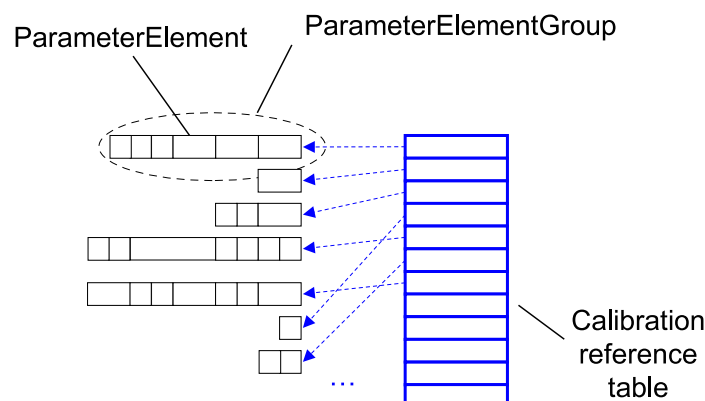


Figure 4.26: ParameterElementGroup in single pointered method context

[SWS_Rte_03913] [If data emulation with SW support with single pointered method is enabled, the RTE generator shall create a table located in RAM with references

to [ParameterElementGroups](#). The type of the table is an array of void pointers.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

One reason why in this approach the calibration reference table is realized as an array is to make ECU internal reference allocation traceable for external tooling. Another is to allow a Basic-SW respectively a complex driver to emulate other calibration parameters which requires the standardization of the calibration reference table too.

[SWS_Rte_03947] [If data emulation with SW support with single method is enabled the name (the label) of the calibration reference table shall be <RteParameter-RefTab>.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

Calibration parameters located in NVRAM are handled same way (also see section [4.2.9.3.6](#)).

[SWS_Rte_03936] [If data emulation with SW support with single or double pointered method is enabled and calibration parameter respectively a [ParameterElementGroups](#) is located in NVRAM the corresponding calibration reference table entry shall reference the PerInstanceMemory working as the NVRAM RAM buffer.]([SRS_Rte_00154](#), [SRS_Rte_00156](#), [SRS_Rte_00157](#))

4.2.9.3.5.2 Double pointered method

There is one calibration reference table in ROM respectively Flash with references to one or several [ParameterElementGroups](#). Accesses to calibration parameters are performed through a double indirection access. During system startup the base reference is initially filled with a reference to the calibration reference table.

Action during calibration procedure e.g. calibration parameter value exchange is not focus of this specification. Nevertheless an example is given for better understanding.

Example how the exchange of calibration parameters could be done for double pointered method:

1. Copy the calibration reference table into RAM
2. Fill a RAM buffer with modified calibration parameter values for complete [ParameterElementGroup](#)
3. Modify the corresponding entry in the RAM copy of the reference table so that a redirection to new [ParameterElementGroup](#) is setup
4. Change the content of the base reference so that it references the calibration reference table copy in RAM.

Now calibration parameter accesses deliver the modified values.

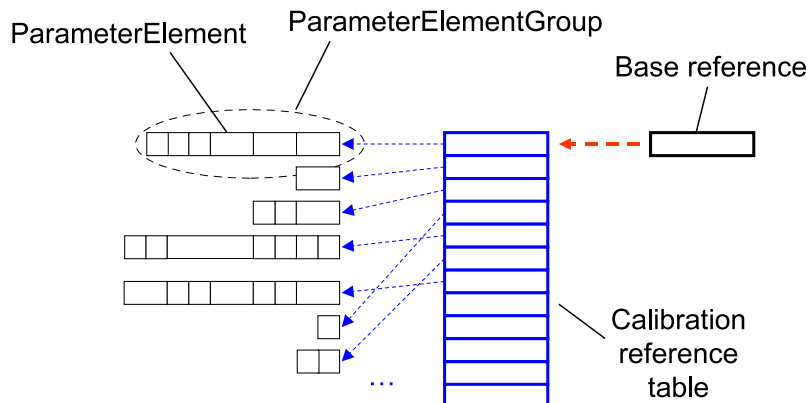


Figure 4.27: ParameterElementGroup in double pointer method context

[SWS_Rte_03914] [If data emulation with SW support with double pointer method is enabled, the RTE generator shall create a table located in ROM respectively FLASH with references to [ParameterElementGroups](#). The type of the table is an array of void pointers.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

Figure 4.27 illustrates the method.

To allow a Basic-SW respectively a complex driver to emulate other calibration parameters the standardization of the base reference is required.

[SWS_Rte_03948] [If data emulation with SW support with double method is enabled the name (the label) of the calibration base reference shall be `<RteParameterBase>`. This label and the base reference type shall be exported and made available to other SW on same ECU.

] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

Calibration parameters located in NVRAM are handled same way (also see section 4.2.9.3.6).

For handling of calibration parameters located in NVRAM with single or double pointer method see [\[SWS_Rte_03936\]](#) in section 4.2.9.3.5.1. General information is found in section 4.2.9.3.6).

4.2.9.3.5.3 InitRam parameter method

For each instance of a [ParameterDataPrototype](#) the RTE generator creates a calibration parameter in RAM and a corresponding value in ROM/FLASH. During startup of RTE the calibration parameter values of ROM/FLASH are copied into RAM. Accesses to calibration parameters are performed through a direct access to RAM without any indirection.

Action during calibration procedure e.g. calibration parameter value exchange is not focus of this specification. Nevertheless an example is given for better understanding:

An implementation simply would have to exchange the content of the RAM cells during runtime.

[SWS_Rte_03915] [If data emulation with SW support with initRam parameter method is enabled, the RTE generator shall create code guaranteeing that

1. calibration parameters are allocated in ROM/Flash and
2. a copy of them is allocated in RAM made available latest during RTE startup

for those [ParameterDataPrototypes](#) for which calibration support is enabled.]
([SRS_Rte_00154](#), [SRS_Rte_00156](#))

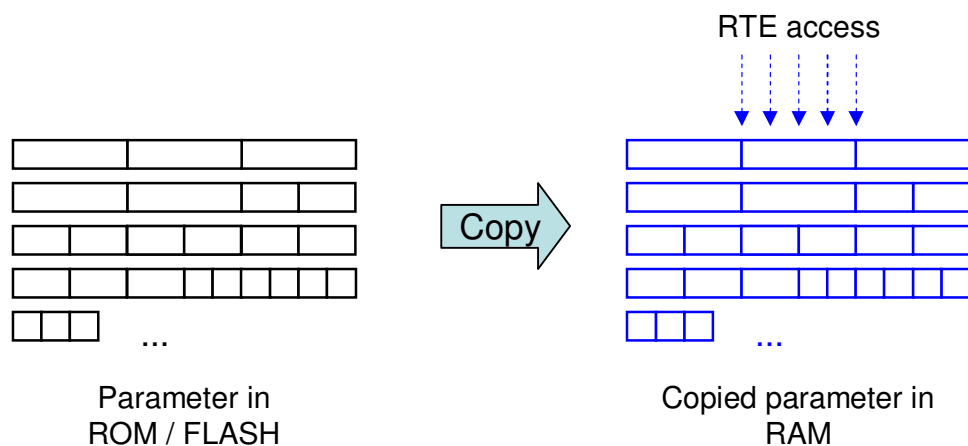


Figure 4.28: initRam Parameter method setup

Figure 4.28 illustrates the method.

A special case is the access of [ParameterDataPrototypes](#) instantiated in NVRAM (also see section 4.2.9.3.6). In this no extra RAM copy is required because a RAM location containing the calibration parameter value still exists.

[SWS_Rte_03935] [If data emulation with SW support with initRam parameter method is enabled, the RTE generator shall create direct accesses to the PerInstanceMemory working as RAM buffer for the calibration parameters defined to be in NVRAM.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

4.2.9.3.5.4 Arrangement of a [ParameterElementGroup](#) for pointered methods

For data emulation with SW support with single or double pointered methods the RTE has to guarantee access to each single member of a [ParameterElementGroup](#) for source code and object code delivery independent if the member is a primitive or a composite data type. For this the creation of a record type for a [ParameterElementGroup](#) was chosen.

[SWS_Rte_03916] [One [ParameterElementGroup](#) shall be realized as one record type.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

The sequence order of [ParameterDataPrototype](#) in a [ParameterElementGroup](#) and the order of [ParameterElementGroups](#) in the reference table will be documented by the RTE Generator by the means of the [McSwEmulationMethodSupport](#), see [4.2.9.4.4](#).

4.2.9.3.5.5 Further definitions for pointered methods

As stated in section [4.2.9.3.1.1](#), dependent of the value of property [swAddrMethod](#) calibration parameters shall be separated in different memory locations.

[SWS_Rte_03908] [If data emulation with SW support with single or double pointered method is enabled the RTE shall create a separate instance specific [ParameterElementGroup](#) for all those [ParameterDataPrototypes](#) with a common value of the appended property [swAddrMethod](#). Those [ParameterDataPrototypes](#) which have no property [swAddrMethod](#) appended, shall be grouped together too.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#), [SRS_Rte_00158](#))

To allow traceability for external tooling the sequence order of [ParameterDataPrototype](#) in a [ParameterElementGroup](#) and the order of [ParameterElementGroups](#) in the reference table will be documented by the RTE Generator by the means of the [McSwEmulationMethodSupport](#), see [4.2.9.4.4](#).

4.2.9.3.5.6 Calibration parameter access

Calibration parameters are derived from [ParameterDataPrototypes](#). The RTE has to provide access to each calibration parameter via a separate API call.

API is specified in [5.6](#).

[SWS_Rte_03922] [If data emulation with SW support and single or double pointered method is enabled the RTE generator shall export the label of the calibration reference table.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

[SWS_Rte_03960] [If data emulation with SW support and double pointered method is enabled the RTE generator shall export the label and the type of the calibration base reference.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

[SWS_Rte_03932] [If data emulation with SW support with single pointered method is enabled the RTE generator shall create API calls using single indirect access via the calibration reference table for those [ParameterDataPrototypes](#) which are in a [ParameterElementGroup](#) for which calibration is enabled.] ([SRS_Rte_00154](#), [SRS_Rte_00156](#))

[SWS_Rte_03933] [If data emulation with SW support with double pointered method is enabled the RTE generator shall create API calls using double indirection access via

the calibration base reference and the calibration reference table for those [ParameterDataPrototypes](#) which are in a [ParameterElementGroup](#) for which calibration is enabled.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

[SWS_Rte_03934] [If data emulation with SW support with double pointer method is enabled, the calibration base reference shall be located in RAM.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

4.2.9.3.5.7 Calibration parameter allocation

Since only the RTE knows which instances of AUTOSAR SW-Cs, [ParameterSwComponentTypes](#) and *Basic Software Modules* are present on the ECU the RTE has to allocate the calibration parameters and reserve memory for them. This approach is also covering multiple instantiated object code integration needs. So memory for instantiated [ParameterDataPrototypes](#) is neither provided by [ParameterSwComponentTypes](#) nor by AUTOSAR SW-C.

Nevertheless AUTOSAR SW-Cs and *Basic Software Modules* can define calibration parameters which are not instantiated by RTE. These are described by [ParameterDataPrototypes](#) in the role `constantMemory`. Further on the RTE can not implement any software support for data emulation for such calibration parameters. Hence those kind of calibration parameters are not described in the generated *McSupportData* of the RTE (see [4.2.9.4](#)).

[SWS_Rte_03961] [The RTE shall allocate the memory for calibration parameters.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

A [ParameterDataPrototype](#) can be defined to be instance specific or can be shared over all instances of an AUTOSAR SW-C or a [ParameterSwComponentType](#). The input for the RTE generator contains the values the RTE shall apply to the calibration parameters.

To support online and offline calibration (see section [4.2.9.1](#)) all parameter values for all instances have to be provided.

Background:

- For online calibration often initially the same default values for calibration parameters can be applied. Variation is then handled later by post link tools. Initial ECU startup is not jeopardized. This allows the usage of a default value e.g. by AUTOSAR SW-C or [ParameterSwComponentType](#) supplier for all instances of a [ParameterDataPrototype](#).
- On the other hand applying separate default values for the different instances of a [ParameterDataPrototype](#) will be required often for online calibration too, to make a vehicle run initially. This requires additional configuration work e.g. for integrator.

- Offline calibration based on new SW build including new RTE build and compilation process requires all calibration parameter values for all instances to be available for RTE.

Shared [ParameterDataPrototype](#)s

[SWS_Rte_03962] [For accesses to a shared [ParameterDataPrototype](#) the RTE API shall deliver the same one value independent of the instance the calibration parameter is assigned to.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

[SWS_Rte_03963] [The calibration parameter of a shared [ParameterDataPrototype](#) shall be stored in one memory location only.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

Requirements [SWS_Rte_03962] and [SWS_Rte_03963] are to guarantee that only one physical location in memory has to be modified for a change of a shared [ParameterDataPrototype](#). Otherwise this could lead to unforeseeable confusion. Multiple locations are possible for calibration parameters stored in NVRAM. But there a shared [ParameterDataPrototype](#) is allowed to have only one logical data too.

Instance specific [ParameterDataPrototype](#)s

[SWS_Rte_03964] [For accesses to an instance specific [ParameterDataPrototype](#) the RTE API shall deliver a separate calibration parameter value for each instance of a [ParameterDataPrototype](#).]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

[SWS_Rte_03965] [For an instance specific [ParameterDataPrototype](#) the calibration parameter value of each instance of the [ParameterDataPrototype](#) shall be stored in a separate memory location.]([SRS_Rte_00154](#), [SRS_Rte_00156](#))

Usage of `swAddrMethod`

[SwDataDefProps](#) contain the optional property `swAddrMethod`. It contains meta information about the memory section in which a measurement data store resp. a calibration parameter shall be allocated in. This abstraction is needed to support the reuse of unmodified AUTOSAR SW-Cs resp. [ParameterSwComponentTypes](#) in different projects but allowing allocation of measurement data stores resp. calibration parameters in different sections.

Section usage typically depends on availability of HW resources. In one project the micro controller might have less internal RAM than in another project, requiring that most measurement data have to be placed in external RAM. In another project one addressing method (e.g. indexed addressing) might be more efficient for most of the measurement data - but not for all. Or some calibration parameters are accessed less often than others and could be - depending on project specific FLASH availability - placed in FLASH with slower access speed, others in FLASH with higher access speed.

[SWS_Rte_03981] [The memory section used to store measurement values in shall be the memory sections associated with the `swAddrMethod` enclosed in the `SwDataDefProps` of a measurement definition.] ([SRS_Rte_00153](#))

Since it's measurement data obviously this must be in RAM.

[SWS_Rte_03982] [The memory section used to store calibration parameters in shall be the memory sections associated with the `swAddrMethod` enclosed in the `SwDataDefProps` of a calibration parameter definition.] ([SRS_Rte_00153](#))

4.2.9.3.6 Calibration parameters in NVRAM

Calibration parameters can be located in NVRAM too. One use case for this is to have the possibility to modify calibration parameters via a diagnosis service without need for special calibration tool.

To allow NVRAM calibration parameters to be accessed, NVRAM with statically allocated RAM buffer in form of PIM memory for the calibration parameters has to be defined or the `ramBlock` of a `NvBlockSwComponentType` defines `readWrite` access for the MCD system. Please see as well [\[SWS_Rte_07174\]](#) and [\[SWS_Rte_07160\]](#).

Note:

As the NVRAM Manager might not be able to access the `PerInstanceMemory` across core boundaries in a multi core environment, the support of Calibration parameters in NVRAM for multi core controllers is limited. See also note in [4.2.10.1](#).

4.2.9.3.7 Multiple calibration parameters instances

In complex systems the situation occur that calibration parameter values may depend on the configuration of the vehicle due to functional side effects. The difficulty is that those dependencies are typically detected after design of the software components and shall not change the software component design. In addition the overall ECU SW has to support all vehicle variants and therefore the detection and selection of the concrete vehicle variant needs to be done post build.

[SWS_Rte_06815] [The RTE Generator shall provide one separate memory location per `FlatInstanceDescriptor` pointing to the identical `ParameterDataPrototype` instance in the root software composition.] ([SRS_Rte_00154](#), [SRS_Rte_00191](#))

Thereby the `FlatInstanceDescriptor` needs to have different `postBuildVariantConditions` as described in [\[constr_3114\]](#). As a consequence at most one location in memory location created according [\[SWS_Rte_06815\]](#) can be active in a specific post build variant. This value needs to be accessed by the according RTE APIs `Rte_CData` and `Rte_Prm` accessing parameters.

[SWS_Rte_06816] [For accesses to a [ParameterDataPrototype](#) the RTE API shall deliver the value of the memory location which belongs to the currently selected post build variant.]([SRS_Rte_00154](#), [SRS_Rte_00156](#), [SRS_Rte_00191](#))

In order to ensure the functionality of [Rte_CData](#) and [Rte_Prm](#) depending on post build variability it needs to be ensured, that exactly one [FlatInstanceDescriptor](#) is selected in a specific post build variant when the RTE generator creates an RTE Post Build Data Set, see section 3.6.

The binding of the post build variability is done at the call of [SchM_Init](#) according the passed post build data set as described in sections section 4.7.2 and section 5.3.10

Please note that the requirements [SWS_Rte_07029] and [SWS_Rte_07030] also apply in this scenario and therefore the different memory locations due to multiple [FlatInstanceDescriptors](#) can get different initial values.

The following example shall illustrate the usage of post build variant [FlatInstanceDescriptors](#) in combination with multiple instantiation. The raw ARXML is listed in the section F.5.

In the given configuration a [ParameterSwComponentType](#) 'PSWC' is defined with on [PPortPrototype](#) 'EP' typed by the [ParameterInterface](#) 'EP'. The root software composition defines two [SwComponentPrototypes](#) 'SWC_PA' and 'SWC_PB'.

The [ApplicationSwComponentType](#) 'ASWC' defines [RPortPrototype](#) 'EP', a [perInstanceParameter](#) 'PIP' and a [sharedParameter](#) 'SP'. The root software composition defines two [SwComponentPrototypes](#) 'SWC_A' and 'SWC_B' and therefore two component instances for the component type ASWC exist. [PPortPrototype](#) 'EP' of 'SWC_PA' is connected to [RPortPrototype](#) 'EP' of 'SWC_A', [PPortPrototype](#) 'EP' of 'SWC_PB' is connected to [RPortPrototype](#) 'EP' of 'SWC_B'. (not shown in the figure 4.29)

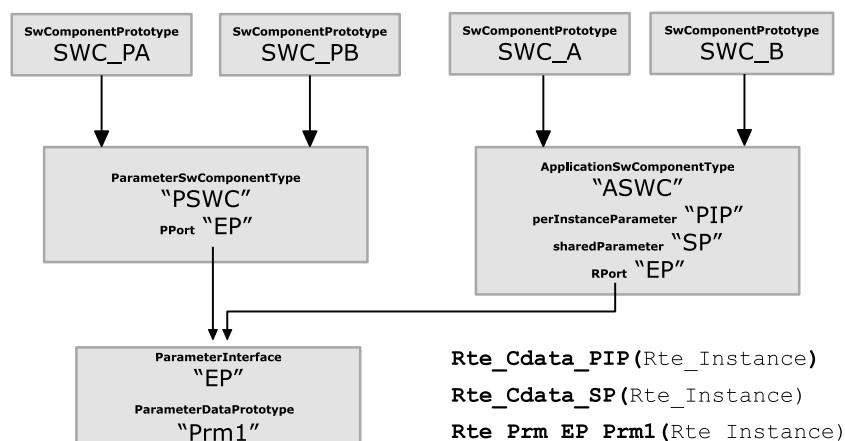


Figure 4.29: Example of component model

When the feature of multiple [FlatInstanceDescriptors](#) per [ParameterDataPrototype](#) is NOT applied the following locations in memory and access by RTE APIs would result:

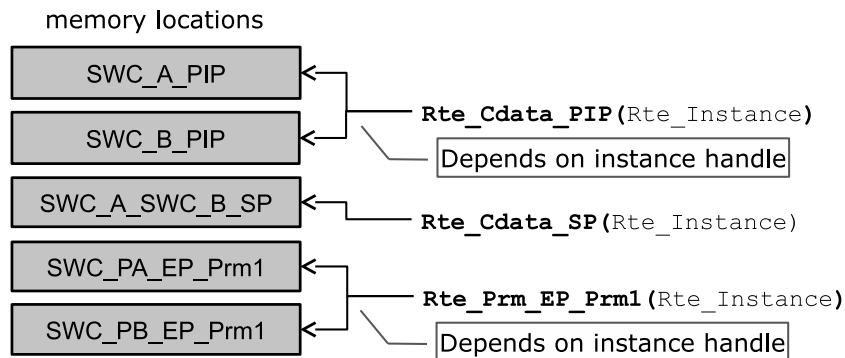


Figure 4.30: Resulting memory location of component model

Please note that the resulting names of the memory locations are not standardized but the applied pattern shall illustrate to which information in the input model they belong to. Assuming now following configuration in the Flat Map:

```

'SWC_A_PIP_Z0' {depends on PostBuildVariantCriterion 'Z'= 0}
'SWC_A_PIP_Z1' {depends on PostBuildVariantCriterion 'Z'= 1}
'SWC_B_PIP'
'SWC_A_SWC_B_SP_Z0' {depends on PostBuildVariantCriterion 'Z'= 0}
'SWC_A_SWC_B_SP_Z1' {depends on PostBuildVariantCriterion 'Z'= 1}
'SWC_PA_EP_Prm1_Z0' {depends on PostBuildVariantCriterion 'Z'= 0}
'SWC_PA_EP_Prm1_Z1' {depends on PostBuildVariantCriterion 'Z'= 1}
'SWC_PB_EP_Prm1'
  
```

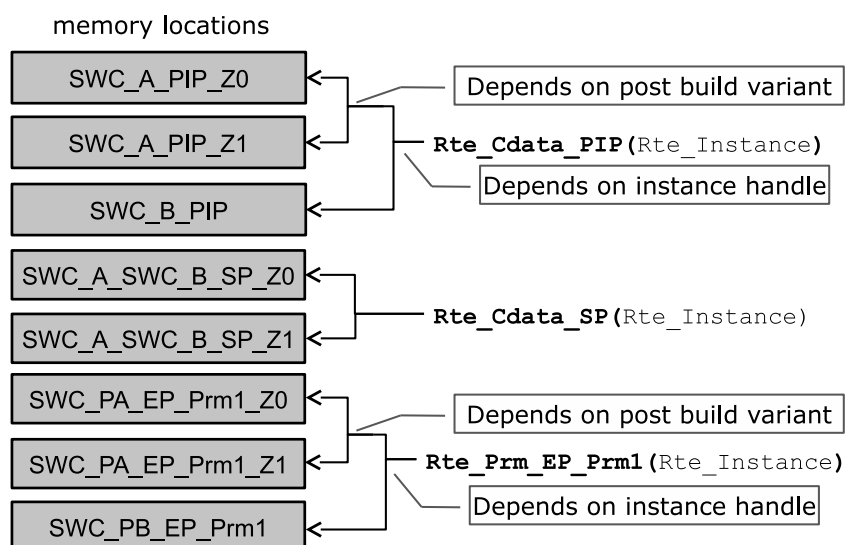


Figure 4.31: Resulting memory location of component model

There are different possibility to implement this mechanism. Nevertheless there are cross dependencies to the requirements concerning 'Data emulation with SW support' in section 4.2.9.3.5.

One possibility is to create an array of parameter values which contains one array element for each different Post Build Variant. The used index for this parameter value array in the relate RTE API is determined by the chosen variant in the post build configuration of the RTE and indexes the active array element. With this approach its easier to combine multiple calibration data instances with the 'Data emulation with SW support' feature since the number of `ParameterElementGroups` are not changed.

An other approach is to create one base pointer per identical combination of `postBuildVariantConditions` applied to calibration parameters. The related calibration parameters are grouped into a structure and for each combination of `postBuildVariantConditions` one instance of the structure is created. The base pointer is initialized according chosen variant in the post build configuration of RTE and points to the active structure instance.

4.2.9.4 Generation of *McSupportData*

The RTE Generator supports the definition, allocation and access to measurement and calibration data for Software Components as well as for Basic Software. The specific support of measurement and calibration tools however is neither in the focus of the RTE Generator nor AUTOSAR. This would require the generation of an "A2L"-file (like specified in [20]) which is the standard in this domain – but out of the focus of AUTOSAR.

The RTE Generator however shall support an intermediate exchange format called `McSupportData` which is building the bridge between the ECU software and the final "A2L"-file needed by the measurement and calibration tools. The details about the `McSupportData` format and the involved methodology are described in the Basic Software Module Description Template document [9].

In this section the requirements on the RTE Generator are collected which elements shall be provided in the `McSupportData` element.

4.2.9.4.1 Export of the *McSupportData*

Figure 4.32 shows the structure of the `McSupportData` element. The `McSupportData` element and its sub-content is part of the `Implementation` element. In case of the RTE this is the `BswImplementation` element which is generated / updated by the RTE Generator in the Generation Phase (see [SWS_Rte_05086] in chapter 3.4.2).

[SWS_Rte_05118] [The RTE Generator in Generation Phase shall create the `McSupportData` element as part of the `BswImplementation` description of the generated RTE.] (*SRS_Rte_00189*)

The individual measurable and calibratable data is described using the element `McDataInstance`. This is aggregated from `McSupportData` in the role `mcVariableInstance` (for measurement) or `mcParameterInstance` (for calibration).

Usage of the *FlatMap*

The `FlatMap` is part of the *Ecu Extract of System Description* and contains a collection of `FlatInstanceDescriptor` elements. The details of the `FlatMap` are described in the *Specification of the System Template* [8].

In particular the `FlatMap` may be request several parameter instances for the identical `ParameterDataPrototype` as described in section 4.2.9.3.7.

Common attributes of `McDataInstance`

The element `McDataInstance` specifies one element of the `McSupportData`. The following requirement specify common attributes which shall to be filled in a harmonized way.

[SWS_Rte_05130] [The RTE Generator shall use the `shortName` of the `FlatInstanceDescriptor` as the `shortName` of the `McDataInstance`.] (*SRS_Rte_00189*)

[SWS_Rte_03998] [The RTE Generator shall use the `AliasNameAssignment.shortLabel` referencing the according `FlatInstanceDescriptor` as the `displayIdentifier` of the `McDataInstance`.] (*SRS_Rte_00189*)

[SWS_Rte_05131] [If the input element (e.g. `ApplicationDataType` or `ImplementationDataType`) has a `category` specified the `category` value shall be copied to the `McDataInstance` element.] (*SRS_Rte_00189*)

[SWS_Rte_05132] [If the input element (e.g. `ApplicationDataType` or `ImplementationDataType`) specifies an array, the attribute `arraySize` of `McDataInstance` shall be set to the size of the array.] (*SRS_Rte_00189*)

[SWS_Rte_05133] [If the input element (e.g. `ApplicationDataType` or `ImplementationDataType`) specifies a record, the `McDataInstance` shall aggregate the record element's parts as `subElements` of type `McDataInstance`.] (*SRS_Rte_00189*)

[SWS_Rte_05119] [The `McSupportData` element and its sub-structure shall be self-contained in the sense that there is no need to deliver the whole upstream descriptions of the ECU (including the ECU Extract, Software Component descriptions, Basic Software Module descriptions, ECU Configuration Values descriptions, Flat Map, etc.) in order to later generate the final "A2L"-file. This means that the RTE Generator has to copy the required information from the upstream descriptions into the `McSupportData` element.] (*SRS_Rte_00189*)

[SWS_Rte_05129] [The RTE Generator in Generation Phase shall export the effective `SwDataDefProps` (including all of the referenced and aggregated sub-elements like e.g. `CompuMethod` or `SwRecordLayout`) in the role `resultingProperties`

for each `McDataInstance` after resolving the precedence rules defined in the SW-Component Template [2] chapter *Properties of Data Definitions*. Thereby the `ImplementationDataType` properties `compuMethod` and `dataConstraint` are not taken in consideration for effective `SwDataDefProps` of the `McDataInstance` due to their refinement nature of **C** and **AI**.] (*SRS_Rte_00189*)

[SWS_Rte_05135] [If a `ParameterDataPrototype` is associated with a `ParameterAccess` the corresponding `SwDataDefProps` and their sub-structure shall be exported.] (*SRS_Rte_00189*)

For each `flatMapEntry` referencing to measurable or calibratable data prototype or measureable `ModeDeclarationGroupPrototype` the `McDataInstance` shall be generated in the `McSupportData`. Thereby the effected `SwDataDefProps` shall be taken from the data prototype according the precedence rules defined in the SWCT.

[SWS_Rte_08313] [The RTE Generator shall create `McDataInstance` element(s) in the `McSupportData` for each measurable or calibratable `DataPrototype` / `ModeDeclarationGroupPrototype` referenced by a `FlatInstanceDescriptor`.] (*SRS_Rte_00189*)

Explanation: In case of connected ports it may occur that the `DataPrototype` in the `DataInterface` of the `PPortPrototype` and the `DataPrototype` in the `DataInterface` of the `RPortPrototype` are referenced by `FlatInstanceDescriptors`. In this case its intended to get two `McDataInstance` in order to access the value by MCD system with two different names and may be with two different scaling (typically offset and resolution).

In case of composite data `FlatInstanceDescriptors` may point to one or several `ApplicationCompositeElementDataPrototypes` in order to define an individual name for each record or array element. Thereby it is even possible that a `FlatInstanceDescriptor` exists for the "whole" `DataPrototype` typed by an `ApplicationCompositeDataType` and additional `FlatInstanceDescriptors` exist for the `ApplicationCompositeElementDataPrototypes` of such `DataPrototype`.

In this case a `McDataInstance` as child of `McSupportData` exists due to the `FlatInstanceDescriptors` for the "whole" `DataPrototype` and additional `McDataInstances` as child of `McSupportData` exists for each `FlatInstanceDescriptor` pointing to a `ApplicationCompositeElementDataPrototypes` in the "whole" `DataPrototype` type.

[SWS_Rte_08314] [If the input element is typed by an `ApplicationDataType` the `subElements` structure of the `McDataInstance` is determined by the `ApplicationDataType`. This means

- in case of `ApplicationRecordDataType` the number and `shortName` of the `subElement` is determined by the `ApplicationRecordElement` if **[SWS_Rte_05133]** and **[SWS_Rte_08316]** is applied,

- in case of `ApplicationArrayType` the number of the `subElements` is determined by the `ApplicationArrayElement` if [SWS_Rte_08315] is applied,
- in case of a `ApplicationPrimitiveDataType`, inclusive compound primitives, no `subElements` are applicable.

](SRS_Rte_00189)

[SWS_Rte_08315] [If the input element (e.g. `ApplicationDataType` or `ImplementationDataType`) specifies an array, the `McDataInstance` shall aggregate `subElements` for each array element. The `McDataInstance.subElements.symbol` shall express the array index in the C-notation. (e.g. [0], [4]).](SRS_Rte_00189)

[SWS_Rte_08316] [If the input element (e.g. `ApplicationDataType` or `ImplementationDataType`) specifies a record and no `FlatInstanceDescriptor` is defined for the record element, the `McDataInstance.subElement` `shortName` shall be set copied either from the related `ApplicationRecordElement`. Or from the `ImplementationDataTypeElement` if no `ApplicationDataType` is typing the `DataPrototype`. The `McDataInstance.subElement.symbol` is set to the related `ImplementationDataTypeElement.shortName`](SRS_Rte_00189)

General handling of the symbol attribute: The concatenation of all symbol strings starting from the root element over the hierarchy of `McDataInstances` shall represent the full combined symbol in the programming language for all hierarchy levels in the `McDataInstance` tree. When the concatenation is applied the `subElements` of `McDataInstances` of category `STRUCTURE` are separated by a dot.

[SWS_Rte_08317] [The RTE Generator shall document the Rte internal grouping of measurement and calibration data in composite data datatypes in each symbol attribute of the `McDataInstances` representing the data which is grouped.

This means the RTE Generator has to document the insertion of structures for Rte internal purpose in the symbol attribute of the related `McDataInstance`. For instance if the Rte groups a set of measurable inside a Rte internal structure (here called `RteInternalBuffer`) the `McDataInstance.symbol` of the first measurable child element carries the information about the internal structure element. e.g. `McDataInstance.shortName`: "MyMeasurable" `McDataInstance.symbol`: "RteInternalBuffer.measurable1"](SRS_Rte_00189)

4.2.9.4.2 Export of Measurement information

Sender-Receiver communication

[SWS_Rte_05120] [If the `swCalibrationAccess` of a `VariableDataPrototype` used in an interface of a sender-receiver port of a `SwComponentPrototype` is set to `readOnly` or `readWrite` and `RteMeasurementSupport` is set to `true` the RTE Generator shall create a `McDataInstance` element with

- `symbol` set to the C-symbol name used for the allocation (see also [SWS_Rte_03900])
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `VariableDataPrototype`

](SRS_Rte_00153, SRS_Rte_00189)

Client-Server communication

[SWS_Rte_05121] [If the `swCalibrationAccess` of an `ArgumentDataPrototype` used in an interface of a client-server port of a `SwComponentPrototype` is set to `readOnly` and `RteMeasurementSupport` is set to `true` the RTE Generator shall create a `McDataInstance` element with

- `symbol` set to the C-symbol name used for the allocation (see also [SWS_Rte_03901])
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `ArgumentDataPrototype`

](SRS_Rte_00153, SRS_Rte_00189)

[SWS_Rte_05172] [If the measurement of client-server communication is ignored due to requirement [SWS_Rte_05170] the corresponding `McDataInstance` in the `McSupportData` shall have a `resultingProperties` `swCalibrationAccess` set to `notAccessible`.](SRS_Rte_00153)

Mode Switch Communication

[SWS_Rte_06702] [If the `swCalibrationAccess` of a `ModeDeclarationGroupPrototype` used in an interface of a mode switch port of a `SwComponentPrototype` is set to `readOnly` and `RteMeasurementSupport` is set to `true` the RTE Generator shall create three `McDataInstance` elements with

- `symbol` set to the C-symbol name used for the allocation (see also [SWS_Rte_06700])
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `ModeDeclarationGroupPrototype`

Thereby the `McDataInstance` element corresponding to the

- *current mode* has to reference the `FlatInstanceDescriptor` which `role` attribute is set to `CURRENT_MODE`,
- *previous mode* has to reference the `FlatInstanceDescriptor` which `role` attribute is set to `PREVIOUS_MODE` and
- *next mode* has to reference the `FlatInstanceDescriptor` which `role` attribute is set to `NEXT_MODE`

](SRS_Rte_00153, SRS_Rte_00189)

Please note that the `resultingProperties` of the `McDataInstance` elements corresponding to the `ModeDeclarationGroupPrototype` may get associated with a `CompuMethod` if a `CompuMethod` is defined at the `FlatInstanceDescriptor` due to [SWS_Rte_05129]. Those `CompuMethod` may specify a literal display of the measured modes.

InterRunnableVariable

[SWS_Rte_05122] [If the `swCalibrationAccess` of a `VariableDataPrototype` in the role `implicitInterRunnableVariable` or `explicitInterRunnableVariable` is set to `readOnly` or `readWrite` and `RteMeasurementSupport` is set to `true` the RTE Generator shall create a `McDataInstance` element with

- `symbol` set to the C-symbol name used for the allocation (see also [SWS_Rte_03902])
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `VariableDataPrototype`

](SRS_Rte_00153, SRS_Rte_00189)

PerInstanceMemory

[SWS_Rte_05123] [If the `swCalibrationAccess` of a `VariableDataPrototype` in the role `arTypedPerInstanceMemory` is set to `readOnly` or `readWrite` and `RteMeasurementSupport` is set to `true` the RTE Generator shall create a `McDataInstance` element with

- `symbol` set to the C-symbol name used for the allocation (see also [SWS_Rte_07160])
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `VariableDataPrototype`

](SRS_Rte_00153, SRS_Rte_00189)

Nv RAM Block

[SWS_Rte_05124] [If the `swCalibrationAccess` of a `VariableDataPrototype` in the role `ramBlock` of a `NvBlockSwComponentType`'s `NvBlockDescriptor` is set to `readOnly` or `readWrite` and `RteMeasurementSupport` is set to `true` the RTE Generator shall create a `McDataInstance` element with

- `symbol` set to the C-symbol name used for the allocation (see also [SWS_Rte_07174])
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `NvBlockSwComponentType`

](SRS_Rte_00153, SRS_Rte_00189)

Non Volatile Data communication

[SWS_Rte_05125] [If the `swCalibrationAccess` of a `VariableDataPrototype` used in an `NvDataInterface` of a non volatile data port of a `SwComponentPrototype` is set to `readOnly` or `readWrite` and `RteMeasurementSupport` is set to `true` the RTE Generator shall create a `McDataInstance` element with

- `symbol` set to the C-symbol name used for the allocation (see also [\[SWS_Rte_07197\]](#))
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `VariableDataPrototype`

]([SRS_Rte_00153](#), [SRS_Rte_00189](#))

4.2.9.4.3 Export Calibration information

Calibration can be either actively supported by the RTE using the pre-defined calibration mechanisms of section [4.2.9.3.5](#) or calibration can be transparent to the RTE. In both cases the location and attributes of the calibratable data has to be provided by the RTE Generator in the Generation Phase in order to support the setup of the measurement and calibration tools.

ParameterDataPrototypes of ParameterSwComponentType

[SWS_Rte_05126] [For each `FlatInstanceDescriptor` referencing a `ParameterDataPrototype` instance in a `PortPrototype` of a `ParameterSwComponentType` with the `swCalibrationAccess` set to `readOnly` or `readWrite` an entry in the `McSupportData` with the role `mcParameterInstance` shall be created with the following attributes:

- `symbol` set to the C-symbol name used for the allocation
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `ParameterDataPrototype`

]([SRS_Rte_00189](#))

Shared ParameterDataPrototypes

[SWS_Rte_05127] [For each `FlatInstanceDescriptor` referencing a `ParameterDataPrototype` instance of a `AtomicSwComponentType`'s `SwInternalBehavior` aggregated in the role `sharedParameter` with the `swCalibrationAccess` set to `readOnly` or `readWrite` an entry in the `McSupportData` with the role `mcParameterInstance` shall be created with the following attributes:

- `symbol` set to the C-symbol name used for the allocation
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `ParameterDataPrototype`

]([SRS_Rte_00189](#))

Instance specific ParameterDataPrototypes

[SWS_Rte_05128] [For each `FlatInstanceDescriptor` referencing a `ParameterDataPrototype` instance of a `AtomicSwComponentType`'s `SwcInternalBehavior` aggregated in the role `perInstanceParameter` with the `swCalibrationAccess` set to `readOnly` or `readWrite` an entry in the `McSupportData` with the role `mcParameterInstance` shall be created with the following attributes:

- `symbol` set to the C-symbol name used for the allocation
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `ParameterDataPrototype`

]([SRS_Rte_00189](#))

[SWS_Rte_07097] [For each `ParameterDataPrototype` of a `BswModuleDescription`'s `BswInternalBehavior` aggregated in the role `perInstanceParameter` with the `swCalibrationAccess` set to `readOnly` or `readWrite` an entry in the `McSupportData` with the role `mcParameterInstance` shall be created with the following attributes:

- `symbol` set to the C-symbol name used for the allocation
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `ParameterDataPrototype`

]([SRS_Rte_00189](#))

Default values for RAM Block

[SWS_Rte_05136] [If the `swCalibrationAccess` of a `ParameterDataPrototype` in the role `romBlock` is set to `readOnly` or `readWrite` an entry in the `McSupportData` with the role `mcParameterInstance` shall be created with the following attributes:

- `symbol` set to the C-symbol name used for the allocation in [[SWS_Rte_07033](#)]
- `flatMapEntry` referencing to the corresponding `FlatInstanceDescriptor` element of the `ParameterDataPrototype`

]([SRS_Rte_00153](#), [SRS_Rte_00189](#))

4.2.9.4.4 Export of the Calibration Method

The RTE does provide several Software Emulation Methods which can be selected in the Ecu Configuration of the RTE (see section [8.2](#)).

Which Software Emulation Method has been used for a particular RTE Generation shall be documented in the `McSupportData` in order to allow measurement and calibration tools to support the RTE's Software Emulation Methods. Additionally it is also possible for an RTE Vendor to add custom Software Emulation Methods which needs to be

documented as well. The structure of the `McSwEmulationMethodSupport` is shown in figure 4.33.

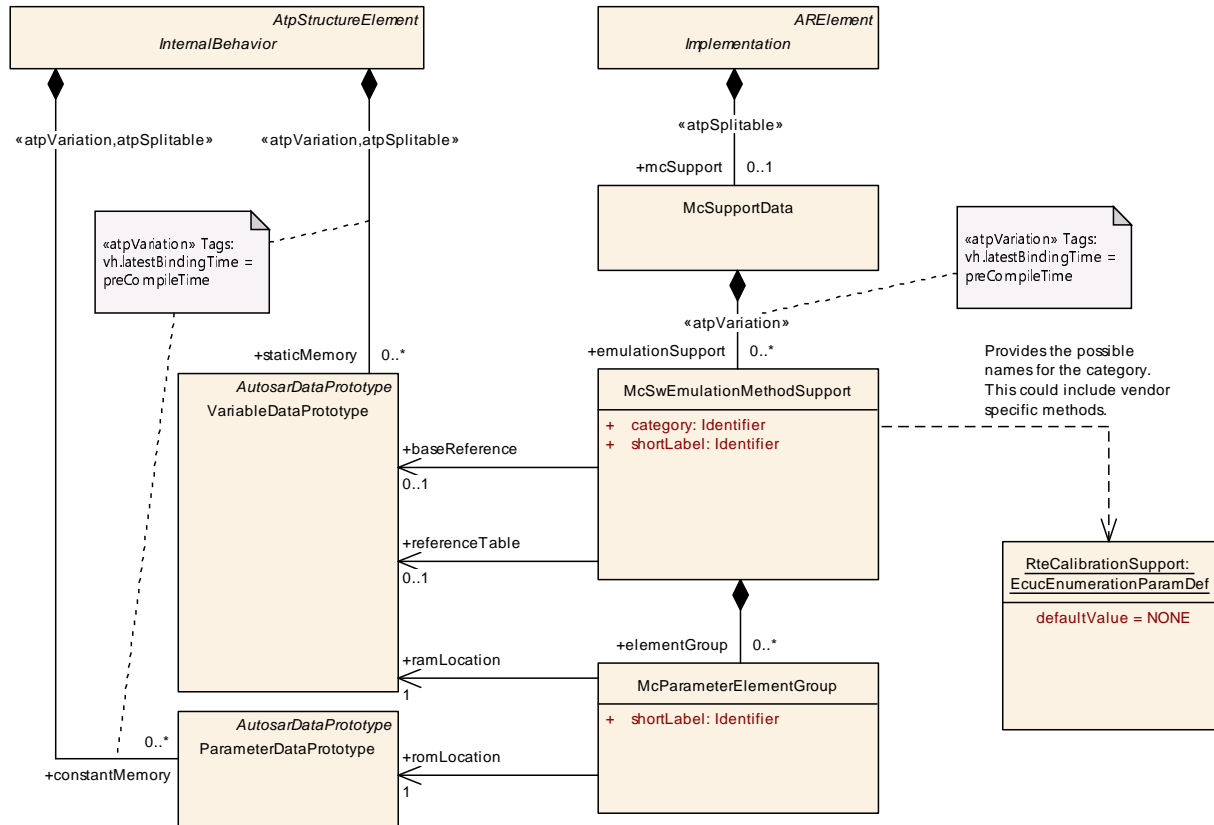


Figure 4.33: Structure of the `McSwEmulationMethodSupport` element

[SWS_Rte_05137] [The RTE Generator in Generation Phase shall create the `McSwEmulationMethodSupport` element as part of the `McSupportData` description of the generated RTE.] (SRS_Rte_00189)

[SWS_Rte_05138] [The RTE Generator in Generation Phase shall set the value of the `category` attribute of `McSwEmulationMethodSupport` element according to the implemented Software Emulation Method based on the Ecu configuration parameter `RteCalibrationSupport`:

- NONE
- SINGLE_POINTERED
- DOUBLE_POINTERED
- INITIALIZED_RAM
- *custom category name*: vendor specific Software Emulation Method

] (SRS_Rte_00189)

The description of the generated structures is using the existing mechanisms already available in the Basic Software Module Description Template [9].

Description of ParameterElementGroup

For the description of the `ParameterElementGroup` an `ImplementationDataType` representing a structure of the group is created ([SWS_Rte_05139]).

[SWS_Rte_05139] [For each generated `ParameterElementGroup` an `ImplementationDataType` shall be created. The contained `ParameterDataPrototypes` are aggregated with the role `subElement` as `ImplementationDataTypeElement`.](SRS_Rte_00189)

In the example figure 4.34 the `ImplementationDataTypes` are called `RteMcSupportGroupType1` and `RteMcSupportGroupType2`.

McSupport description of the InitRam parameter method

For the description of the `InitRam` parameter method the specific `ParameterElementGroups` allocated in ram and rom are specified ([SWS_Rte_05140] and [SWS_Rte_05141]). Then the collection and correspondence of these groups is specified (in [SWS_Rte_05142]).

[SWS_Rte_05140] [If the RTE Generator is configured to support the (`INITIALIZED_RAM`) method the RTE Generator in generation phase shall generate for each `ParameterElementGroup` a `ParameterDataPrototype` with the role `constantMemory` in the `InternalBehavior` of the RTE's Basic Software Module Description. The `ParameterDataPrototype` shall have a reference to the corresponding `ImplementationDataType` from [SWS_Rte_05139] with the role `type`.](SRS_Rte_00189)

[SWS_Rte_05141] [If the RTE Generator is configured to support the (`INITIALIZED_RAM`) method the RTE Generator in generation phase shall generate for each `ParameterElementGroup` a `VariableDataPrototype` with the role `staticMemory` in the `InternalBehavior` of the RTE's Basic Software Module Description. The `VariableDataPrototype` shall have a reference to the corresponding `ImplementationDataType` from [SWS_Rte_05139] with the role `type`.](SRS_Rte_00189)

[SWS_Rte_05142] [If the RTE Generator is configured to support the (`INITIALIZED_RAM`) method the RTE Generator in generation phase shall generate for each `ParameterElementGroup` a `McParameterElementGroup` with the role `elementGroup` in the `McSwEmulationMethodSupport` [SWS_Rte_05137] element.

- The `McParameterElementGroup` shall have a reference to the corresponding `ParameterDataPrototype` from [SWS_Rte_05140] with the role `romLocation`.
- The `McParameterElementGroup` shall have a reference to the corresponding `VariableDataPrototype` from [SWS_Rte_05141] with the role `ramLocation`.

] (SRS_Rte_00189)

McSupport description of the Single pointered method

For the description of the Single pointered method the specific `ParameterElementGroups` allocated in rom are specified ([SWS_Rte_05143]). Then an array data type is specified which contains as many number of elements (void pointers) as there are `ParameterElementGroups` ([SWS_Rte_05144]). Then the instance of this array is specified in ram ([SWS_Rte_05152]) and referenced from the `McSwEmulationMethodSupport` ([SWS_Rte_05153]). The actual values for each array element are specified as references to the `ParameterElementGroup` prototypes ([SWS_Rte_05154]).

[SWS_Rte_05143] [If the RTE Generator is configured to support the (SINGLE_POINTERED) method the RTE Generator in generation phase shall generate for each `ParameterElementGroup` a `ParameterDataPrototype` with the role `constantMemory` in the `InternalBehavior` of the RTE's Basic Software Module Description. The `ParameterDataPrototype` shall have a reference to the corresponding `ImplementationDataType` from [SWS_Rte_05139] with the role `type`.] (SRS_Rte_00189)

[SWS_Rte_05144] [If the RTE Generator is configured to support the (SINGLE_POINTERED) method the RTE Generator in generation phase shall generate an `ImplementationDataType` with one `ImplementationDataTypeElement` in the role `subElement`.

- The `ImplementationDataTypeElement` shall have the attribute `arraySize` set to the number of `ParameterElementGroups` from [SWS_Rte_05139].
- The `ImplementationDataTypeElement` shall have a `SwDataDefProps` element with a reference to an `ImplementationDataType` representing a *void pointer*, in the role `implementationDataType`.

] (SRS_Rte_00189)

[SWS_Rte_05152] [If the RTE Generator is configured to support the (SINGLE_POINTERED) method the RTE Generator in generation phase shall generate a `VariableDataPrototype` with the role `staticMemory` in the `InternalBehavior` of the RTE's Basic Software Module Description. The `VariableDataPrototype` shall have a reference to the `ImplementationDataType` from [SWS_Rte_05144] with the role `type`.] (SRS_Rte_00189)

[SWS_Rte_05153] [If the RTE Generator is configured to support the (SINGLE_POINTERED) method the RTE Generator in generation phase shall generate a reference from the `McSwEmulationMethodSupport` [SWS_Rte_05137] element to the `VariableDataPrototype` [SWS_Rte_05152] in the role `referenceTable`.] (SRS_Rte_00189)

[SWS_Rte_05154] [If the RTE Generator is configured to support the (SINGLE_POINTERED) method the RTE Generator in generation phase shall generate an `ArrayValueSpecification` as the `initValue` of the array [SWS_Rte_05152] and for each `ParameterElementGroup` a `ReferenceValueSpecification`

element in the [ArrayValueSpecification](#) defining the references to the individual [ParameterElementGroup](#) prototypes [[SWS_Rte_05143](#)].] ([SRS_Rte_00189](#))

McSupport description of the Double pointered method

The description of the Double pointered method is quite similar to the Single pointered method, but the allocation to ram and rom is different and it allocates the additional pointer parameter. The specific [ParameterElementGroups](#) allocated in rom are specified ([[SWS_Rte_05155](#)]). Then an array data type is specified which contains as many number of elements (void pointers) as there are [ParameterElementGroups](#) ([[SWS_Rte_05156](#)]). Then the instance of this array is specified in rom ([[SWS_Rte_05157](#)]) and referenced from the [McSwEmulationMethodSupport](#) ([[SWS_Rte_05158](#)]). The actual values for each array element are specified as references to the [ParameterElementGroup](#) prototypes ([[SWS_Rte_05159](#)]). Then the type of the base pointer is then created ([[SWS_Rte_05160](#)]) and an instance is allocated in ram ([[SWS_Rte_05161](#)]). The reference is initialized to the array in rom ([[SWS_Rte_05162](#)]).

[SWS_Rte_05155] [If the RTE Generator is configured to support the (DOUBLE_POINTERED) method the RTE Generator in generation phase shall generate for each [ParameterElementGroup](#) a [ParameterDataPrototype](#) with the role `constantMemory` in the [InternalBehavior](#) of the RTE's Basic Software Module Description. The [ParameterDataPrototype](#) shall have a reference to the corresponding [ImplementationDataType](#) from [[SWS_Rte_05139](#)] with the role `type`.] ([SRS_Rte_00189](#))

In the example figure [4.34](#) the [ParameterDataPrototypes](#) are called `RteMcSupportParamGroup1` and `RteMcSupportParamGroup1`.

[SWS_Rte_05156] [If the RTE Generator is configured to support the (DOUBLE_POINTERED) method the RTE Generator in generation phase shall generate an [ImplementationDataType](#) with one [ImplementationDataTypeElement](#) in the role `subElement`.

- The [ImplementationDataTypeElement](#) shall be of category `ARRAY` with the attribute `arraySize` set to the number of [ParameterElementGroups](#) from [[SWS_Rte_05139](#)].
- The [ImplementationDataTypeElement](#) shall have a [SwDataDefProps](#) element with a reference to an [ImplementationDataType](#) representing a *void pointer*, in the role `implementationDataType`.

] ([SRS_Rte_00189](#))

In the example figure [4.34](#) the [ImplementationDataType](#) is called `RteMcSupportPointerType`.

[SWS_Rte_05157] [If the RTE Generator is configured to support the (DOUBLE_POINTERED) method the RTE Generator in generation phase shall generate a [ParameterDataPrototype](#) with the role `constantMemory` in the [InternalBehavior](#) of the RTE's Basic Software Module Description. The [ParameterDataPrototype](#) shall

have a reference to the `ImplementationDataType` from [SWS_Rte_05156] with the role `type`.] (SRS_Rte_00189)

In the example figure 4.34 the `ParameterDataPrototype` is called `RteMcSupportPointerTable`.

[SWS_Rte_05158] [If the RTE Generator is configured to support the (DOUBLE_POINTERED) method the RTE Generator in generation phase shall generate a reference from the `McSwEmulationMethodSupport` [SWS_Rte_05137] element to the `ParameterDataPrototype` [SWS_Rte_05157] in the role `referenceTable`.] (SRS_Rte_00189)

[SWS_Rte_05159] [If the RTE Generator is configured to support the (DOUBLE_POINTERED) method the RTE Generator in generation phase shall generate an `ArrayValueSpecification` as the `initValue` of the array [SWS_Rte_05157] and for each `ParameterElementGroup` a `ReferenceValueSpecification` element in the `ArrayValueSpecification` defining the references to the individual `ParameterElementGroup` prototypes [SWS_Rte_05155].] (SRS_Rte_00189)

In the example figure 4.34 the `ArrayValueSpecification` is called `RteMcSupportPointerTableInit`. The `ReferenceValueSpecifications` are called `RteMcSupportParamGroup1Ref` and `RteMcSupportParamGroup2Ref`.

[SWS_Rte_05160] [If the RTE Generator is configured to support the (DOUBLE_POINTERED) method the RTE Generator in generation phase shall generate an `ImplementationDataType` with one `ImplementationDataTypeElement` being a reference to the array type from [SWS_Rte_05156].] (SRS_Rte_00189)

In the example figure 4.34 the `ImplementationDataType` is called `RteMcSupportBasePointerType`.

[SWS_Rte_05161] [If the RTE Generator is configured to support the (DOUBLE_POINTERED) method the RTE Generator in generation phase shall generate a `VariableDataPrototype` with the role `staticMemory` in the `InternalBehavior` of the RTE's Basic Software Module Description. The `VariableDataPrototype` shall have a reference to the `ImplementationDataType` from [SWS_Rte_05160] with the role `type`.] (SRS_Rte_00189)

In the example figure 4.34 the `VariableDataPrototype` is called `RteMcSupportBasePointer`.

[SWS_Rte_05162] [If the RTE Generator is configured to support the (DOUBLE_POINTERED) method the RTE Generator in generation phase shall generate a `ReferenceValueSpecification` to the array from [SWS_Rte_05157] as the `initValue` of the reference [SWS_Rte_05161].] (SRS_Rte_00189)

In the example figure 4.34 the `ReferenceValueSpecification` is called `RteMcSupportBasePointerInit`.

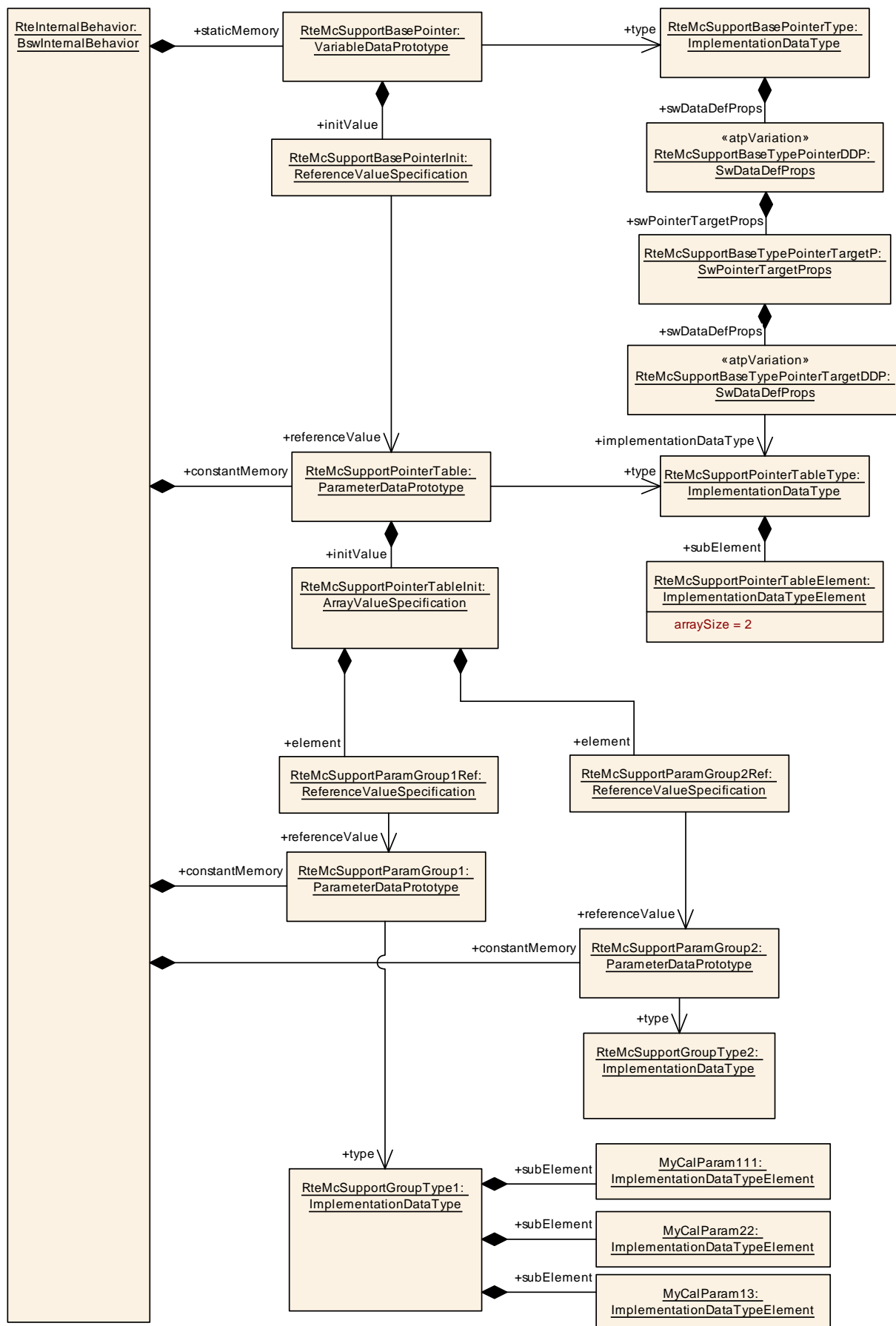


Figure 4.34: Example of the structure for Double Pointered Method

4.2.9.4.5 Export of Variant Handling

The Rte Generator shall provide information on values of system constants. The values are part of the input information and need to be collected and copied into a dedicated artifact to be delivered with the `McSupportData`.

[SWS_Rte_05168] [The Rte Generator in generation phase shall create an elements of type `SwSystemconstantValueSet` and create copies of all system constant values found in the input information of type `SwSystemconstValue` where the referenced `SwSystemconst` element has the `swCalibrationAccess` set to `readOnly`.] (*SRS_Rte_00153, SRS_Rte_00191*)

In case the `SwSystemconstValue` is subject to variability and the variability can be resolved during Rte generation phase

[SWS_Rte_05176] [If a `SwSystemconst` with `swCalibrationAccess` set to `readOnly` has an assigned `SwSystemconstValue` which is subject to variability with the latest binding time `SystemDesignTime` or `CodeGenerationTime` the related `SwSystemconstValue` copy in the `SwSystemconstantValueSet` according to **[SWS_Rte_05168]** shall contain the resolved value.] (*SRS_Rte_00153, SRS_Rte_00191*)

[SWS_Rte_05174] [If a `SwSystemconst` with `swCalibrationAccess` set to `readOnly` has an assigned `SwSystemconstValue` which is subject to variability with the latest binding time `PreCompileTime` the related `SwSystemconstValue` copy in the `SwSystemconstantValueSet` according to **[SWS_Rte_05168]** shall have an `AttributeValueVariationPoint`. The *PreBuild* conditions of the `AttributeValueVariationPoint` shall correspond to the *PreBuild* conditions of the input `SwSystemconstValue`'s conditions.] (*SRS_Rte_00153, SRS_Rte_00191*)

[SWS_Rte_05169] [The Rte Generator in generation phase shall create a reference from the `McSupportData` element (**[SWS_Rte_05118]**) to the `SwSystemconstantValueSet` element (**[SWS_Rte_05168]**).] (*SRS_Rte_00153, SRS_Rte_00191*)

In case the RTE Generator implements variability on an element which is accessible by a MCD system the related existence condition has to be documented in the `McSupportData` structure as well.

[SWS_Rte_05175] [If an element in the `McSupportData` is related to an element in the input configuration which is subject to variability with the latest binding time `PreCompileTime` or *PostBuild* the RTE Generator shall add a `VariationPoint` for such element. The *PreBuild* and *PostBuild* conditions of the `VariationPoint` shall correspond to the *PreBuild* and *PostBuild* conditions of the input element's conditions.] (*SRS_Rte_00153, SRS_Rte_00191*)

4.2.10 Access to NVRAM data

4.2.10.1 General

There are different methods available for AUTOSAR SW-Cs to access data stored in NVRAM.

- **“Calibration data”** – Calibrations can be stored in NVRAM, but are not modified during a "normal" execution of the ECU. Calibrations are usually directly read from their memory location, but can also be read from a RAM buffer when the access time needs to be optimized (e.g. for interpolation tables). They are described in section 4.2.9.
- **“Access to NVRAM blocks”** – This method uses `PerInstanceMemory` as a RAM Block for the NVRAM blocks. While this method is efficient, its use is restricted.

The NVRAM Manager [21] is a BSW module which provides services for SW-C to access NVRAM Blocks during runtime. The NVM block data is not accessed directly, but through a RAM Block, which can be a `PerInstanceMemory` instantiated by the RTE, or a SW-C internal buffer. When this method is used, the RTE does not provide any data consistency mechanisms (i.e. different runnables from the SW-C and the NVM can access the RAM Block concurrently without being protected by the RTE).

Note:

This mechanism permits efficient usage of NVRAM data, but requires the SW-C designer to take care that accesses to the `PerInstanceMemory` from different task contexts don't cause data inconsistencies. The “Access to NVRAM blocks” should not be used in multi core environments. In AUTOSAR release 4.0, it can not be expected that the NVRAM Manager can access the `PerInstanceMemory` of another core. The presence of a shared memory section is not required by AUTOSAR. Only in the case of `arTypedPerInstanceMemory`, a `SwDataDef-Props` item is available to assign the `PerInstanceMemory` to a shared memory section.

- **“Access to NVRAM data with a `NvBlockSwComponentType`”** – The data is accessed through a `NvDataInterface` connected to a `NvBlockSwComponentTypes`. This access is modeled at the VFB level, and, when necessary, protected by the RTE against concurrent accesses. It will be described further in this section.

Please note that the terms NVRAM Block, NV Block, RAM Block, ROM Block and RAM mirror used in this document are defined in the specification of the NVRAM Manager [21].

4.2.10.2 Usage of the `NvBlockSwComponentType`

The code of `NvBlockSwComponentPrototypes` is implemented by the RTE Generator. `NvBlockSwComponentTypes` provide a port interface for the access and management of data stored in NVRAM.

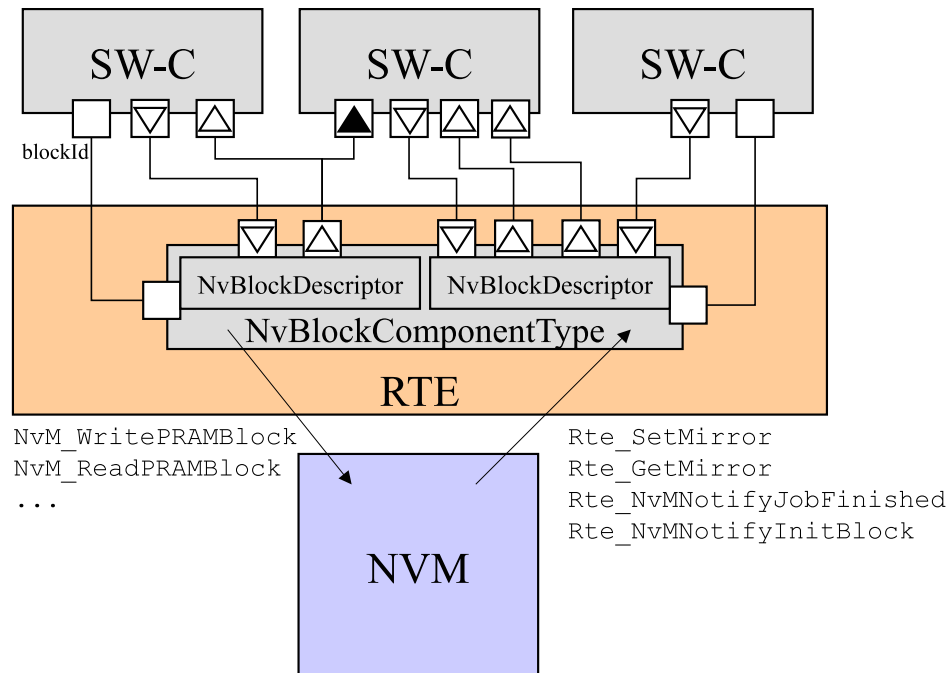


Figure 4.35: Connection to the `NvBlockSwComponentType`

Figure 4.35 illustrates the usage of a `NvBlockSwComponentType`. Depending on the use-case SW-Cs can be connected to a `NvBlockSwComponentType` in different ways. For example by Ports typed by `SenderReceiverInterfaces / NvDataInterfaces` only or by Ports typed by `SenderReceiverInterfaces / NvDataInterfaces` and `ClientServerInterfaces`. Ports typed by `SenderReceiverInterfaces / NvDataInterfaces` are used to provide access to NV data and Ports typed by `ClientServerInterfaces` are used for the management of NV data. Managing NV data by SW-Cs is useful in order to copy data of the RAM Block to NV block vice versa at certain points in time (SW-Cs are clients). Additionally SW-Cs can get notifications from NVM (SW-Cs are servers).

In the following sections the requirements for the usage of `NvBlockSwComponentType` will be given.

[SWS_Rte_07301] [Several AUTOSAR SW-Cs (and also several instances of a AUTOSAR SW-C) shall be able to read the same `VariableDataPrototypes` of a `NvBlockSwComponentType`.] (*SRS_Rte_00176*)

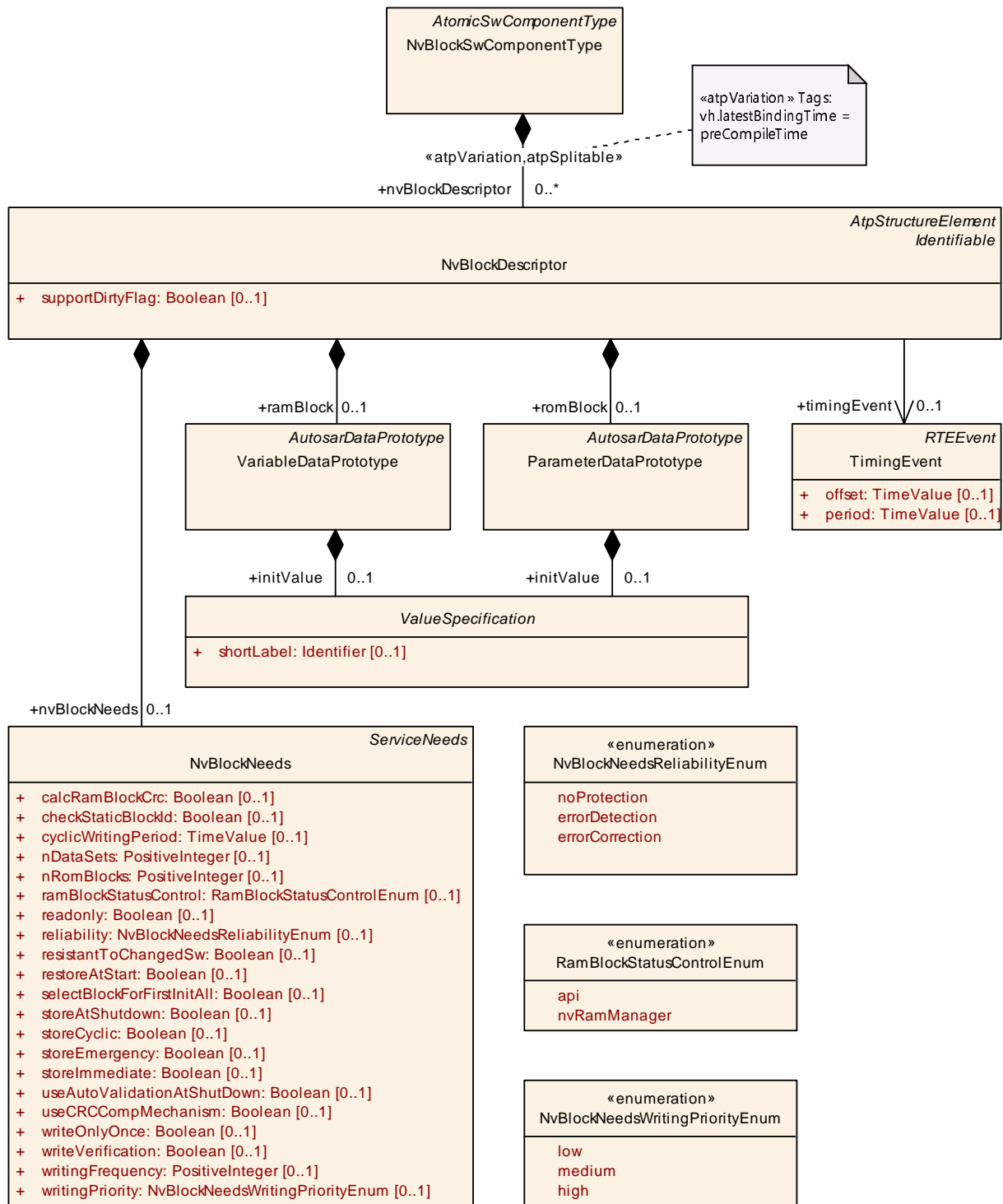


Figure 4.36: NvBlockSwComponentType and NvBlockDescriptor

A **NvBlockSwComponentType** contains multiple **NvBlockDescriptors**. Each of these **NvBlockDescriptor** is associated to exactly one NVRAM Block.

A **NvBlockDescriptor** contains a **VariableDataPrototype** which acts as a RAM Block for the NVRAM Block, and optionally a **ParameterDataPrototype** to act as the default ROM value for the NVRAM Block.

[SWS_Rte_07353] [The RTE Generator shall reject configurations where a `NvBlockDescriptor` of a `NvBlockSwComponentType` contains a `romBlock` whose data type is not compatible with the type of the `ramBlock`.] (*SRS_Rte_00177*, *SRS_Rte_00018*)

[SWS_Rte_07303] [The RTE shall allocate memory for the `ramBlock Variable-DataPrototype` of the `NvBlockDescriptor` instances.] (*SRS_Rte_00177*)

[SWS_Rte_07632] [The variables allocated for the `ramBlocks` shall be initialized if the general initialization conditions in [SWS_Rte_07046] are fulfilled. The initialization as to be applied during `Rte_Start` and `Rte_RestartPartition` depending from the configured `RteInitializationStrategy`.] (*SRS_Rte_00177*)

Note: When blocks are configured to be read by `NvM_ReadAll`, the initialization may erase the value read by the NVM. These blocks should not have an `initValue`.

[SWS_Rte_07355] [For each `NvBlockDescriptor` with a `romBlock Parameter-DataPrototype`, the RTE shall allocate a constant block of default values.] (*SRS_Rte_00177*)

[SWS_Rte_07633] [The constants allocated for the `romBlocks` shall be initialized to the value of the `initValue`, if they have an `initValue`.] (*SRS_Rte_00177*)

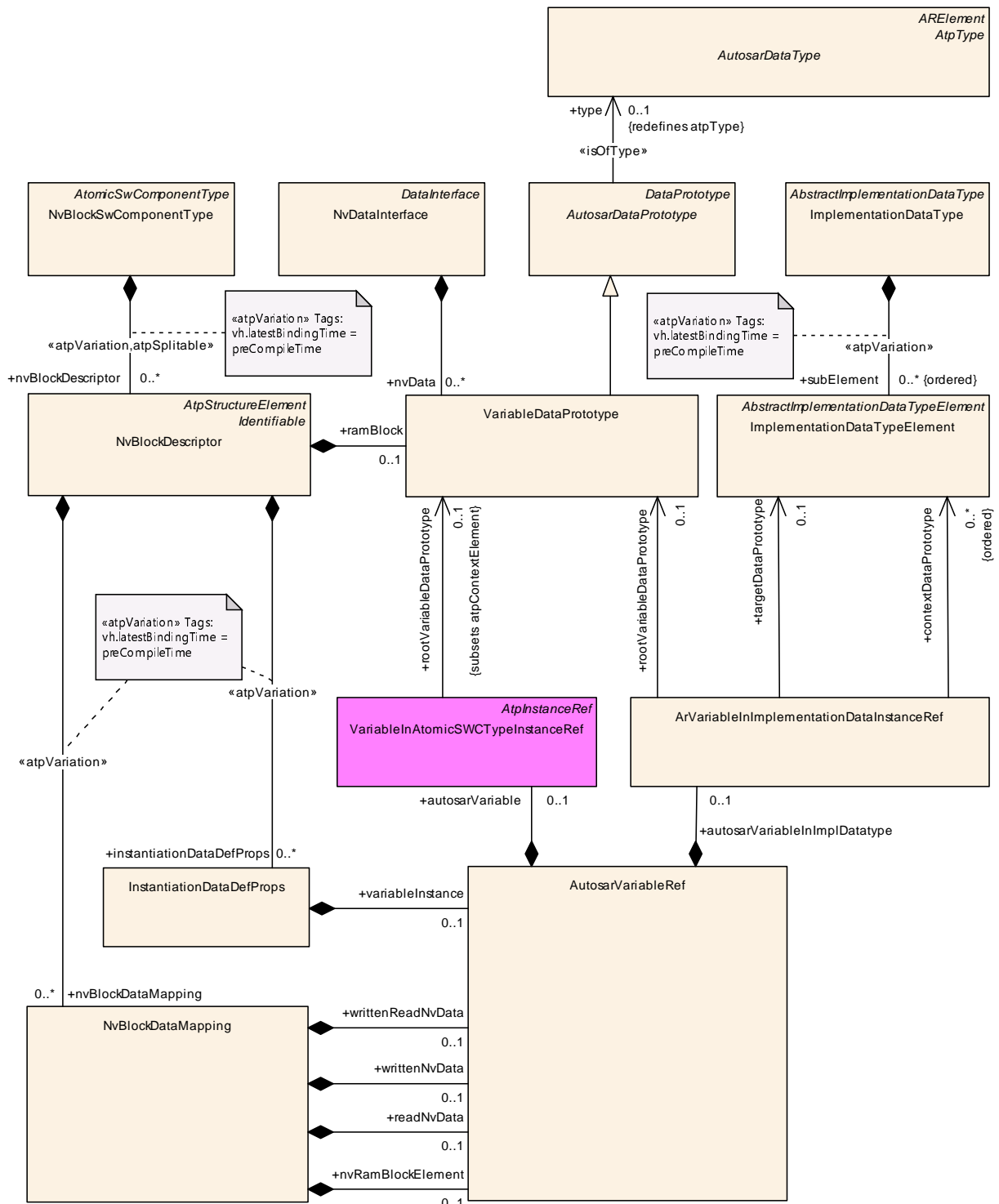


Figure 4.37: NvBlockDataMapping

For each element stored in the NVRAM Block of a **NvBlockDescriptor**, there should be one **NvBlockDataMapping** to associate the **VariableDataPrototypes** of the ports used for read and write access and the **VariableDataPrototype** defining the location of the element in the **ramBlock**. Thereby the **ImplementationDataTypes** of the **VariableDataPrototypes** have to compatible.

[SWS_Rte_03866] [The RTE Generator shall reject any configuration that violates [constr_1395], [constr_1403] and [constr_1404].] ([SRS_Rte_00018](#))

[SWS_Rte_07621] [The RTE Generator shall reject configurations where [constr_2013] or [constr_1285] is violated.] ([SRS_Rte_00018](#))

Note: This is required to ensure that the default values in `romBlock` are structurally matching data in the `ramBlock` and therefore can be copied to the `ramBlock` in case that the callback `Rte_NvMNotifyInitBlock` of the related `NvBlock` is called.

[SWS_Rte_07343] [The RTE Generator shall reject configurations where a `VariableDataPrototype` instance in the role `ramBlock` is accessed by SW-C instances of different partitions.] ([SRS_Rte_00177](#), [SRS_Rte_00018](#))

The rational for [\[SWS_Rte_07343\]](#) is to allow the implementation of cleanup activities in case of termination or restart of a partition. These cleanup activities may require to invalidate the `RAM Block` or reload data from the NVRAM device, which would impact other partitions if a the `ramBlock` is accessed by SW-Cs of different partitions.

A `NvBlockSwComponentType` can be used to reduce the quantity of `NVRAM Blocks` needed on an ECU:

- the same block can be used to store different flags or other small data elements;
- the same data element can be used by different SW-Cs or different instances of a SW-C.

It also permits to simplify processes and algorithms when it must be guaranteed that two SW-Cs of an ECU use the same NVRAM data.

Note: this feature can increase the RAM usage of the ECU because it forces the NVRAM Manager to instantiate an additional RAM buffer, called `RAM mirror`. However, when the same data elements have to be shared between SW-Cs, it reduces the number of `RAM Blocks` needed to be instantiated by the RTE, and can reduce the overall RAM usage of the ECU.

[SWS_Rte_07356] [The RTE Generator shall reject configurations where a `VariableDataPrototype` referenced by a `NvDataInterface` has a `queued swImplPolicy`.] ([SRS_Rte_00018](#))

[SWS_Rte_CONSTR_09011] `NvMBlockDescriptor` related to a `RAM Block` of a `NvBlockSwComponentType` shall use `NvmBlockUseSyncMechanism` [The `NVRAM Block` associated to the `NvBlockDescriptors` of a `NvBlockSwComponentType` shall be configured with the `NvMBlockUseSyncMechanism` feature enabled, and the `NvMWriteRamBlockToNvCallback` and `NvMReadRamBlockFromNvCallback` parameters set to the `Rte_GetMirror` and `Rte_SetMirror` API of the `NvBlockDescriptor`.] ()

An `NvBlockSwComponentType` may have unconnected p-ports or r-ports (see [\[SWS_Rte_01329\]](#)).

[SWS_Rte_07669] [An `NvBlockSwComponentType` with an unconnected r-port shall behave as if no updated data were received for `VariableDataPrototypes` this unconnected r-port.] (*SRS_Rte_00139*)

4.2.10.3 Interface of the `NvBlockSwComponentType`

4.2.10.3.1 Access to the NVRAM data

The `NvBlockSwComponentType` provides `PPortPrototypes` and `RPortPrototypes` with an `NvDataInterface` data Sender-Receiver semantic to read the value of the NVRAM data or write the new value.

Like the `SenderReceiverInterfaces`, each of these `NvDataInterfaces` can provide access to multiple `VariableDataPrototypes`.

The same `Rte_Read`, `Rte_IRead`, `Rte_DRead`, `Rte_Write`, `Rte_IWrite`, `Rte_IWriteRef` APIs are used to access these `VariableDataPrototypes` as for `SenderReceiverInterfaces`.

Due to the usage of the implicit APIs `Rte_IRead` and `Rte_IWriteRef` multiple buffering can be avoided, i.e. the `RunnableEntitys` of application SW-Cs or `ExecutableEntitys` of BSW modules (e.g. DCM) can directly access the `VariableDataPrototypes` on the `RAM Block`. To guarantee this behavior one of the following preconditions must apply:

- `VariableDataPrototypes` on a `RAM Block` are only accessed by `dataReadAccess`
- `VariableDataPrototypes` on a `RAM Block` are accessed by `dataReadAccess` and `dataWriteAccess` and there is no mutual preemption between the write accesses or between the write and read accesses, including no preemption by `Rte_SetMirror` and `Rte_GetMirror`.
- No `PortInterfaceMappings` are applied which requiring data conversions

See also chapter 4.3.1.5.1 about `ConsistencyNeeds`.

[SWS_Rte_07667] [The RTE Generator shall reject configurations where an r-port typed with an `NvDataInterface` is not connected and no `NvRequireComSpec` with an `initValue` are provided for each `VariableDataPrototype` of this `NvDataInterface`. This requirement does not apply if the r-port belongs to a `NvBlockSwComponentType`.] (*SRS_Rte_00018*, *SRS_Rte_00139*)

[SWS_Rte_07667] is required to avoid unconnected r-port without a defined `initValue`. Please note that for `NvBlockSwComponent` unconnected r-ports without init values are not a fault because the init values are defined in the `NvBlockDescriptors ramBlock` (see as well **[SWS_Rte_07632]**, **[SWS_Rte_07669]**)

[SWS_Rte_07668] [The RTE shall initialize the `VariableDataPrototypes` of an r-port according to the `initValue` of the r-port's `NvRequireComSpec` referring to the `VariableDataPrototype`.] (*SRS_Rte_00139, SRS_Rte_00108, SRS_Rte_00068*)

In order to write updated NV data of NVRAM Blocks to NV memory with a certain timing schema the RTE provides a functionality called "dirty flag mechanism". This mechanism interacts directly with the NvM module when write APIs of the RTE are invoked by an `AtomicSwComponentType` using a `PortPrototype` typed by an `NvDataInterface`. The behavior of the dirty flag mechanism depends on the writing strategy of the related `NvBlockDescriptors`.

[SWS_Rte_04565] [The cyclic writing strategy is enabled for an `NvBlockDescriptor` if the attribute `NvBlockNeeds.storeCyclic` is set to true.] (*SRS_Rte_00177, SRS_Rte_00245*)

[SWS_Rte_04566] [The shutDown writing strategy is enabled for an `NvBlockDescriptor` if the attribute `NvBlockDescriptor.writingStrategyRole.role` is set to `storeAtShutdown` or `NvBlockNeeds.storeAtShutdown` is set to true.] (*SRS_Rte_00177, SRS_Rte_00245*)

[SWS_Rte_04567] [The immediate writing strategy is enabled for an `NvBlockDescriptor` if the attribute `NvBlockDescriptor.writingStrategyRole.role` is set to `storeImmediate` or `NvBlockNeeds.storeImmediate` is set to true.] (*SRS_Rte_00177, SRS_Rte_00245*)

[SWS_Rte_04568] [The mode switch writing strategy is enabled for an `NvBlockDescriptor` if the attribute `NvBlockDescriptor.modeSwitchEventTriggeredActivity` is set to true.] (*SRS_Rte_00177, SRS_Rte_00245*)

[SWS_Rte_08080] [If an `AtomicSwComponentType` using a `PortPrototype` with an `NvDataInterface` invokes the explicit API `Rte_Write` and the attribute `NvBlockDescriptor.supportDirtyFlag` is set to true and the writing strategy `storeAtShutdown` ([SWS_Rte_04566] applies) is enabled, the RTE shall mark the associated RAM Block(s) as CHANGED by calling the `NvM_SetRamBlockStatus` function of the NvM module with the `BlockChanged` parameter set to true. The `NvM_SetRamBlockStatus` function shall be called by the RTE after the data accessed by the `Rte_Write` function is written back to the RAM Block(s).] (*SRS_Rte_00177, SRS_Rte_00245*)

[SWS_Rte_08081] [If an `AtomicSwComponentType` using a `PortPrototype` with an `NvDataInterface` invokes the implicit APIs `Rte_IWrite` / `Rte_IWriteRef` and the attribute `NvBlockDescriptor.supportDirtyFlag` is set to true and the writing strategy `storeAtShutdown` ([SWS_Rte_04566] applies) is enabled, the RTE shall mark the associated RAM Block(s) as CHANGED by calling the `NvM_SetRamBlockStatus` function of the NvM module with the `BlockChanged` parameter set to true. The function `NvM_SetRamBlockStatus` shall be called by the RTE after the data accessed by the `Rte_IWrite` / `Rte_IWriteRef` functions is written back from the pre-emption area buffer to the RAM Block(s) (for further details see chapter 4.3.1.5.1).] (*SRS_Rte_00177, SRS_Rte_00245*)

[SWS_Rte_08082] [If an [AtomicSwComponentType](#) using a [PortPrototype](#) with an [NvDataInterface](#) invokes the explicit API [Rte_Write](#) and the attribute is set to `true` and the writing strategy `storeCyclic` ([\[SWS_Rte_04565\]](#) applies) is enabled, the RTE shall write the associated RAM Block(s) to NV memory by calling the `NvM_WritePRAMBlock` function of the NvM module in the next cycle of a periodic activity after the data accessed by the [Rte_Write](#) function is written back to the RAM Block(s). The periodic activity shall be implemented in the context of an [NvBlockDescriptor](#)'s [RunnableEntity](#) (see requirements [\[SWS_Rte_08086\]](#), [\[SWS_Rte_08087\]](#), [\[SWS_Rte_08089\]](#), [\[SWS_Rte_08090\]](#)) according to the cycle period defined in the attribute `NvBlockDescriptor.timingEvent.period`.] ([SRS_Rte_00177](#), [SRS_Rte_00245](#))

[SWS_Rte_08083] [If an [AtomicSwComponentType](#) using a [PortPrototype](#) with an [NvDataInterface](#) invokes the implicit APIs [Rte_IWrite](#) / [Rte_IWriteRef](#) and the attribute `NvBlockDescriptor.supportDirtyFlag` is set to `true` and the writing strategy `storeCyclic` ([\[SWS_Rte_04565\]](#) applies) is enabled, the RTE shall write the associated RAM Block(s) to NV memory by calling the `NvM_WritePRAMBlock` function of the NvM module in the cycle of a periodic activity after the data accessed by the [Rte_IWrite](#) / [Rte_IWriteRef](#) functions is written back from the preemption area buffer to the RAM Block(s) (for further details see chapter 4.3.1.5.1). The periodic activity shall be implemented in the context of an [NvBlockDescriptor](#)'s [RunnableEntity](#) (see requirements [\[SWS_Rte_08086\]](#), [\[SWS_Rte_08087\]](#), [\[SWS_Rte_08089\]](#), [\[SWS_Rte_08090\]](#)) according to the cycle period defined in the attribute `NvBlockDescriptor.timingEvent.period`.] ([SRS_Rte_00177](#), [SRS_Rte_00245](#))

[SWS_Rte_08084] [If an [AtomicSwComponentType](#) using a [PortPrototype](#) with an [NvDataInterface](#) invokes the explicit API [Rte_Write](#) and the attribute `NvBlockDescriptor.supportDirtyFlag` is set to `true` and the writing strategy `storeImmediate` ([\[SWS_Rte_04567\]](#) applies) is enabled, the RTE shall write the associated RAM Block(s) to NV memory by calling the `NvM_WritePRAMBlock` function of the NvM module. The `NvM_WritePRAMBlock` function shall be called in the context of an [NvBlockDescriptor](#)'s [RunnableEntity](#) (see requirements [\[SWS_Rte_08086\]](#), [\[SWS_Rte_08088\]](#), [\[SWS_Rte_08089\]](#), [\[SWS_Rte_08090\]](#)) after the data accessed by the [Rte_Write](#) function is written back to the RAM Block(s).] ([SRS_Rte_00177](#), [SRS_Rte_00245](#))

[SWS_Rte_08085] [If an [AtomicSwComponentType](#) using a [PortPrototype](#) with an [NvDataInterface](#) invokes the implicit APIs [Rte_IWrite](#) / [Rte_IWriteRef](#) and the attribute `NvBlockDescriptor.supportDirtyFlag` is set to `true` and the writing strategy `storeImmediate` ([\[SWS_Rte_04567\]](#) applies) is enabled, the RTE shall write the associated RAM Block(s) to NV memory by calling the `NvM_WritePRAMBlock` function of the NvM module. The function `NvM_WritePRAMBlock` shall be called in the context of an [NvBlockDescriptor](#)'s [RunnableEntity](#) (see requirements [\[SWS_Rte_08086\]](#), [\[SWS_Rte_08088\]](#), [\[SWS_Rte_08089\]](#), [\[SWS_Rte_08090\]](#)) after the data accessed by the [Rte_IWrite](#) / [Rte_IWriteRef](#) functions is written back from the preemption area buffer to the RAM Block(s) (for further details see chapter 4.3.1.5.1).] ([SRS_Rte_00177](#), [SRS_Rte_00245](#))

Note: Notifications received from the NVM module (e.g. `NvMNotifyJobFinished`) will not be forwarded to the SW-Cs by the dirty flag mechanism. The standardized NvM Client-Server interfaces can be used (see chapter 4.2.10.3.3) if a SW-C needs to be informed regarding the NvM job result.

4.2.10.3.2 Access to the Bulk NvData

The `NvBlockSwComponentType` provides `PPortPrototypes` with an `NvDataInterface` data Sender-Receiver semantics to read the value of the Bulk NvData.

Like the `SenderReceiverInterfaces`, each of these `NvDataInterfaces` can provide access to multiple `VariableDataPrototypes`.

The same `Rte_Read`, `Rte_IRead`, or `Rte_DRead` APIs are used to access these `VariableDataPrototypes` as for `SenderReceiverInterfaces`.

Due to the usage of the implicit API `Rte_IRead` a direct access to the flash block is possible.

[SWS_Rte_03883] [The RTE shall create for each `BulkNvDataDescriptor` a `BndMBlockDescriptor` in the `BndM` module. The corresponding `BlockId` value shall be used for the invocation of `BndM` API functions.] (*SRS_Rte_00177*)

[SWS_Rte_03884] [The RTE shall use for each read access to the `BulkNvDataDescriptor` the `BndM_GetBlockPtr` API to get the base pointer to the `ImplementationDataPrototype`.] (*SRS_Rte_00177*)

4.2.10.3.3 NVM interfaces

The `NvBlockSwComponentType` can also have ports used for NV data management and typed by Client-Server interfaces derived from the NVRAM Manager [21] standardized ones. Note that these ports shall always have a `PortInterface` with the attribute `isService` set to `FALSE`. The definition of blueprints for these interfaces can be found in document `MOD_GeneralBlueprints` [22] in the `ARPackage` `AUTOSAR/NvBlockSoftwareComponentType/ClientServerInterfaces_Blueprint`.

The standardized NvM Client-Server interfaces are composed as follows:

- `NvMService`

This interface is used to send commands to the NVM. The `NvBlockSwComponentType` provides a server port intended to be used by the SW-C users of this `NvBlockSwComponentType`.

- `NvMNotifyJobFinished`

This interface is used by the NVM to notify the end of job. The `NvBlockSwComponentType` provides a server port intended to be used by the NVM, and client

ports intended to be connected to the SW-C users of this [NvBlockSwComponentType](#).

- `NvMNotifyInitBlock`

This interface is used by the NVM to request users to provide the default values in the `RAM Block`. The [NvBlockSwComponentType](#) provides a server port intended to be used by the NVM, and client ports intended to be connected to the SW-C users of this [NvBlockSwComponentType](#).

- `NvMAdmin`

This interface is used to order some administrative operations to the NVM. The [NvBlockSwComponentType](#) provides a server port intended to be used by the SW-C users of this [NvBlockSwComponentType](#).

For the implementation of [NvBlockSwComponentTypes](#) that have NvM service ports the RTE has to call the API of NvM. In order to access NvM API the `NvM.h` file has to be included.

[SWS_Rte_08063] [The RTE shall include the `NvM.h` file, if it has to access NvM API.]
([SRS_Rte_00177](#))

Note: no restrictions have been added to the NVM interfaces. However, some operations of the NVM might require cooperation between the different users of the [NvBlockSwComponentType](#). For example, a `ReadBlock` operation will overwrite the `RAM Block`, which might affect multiple SW-Cs.

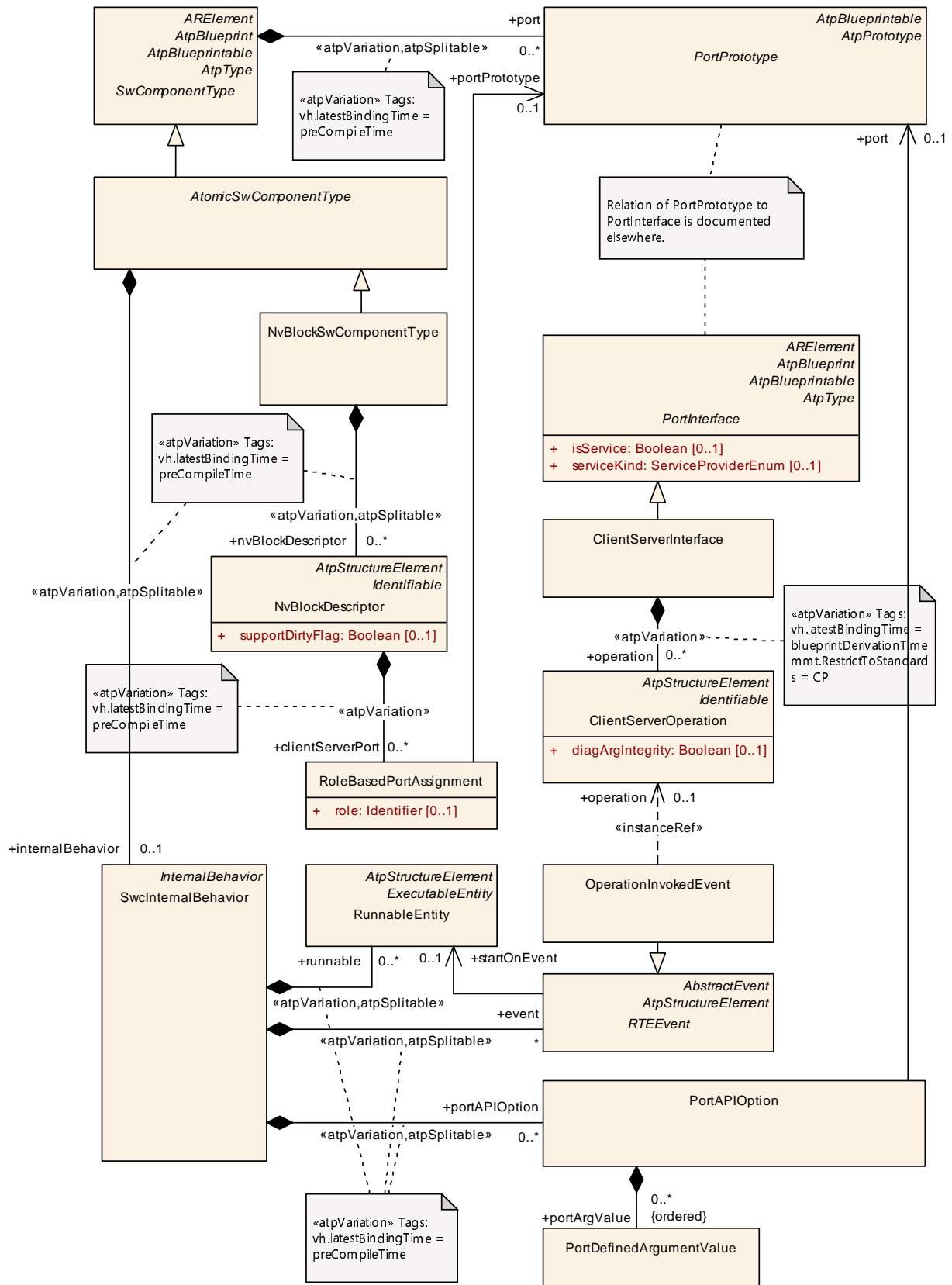


Figure 4.38: SwcInternalBehavior of NvBlockSwComponentTypes

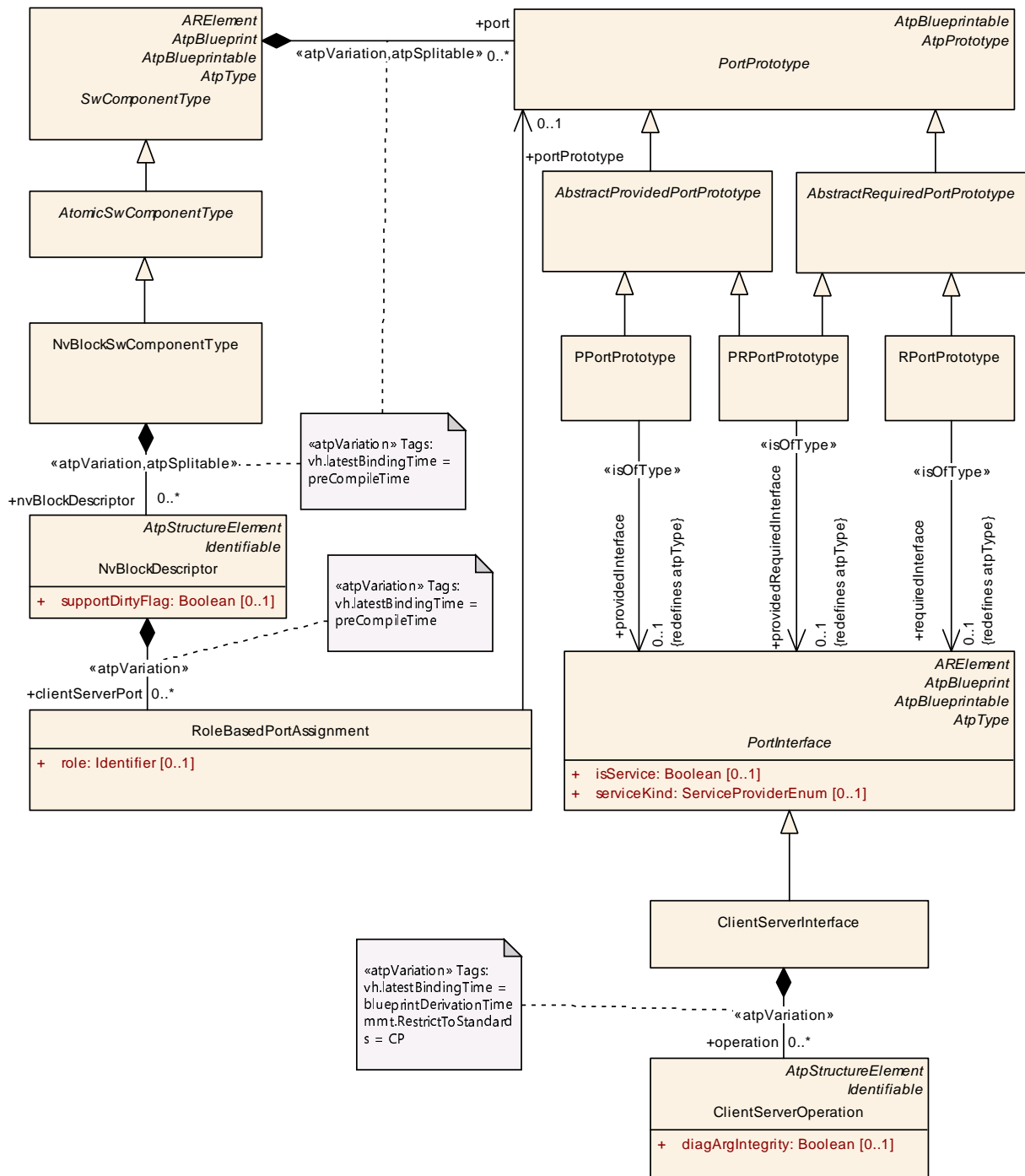


Figure 4.39: NVM notifications

The requests received from the SW-C side are forwarded by the **NvBlockSwComponentType**'s runnables to the NVM module, using the NVM C API indicated by the **RoleBasedPortAssignment**. See figure 4.38.

Notifications received from the NVM are forwarded to all the SW-C connected to the notification interfaces of the **NvBlockSwComponentType** with a **RoleBasedPortAssignment** of the corresponding type. See figure 4.39.

[SWS_Rte_07398] [The RTE Generator shall implement runnables for each connected server port of a `NvBlockSwComponentType`.] ([SRS_Rte_00177](#))

[SWS_Rte_07399] [The `NvBlockSwComponentType`'s runnables used as servers connected to the SW-C shall forward the request to the NVM by calling the associated NVM API.] ([SRS_Rte_00177](#))

[SWS_Rte_04535] [The return values of NvM APIs `NvM_WriteBlock` and `NvM_SetRAMBlockStatus` (See requirements [\[SWS_Rte_08080\]](#), [\[SWS_Rte_08081\]](#), [\[SWS_Rte_08082\]](#), [\[SWS_Rte_08083\]](#), [\[SWS_Rte_08084\]](#), [\[SWS_Rte_08085\]](#)) called by the RTE shall be ignored.] ([SRS_Rte_00177](#))

[SWS_Rte_08064] [The `symbol` attribute of `RunnableEntity`s triggered by an `OperationInvokedEvent` of `NvBlockSwComponentTypes` shall be used by the RTE generator to identify the to be called NvM API function (see [\[constr_1234\]](#) in software component template [\[2\]](#)).] ([SRS_Rte_00177](#))

The `NvBlockSwComponentType` may define `PortDefinedArgumentValues` to provide the `BlockId` value in case the `NvBlockSwComponentType` defines server ports for the call of NvM services. Till R4.2 this was the only possibility to provide the `BlockId` value. But these values are not mandatory any longer and are superseded by the configuration of `RteNvRamAllocation`, see [\[SWS_Rte_06211\]](#) and [\[SWS_Rte_06212\]](#).

[SWS_Rte_06211] [The RTE generator shall determine the appropriate `BlockId` value for the invocation of NvM API functions from the parameter of the `NvMBlockDescriptor` which is mapped via `RteNvRamAllocation.RteNvmBlockRef` to the according `NvBlockDescriptor`.] ([SRS_Rte_00177](#))

Please note: Thereby the relationship of an invocation to a specific `NvBlockDescriptor` can be determined by following ways:

- `NvBlockDescriptor.timingEvent` for the cyclic invocation
- `NvBlockDescriptor.clientServerPort` where attribute `role` has the value `NvMService` or `NvMAdmin`. In this case all `OperationInvokedEvents` referencing an `operation` in such a `PPortPrototype` are belonging to the `NvBlockDescriptor`.
- `VariableDataPrototype` instances in `AbstractProvidedPortPrototype` mapped to the `NvBlockDescriptor.ramBlock` via an `NvBlockDataMapping`. In this case all `DataReceivedEvents` referencing those `VariableDataPrototype` instances are belonging to the `NvBlockDescriptor`.
- `NvBlockDescriptor.modeSwitchEventTriggeredActivity` for the mode switch based invocation.

[SWS_Rte_06212] [The RTE generator shall ignore the given `PortAPIOption` with `PortDefinedArgumentValue` applied to a `PPortPrototype` of a `NvBlockSwComponentType` when the `BlockId` value is determined according [\[SWS_Rte_06211\]](#).] ([SRS_Rte_00177](#))

Besides forwarding requests from the SW-C side to the NVM module via NvM service ports, the `NvBlockSwComponentType` also supports the dirty flag mechanism mentioned in chapter 4.2.10.3.1. In order to realize the behavior of the dirty flag mechanism the RTE implements `RunnableEntity`s for each `NvBlockDescriptor` that can be triggered by `RTEEvents`. Depending on the writing strategy different kind of `RTEEvents` will be used for triggering the `RunnableEntity`s.

The configuration of the `NvBlockSwComponentType` (i.e. defining `RTEEvents` for triggering the `RunnableEntity`s for the `NvBlockDescriptors` and mapping of `RTEEvents` to tasks) is usually not in the responsibility of the SW-C developer. For this reason the SW-C developer can provide the required writing strategy in the `SwcServiceDependency.serviceNeeds` by using the attributes `storeAtShutdown`, `storeCyclic`, `cyclicWritingPeriod`, `storeEmergency` and `storeImmediate` (for more details see Software Component Template [2]).

[SWS_Rte_08086] [The RTE generator shall implement `RunnableEntity`s for each `NvBlockDescriptor` of an `NvBlockSwComponentType` with the attribute `supportDirtyFlag` set to `true`.] (*SRS_Rte_00177*, *SRS_Rte_00245*)

[SWS_Rte_08087] [A `RunnableEntity` of an `NvBlockDescriptor` shall be activated by a `TimingEvent` if the `storeCyclic` writing strategy is enabled (See [SWS_Rte_04565]).] (*SRS_Rte_00177*, *SRS_Rte_00245*)

[SWS_Rte_08088] [A `RunnableEntity` of an `NvBlockDescriptor` shall be activated by a `DataReceivedEvent` if the `storeAtShutdown` or `storeImmediate` is enabled (See [SWS_Rte_04566], [SWS_Rte_04567]).] (*SRS_Rte_00177*, *SRS_Rte_00245*)

[SWS_Rte_08111] [A `RunnableEntity` of an `NvBlockDescriptor` shall be activated by a `SwcModeSwitchEvent` if the mode switch writing strategy has been enabled (See [SWS_Rte_04568]).] (*SRS_Rte_00177*, *SRS_Rte_00245*)

[SWS_Rte_08089] [For `NvBlockDescriptors` which need to combine several writing strategies (See [SWS_Rte_04565], [SWS_Rte_04566], [SWS_Rte_04567]), the `RunnableEntity` of the `NvBlockDescriptor` shall be activated by one `TimingEvent` or `DataReceivedEvent` per writing strategy according to the requirements [SWS_Rte_08087] and [SWS_Rte_08088].] (*SRS_Rte_00177*, *SRS_Rte_00245*)

[SWS_Rte_08090] [If no `RteEventToTaskMapping` is defined for `DataReceivedEvents` or `SwcModeSwitchEvents` which are responsible for activating `RunnableEntity`s of `NvBlockDescriptors` (see [SWS_Rte_08087] and [SWS_Rte_08088]), the according activities shall be processed in the RTE code issuing the `DataReceivedEvents` or `SwcModeSwitchEvents`. For explicit communication this shall be done in the related `Rte_Write` function and for implicit communication in the task bodies where the preemption buffers are handled. For `SwcModeSwitchEvents` using asynchronous mode switch procedure, this shall be done in the related `Rte_Switch` function.

Note: For `SwcModeSwitchEvents` a direct-call requires an asynchronous mode switch.

|(SRS_Rte_00177, SRS_Rte_00245)

4.2.10.4 Data Consistency

A `VariableDataPrototype` contained in a `NvBlockSwComponentType` is accessed when SW-Cs read the value or write a new value. It is also accessed by the NVM when read or write requests are processed by the NVM for the associated block.

The NVM does not access directly the `VariableDataPrototypes`, but shall use the `Rte_GetMirror`, and `Rte_SetMirror` APIs specified in section 5.9.3

The RTE has to ensure the data consistency of the `VariableDataPrototypes`, with any of the data consistency mechanisms defined in section 4.2.6. Depending on the user's input, an efficient scheduling with the use of implicit APIs should permit a low resources (OS resources, RAM, and code) implementation.

4.3 Communication Paradigms

AUTOSAR supports two basic communication paradigms: Client-Server and Sender-Receiver. AUTOSAR software-components communicate through well defined ports and the behavior is statically defined by attributes. Some attributes are defined on the modeling level and others are closely related to the network topology and must be defined on the implementation level.

The RTE provides the implementation of these communication paradigms. For inter-ECU communication the RTE uses the functionalities provided by COM. For inter-Partition communication (within the same ECU) the RTE may use functionalities provided by the IOC module. For intra-Partition the RTE provides the functionality on its own.

Both communication paradigms can be used together with data transformation which is described in chapter 4.10.

With Sender-Receiver communication there are two main principles: Data Distribution and Event Distribution. When data is distributed, the last received value is of interest (last-is-best semantics). When events are distributed the whole history of received events is of interest, hence they must be queued on receiver side. Therefore the software implementation policy can be queued or non queued. This is stated in the `swImplPolicy` attribute of the `SwDataDefProps`, which can have the value `queued` (corresponding to event distribution with a queue) or `standard` (corresponding to last-is-best data distribution). If a data element has `event semantics`, the `swImplPolicy` is set to `queued`. The other possible values of this attribute correspond to `data semantics`.

[SWS_Rte_07192] [The RTE generator shall reject the configuration when an `r-port` is connected to an `r-port` or a `p-port` is connected to a `p-port` with an `AssemblySwConnector`.] ([SRS_Rte_00018](#))

For example, a require port (`r-port`) of a component typed by an AUTOSAR sender-receiver interface can read data elements of this interface. A provide port (`p-port`) of a component typed by an AUTOSAR sender-receiver interface can write data elements of this interface.

[SWS_Rte_07006] [The RTE generator shall reject the configuration violating the `[constr_1032]`, so when an `r-port` is connected to a `p-port` or a `p-port` is connected to an `r-port` with a `DelegationSwConnector`.] ([SRS_Rte_00018](#))

[SWS_Rte_08767] [In case of functionality depending on attributes of `ComSpecs` the RTE Generator shall consider only the `ComSpecs` defined in the context of `AtomicSwComponentTypes` or `ParameterSwComponentTypes`.] ([SRS_Rte_00018](#))

4.3.1 Sender-Receiver

4.3.1.1 Introduction

Sender-receiver communication involves the transmission and reception of signals consisting of atomic data elements that are sent by one component and received by one or more components. A sender-receiver interface can contain multiple data elements. Sender-receiver communication is one-way - any reply sent by the receiver is sent as a separate sender-receiver communication.

A require port (`r-port`) of a component typed by an AUTOSAR sender-receiver interface can read data elements of this interface. A provide port (`p-port`) of a component typed by an AUTOSAR sender-receiver interface can write data elements of this interface.

4.3.1.2 Receive Modes

The RTE supports multiple receive modes for passing data to receivers. The four possible receive modes are:

- **“Implicit data read access”** – when the receiver’s runnable executes it shall have access to a “copy” of the data that remains unchanged during the execution of the runnable.

[SWS_Rte_06000] [For data elements specified with implicit data read access, the RTE shall make the receive data available to the runnable through the `semantics of a copy`.] ([SRS_Rte_00128](#), [SRS_Rte_00019](#))

[SWS_Rte_06001] [For data elements specified with implicit data read access the receive data shall not change during execution of the runnable.] ([SRS_Rte_00128](#))

When “implicit data read access” is used the RTE is required to make the data available as a “copy”. It is not necessarily required to use a unique copy for each runnable. Thus the RTE may use a unique copy of the data for each runnable entity or may, if several runnables (even from different components) need the same data, share the same copy between runnables. Runnable entities can only share a copy of the same data when the scheduling structure can make sure the contents of the data is protected from modification by any other party.

[SWS_Rte_06004] [The RTE shall read the data elements specified with implicit data read access before the associated runnable entity is invoked.] ([SRS_Rte_00128](#))

Composite data types shall be handled in the same way as primitive data types, i.e. RTE shall make a “copy” available for the [RunnableEntity](#).

[SWS_Rte_06003] [The “implicit data read access” receive mode shall be valid for all categories of runnable entity (i.e. 1A, 1B and 2).] ([SRS_Rte_00134](#))

- **“Explicit data read access”** – the RTE generator creates a non-blocking API call to enable a receiver to poll (and read) data. This receive mode is an “explicit” mode since an explicit API call is invoked by the receiver.

The explicit “data read access” receive mode is only valid for category 1B or 2 runnable entities [[SRS_Rte_00134](#)].

- **“wake up of wait point”** – the RTE generator creates a blocking API call that the receiver invokes to read data.

[SWS_Rte_06002] [The “wake up of wait point” receive mode shall support a time-out to prevent infinite blocking if no data is available.] ([SRS_Rte_00109](#), [SRS_Rte_00069](#))

The “wake up of wait point” receive mode is inherently only valid for a category 2 runnable entity.

A category 2 runnable entity is required since the implementation may need to suspend execution of the caller if no data is available.

- **“activation of runnable entity”** – the receiving runnable entity is invoked automatically by the RTE whenever new data is available. To access the new data, the runnable entity either has to use “implicit data read access” or “explicit data read access”, i.e. invoke an [Rte_IRead](#), [Rte_Read](#), [Rte_DRead](#) or [Rte_Receive](#) call, depending on the input configuration. This receive mode differs from “implicit data read access” since the receiver is invoked by the RTE in response to a [DataReceivedEvent](#).

[SWS_Rte_06007] [The “activation of runnable entity” receive mode shall be valid for category 1A, 1B and 2 runnable entities.] ([SRS_Rte_00134](#))

The validity of receive modes in conjunction with different categories of runnable entity is summarized in Table [4.16](#).

Receive Mode	Cat 1A	Cat 1B	Cat 2
Implicit Data Read Access	Yes	Yes	Yes
Explicit Data Read Access	No	Yes	Yes
Wake up of wait point	No	No	Yes
Activation of runnable entity	Yes	Yes	Yes

Table 4.16: Receive mode validity

The category of a runnable entity is not an inherent property but is instead determined by the features of the runnable. Thus the presence of explicit API calls makes the runnable at least category 1B and the presence of a [WaitPoint](#) forces the runnable to be category 2.

4.3.1.2.1 Applicability

The different receive modes are not just used for receivers in sender-receiver communication. The same semantics are also applied in the following situations:

- **Success feedback** – The mechanism used to return transmission acknowledgments to a component. See Section [5.2.6.9](#).
- **Asynchronous client-server result** – The mechanism used to return the result of an asynchronous client-server call to a component. See Section [5.7.5.4](#).

4.3.1.2.2 Representation in the Software Component Template

The following list serves as a reference for how the RTE Generator determines the Receive Mode from its input [[SRS_Rte_00109](#)]. Note that references to “the [VariableDataPrototype](#)” within this sub-section will implicitly mean “the [VariableDataPrototype](#) for which the API is being generated”.

- **“wake up of wait point”** – A [VariableAccess](#) in the [dataReceivePointByValue](#) or [dataReceivePointByArgument](#) role references a [VariableDataPrototype](#) and a [WaitPoint](#) references a [DataReceivedEvent](#) which in turn references the same [VariableDataPrototype](#).
- **“activation of runnable entity”** – a [DataReceivedEvent](#) references the [VariableDataPrototype](#) and a runnable entity to start when the data is received.
- **“explicit data read access”** – A [VariableAccess](#) in the [dataReceivePointByValue](#) or [dataReceivePointByArgument](#) role references the [VariableDataPrototype](#).
- **“implicit data read access”** – A [VariableAccess](#) in the [dataReadAccess](#) role references the [VariableDataPrototype](#).

It is possible to combine certain access methods; for example ‘activation of runnable entity’ can be combined with ‘explicit’ or ‘implicit’ data read access (indeed, one of these pairings is necessary to cause API generation to actually *read* the datum) but it is an input error if ‘activation of runnable entity’ and ‘wakeup of wait point’ are combined (i.e. a [WaitPoint](#) references a [DataReceivedEvent](#) that references a runnable entity). It is also possible to specify both implicit and explicit data read access simultaneously.

For details of the semantics of “implicit data read access” and “explicit data read access” see Section [4.3.1.5](#).

4.3.1.3 Multiple Data Elements

A sender-receiver interface can contain one or more data elements. The transmission and reception of elements is independent – each data element, e.g. AUTOSAR signal, can be considered to form a separate logical data channel between the “provide” port and a “require” port.

[SWS_Rte_06008] [Each data element in a sender-receiver interface shall be sent separately.] ([SRS_Rte_00089](#))

Example 4.5

Consider an interface that has two data elements, `speed` and `freq` and that a component template defines a provide port that is typed by the interface. The RTE generator will then create two API calls; one to transmit `speed` and another to transmit `freq`.

Where it is important that multiple data elements are sent simultaneously they should be combined into a composite data structure (Section [4.3.1.11.1](#)). The sender then creates an instance of the data structure which is filled with the required data before the RTE is invoked to transmit the data.

4.3.1.3.1 Initial Values

[SWS_Rte_06009] [For each data element in an interface specified with `data semantics`, the RTE shall support the `initValue` attribute.] ([SRS_Rte_00108](#))

The `initValue` attribute is used to ensure that AUTOSAR software-components always access valid data even if no value has yet been received. This information is required for inter-ECU, inter-Partition, and intra-Partition communication. For inter-ECU communication initial values can be handled by COM but for intra-ECU communication RTE has to guarantee that `initValue` is handled.

In general, the specification of an `initValue` is mandatory for each data element prototype with `data semantics`, see [\[SWS_Rte_07642\]](#). If all senders and receivers are located in the same partition, this restriction is relaxed, see [\[SWS_Rte_04501\]](#).

[SWS_Rte_06010] [The RTE shall use any specified initial value to prevent the receiver performing calculations based on invalid (i.e. uninitialized) values when the `swImplPolicy` is not `queued` and if the general initialization conditions in [\[SWS_Rte_07046\]](#) are fulfilled.]([SRS_Rte_00107](#))

The above requirement ensures that RTE API calls return the initialized value until a “real” value has been received, possibly via the communication service. The requirement does *not* apply when “event” semantics are used since the implied state change when the event data is received will mean that the receiver will not start to process invalid data and would therefore never see the initialized value.

[SWS_Rte_04500] [An initial value cannot be specified when the implementation policy is set to ‘queued’ attribute is specified as true.]([SRS_Rte_00107](#))

For senders, an initial value is not used directly by the RTE (since an AUTOSAR SW-C must supply a value using `Rte_Send`) however it may be needed to configure the communication service - for example, an un-initialised signal can be transmitted if multiple signals are mapped to a single frame and the communication service transmits the whole frame when any contained signal is sent by the application. Note that it is not the responsibility of the RTE generator to configure the communication service.

It is permitted for an initial value to be specified for either the sender or receiver. In this case the same value is used for both sides of the communication.

[SWS_Rte_04501] [If in context of one partition a sender specifies an initial value and the receiver does not (or *vice versa*) the same initial value is used for both sides of the communication.]([SRS_Rte_00108](#))

Please note: In case [\[SWS_Rte_04501\]](#) combined with data conversion (section [4.3.7](#)) applies the init value for the receiver needs to be converted from the sender’s representation.

It is also permitted for both sender and receiver to specify an initial value. In this case it is defined that the receiver’s initial value is used by the RTE generator for both sides of the communication.

[SWS_Rte_04502] [If in context of one partition both receiver and sender specify an initial value the specification for the *receiver* takes priority.]([SRS_Rte_00108](#))

4.3.1.4 Multiple Receivers and Senders

Sender-receiver communication is not restricted to communication connections between a single sender and a single receiver. Instead, sender receiver communication connection can have multiple senders (‘n:1’ communication) or multiple receivers (‘1:m’ communication) with the restrictions that multiple senders are not allowed for `mode switch notifications`, see metamodel restriction [\[SWS_Rte_02670\]](#).

The RTE does not impose any co-ordination on senders – the behavior of senders is independent of the behavior of other senders. For example, consider two senders A

and B that both transmit data to the same receiver (i.e. 'n:1' communication). Transmissions by either sender can be made at any time and there is no requirement that the senders co-ordinate their transmission. However, while the RTE does not impose any co-ordination on the senders it does ensure that simultaneous transmissions do not conflict.

In the same way that the RTE does not impose any co-ordination on senders there is no co-ordination imposed on receivers. For example, consider two receivers P and Q that both receive the same data transmitted by a single sender (i.e. '1:m' communication). The RTE does not guarantee that multiple receivers see the data simultaneously even when all receivers are on the same ECU.

4.3.1.5 Implicit and Explicit Data Reception and Transmission

[SWS_Rte_06011] [The RTE shall support 'explicit' and 'implicit' data reception and transmission.] ([SRS_Rte_00019](#), [SRS_Rte_00098](#), [SRS_Rte_00129](#), [SRS_Rte_00128](#), [SRS_Rte_00141](#))

Implicit data access transmission means that a runnable does not actively initiate the reception or transmission of data. Instead, the required data is received automatically when the runnable starts and is made available for other runnables at the earliest when it terminates.

Explicit data reception and transmission means that a runnable employs an explicit API call to send or receive certain data elements. Depending on the category of the runnable and on the configuration of the according ports, these API calls can be either blocking or non-blocking.

4.3.1.5.1 Implicit

Implicit Read

For the implicit reading of data, [VariableAccesses](#) aggregated with a [dataReadAccess](#) role [[SRS_Rte_00128](#)], the data is made available when the runnable starts using the [semantics of a copy](#) operation and the RTE ensures that the 'copy' will not be modified until the runnable terminates.

If data transformation shall be executed for this data element, the data transformation takes place after reception of the data from the Com stack and before start of the runnable execution. (See [[SWS_Rte_08570](#)], [[SWS_Rte_08108](#)])

When a runnable *R* is started, the RTE reads all [VariableDataPrototypes](#) referenced by a [VariableAccess](#) in the [dataReadAccess](#) role, if the data elements may be changed by other runnables a copy is created that will be available to runnable *R*. The runnable *R* can read the data element by using the RTE APIs for implicit read (see the API description in Section [5.6.18](#)). That way, the data is guaranteed not to change (e.g. by write operations of other runnables) during the entire lifetime of *R*. If

several runnables (even from different components) need the data, they can share the *same* buffer. This is only applicable when the scheduling structure can make sure the contents of the data is protected from modification by any other party.

Note that this concept implies that the runnable does in fact terminate. Therefore, while implicit read is allowed for category 1A and 1B runnable entities as well as category 2 only the former are guaranteed to have a finite execution time. A category 2 runnable that runs forever will not see any updated data.

`VariableAccess` in the `dataReadAccess` role is only allowed for `VariableDataPrototypes` with their `swImplPolicy` different from 'queued' ([constr_2020]).

Implicit Write

Implicit writing, `VariableAccesses` aggregated with a `dataWriteAccess` role [SRS_Rte_00129], is the opposite concept. `VariableDataPrototypes` referenced by a `VariableAccess` in the `dataWriteAccess` role are sent by the RTE after the runnable terminates. The runnable can write the data element by using the RTE APIs for implicit write (see the API description in Sect. 5.6.20 and 5.6.21). The sending is independent from the position in the execution flow in which the `Rte_IWrite` is performed inside the Runnable. When performing several write accesses during runnable execution to the same data element, only the last one will be recognized. Here we have a last-is-best semantics.

If data transformation shall be executed for this data element, the data transformation takes place after termination of the runnable and before sending the data to the Com stack. (See [SWS_Rte_08571], [SWS_Rte_08109])

[SWS_Rte_08418] [The content of a `preemption area` specific buffer which is used exclusively for an `implicit write access` to a `VariableDataPrototype` shall be initialized by the generated RTE with a copy of the global buffer between the beginning of the task and the execution of the first `RunnableEntity` with access to this `VariableDataPrototype` in the task/ISR2.] (SRS_Rte_00129)

Note:

[SWS_Rte_08418] ensures that no undefined values are written back to a `preemption area` specific buffer at runnable termination if a `VariableDataPrototype` is referenced by a `VariableAccess` in the `dataWriteAccess` role and no RTE API for implicit write of this `VariableDataPrototype` is called during an execution of the Runnable. For the first entry to the `preemption area` the "global buffer" will contain the `initValue` of the `VariableDataPrototype` (if no `initValue` is configured then the value will depend on the initialization strategy of the startup code). For second and subsequent entries the "global buffer" will contain the previously written value (if any).

[SWS_Rte_03570] [For `VariableAccesses` in the `dataWriteAccess` role the RTE shall make the sent data available to others (other runnables, other AUTOSAR SWCs, Basic SW, ..) with the `semantics of a copy`.] (SRS_Rte_00129)

[SWS_Rte_03571] [For [VariableAccesses](#) in the [dataWriteAccess](#) role the RTE shall make the sent data available to others (other runnables, other AUTOSAR SWCs, Basic SW, ..) at the earliest when the runnable has terminated.]([SRS_Rte_00129](#))

[SWS_Rte_03572] [For [VariableAccesses](#) in the [dataWriteAccess](#) role several accesses to the same [VariableDataPrototype](#) performed inside a runnable during one runnable execution shall lead to only one transmission of the [VariableDataPrototype](#).]([SRS_Rte_00129](#))

[SWS_Rte_03573] [If several [VariableAccesses](#) in the [dataWriteAccess](#) role referencing the same [VariableDataPrototype](#) are performed inside a runnable during the runnable execution, the RTE shall use the last value written. (last-is-best semantics)]([SRS_Rte_00129](#))

A [VariableAccess](#) in the [dataWriteAccess](#) role is only sensible for runnable entities that are guaranteed to terminate, i.e. category 1A and 1B. If it is used for a category 2 runnable which does not terminate then no data write-back will occur.

[SWS_Rte_03574] [[VariableAccess](#) in the [dataWriteAccess](#) role shall be valid for all categories of runnable entity.]([SRS_Rte_00129](#), [SRS_Rte_00134](#))

To get common behavior in RTEs from different suppliers further requirements defining the semantic of implicit communication exist:

Please note that the behavior of Implicit Communication can be adjusted with ECU Configuration. For further information see section [8.7](#).

Implicit Communication Behavior in case of incoherent implicit data access

[SWS_Rte_03954] [The RTE generator shall use exactly one buffer to contain data copies of the same [VariableDataPrototype](#) per [preemption area](#) for the implementation of the [copy semantic](#) of [incoherent implicit data access](#).]([SRS_Rte_00128](#), [SRS_Rte_00129](#), [SRS_Rte_00134](#))

Requirement [\[SWS_Rte_03954\]](#) means that all runnable entities mapped to tasks/ISR2s of a [preemption area](#) with an [incoherent implicit read access](#) or [incoherent implicit write access](#) access the same buffers.

[SWS_Rte_03598] [For implicit communication, the RTE shall provide a single shared read/write buffer when no runnable entity mapped to tasks/ISR2s of the [preemption area](#) has [VariableAccess](#) in both [incoherent implicit read access](#) and [incoherent implicit write access](#) referencing the same [VariableDataPrototype](#).]([SRS_Rte_00128](#), [SRS_Rte_00129](#))

If either the sender or the receiver uses a [data element with status](#) and the other uses a [data element without status](#), a [data element with status](#) can be implemented and casted in the component data structure when a pointer to a [data element without status](#) is needed.

[SWS_Rte_03955] [For implicit communication, in case that dedicated [RPortPrototype](#) and [PPortPrototype](#) are used, separate read and write buffers shall be

used when at least one `RunnableEntity` mapped to tasks/ISR2s of the `preemption area` has `implicit read access` and `implicit write access` referencing the same `VariableDataPrototype`.] ([SRS_Rte_00128](#), [SRS_Rte_00129](#))

In the case that a `RunnableEntity` defines `dataWriteAccess` and `dataReadAccess` to the same `VariableDataPrototype` in the context of a `PRPortPrototype` [[SWS_Rte_03955](#)] does not apply. In such configuration the writing `RunnableEntity` immediately sees its own updates of the data values even before the `RunnableEntity` has terminated.

[SWS_Rte_08408] [If a `RunnableEntity` has both `dataWriteAccess` and `dataReadAccess` to a `VariableDataPrototype` in the context of a `PRPortPrototype` the result of the write access shall be immediately visible to subsequent read accesses from within the same `RunnableEntity`.] ([SRS_Rte_00128](#), [SRS_Rte_00129](#))

Please note that the content of the write buffers are copied into the read buffer of the `preemption area` after the `RunnableEntity` with the write access terminates (see [[SWS_Rte_07041](#)]). Therefore the write buffer might be implemented as temporary buffer.

[SWS_Rte_03599] [For implicit communication with `incoherent implicit data access` all readers within a `preemption area` shall access the same buffer.] ([SRS_Rte_00128](#))

[SWS_Rte_03953] [For implicit communication with `incoherent implicit data access` all writers within a `preemption area` shall access the same buffer.] ([SRS_Rte_00129](#))

The content of a shared buffer (see [[SWS_Rte_03598](#)]) is not guaranteed to stay constant during the whole task/ISR2 since a writer will change the shared copy and hence readers mapped in the task after the writer will access the updated copy. When buffers are shared, written data is visible to other `RunnableEntity`s within the same execution of the task/ISR2. However since no runnable within the task/ISR2 will both read and write the same buffer ([[SWS_Rte_03598](#)] and [[SWS_Rte_03955](#)]) consistency *within a runnable* is ensured.

When separate buffers used for implicit communication (see [[SWS_Rte_03955](#)]) any data written by a runnable is not visible (to either other `RunnableEntity`s or to the writing runnable) until the data is written back after the runnable has terminated.

Implicit Communication Behavior in case of coherent implicit data access

[SWS_Rte_07062] [The RTE generator shall use exactly one buffer to contain data copies of the same `VariableDataPrototype` per `coherency group` for the implementation of the `copy semantic` of `coherent implicit data access`.] ([SRS_Rte_00128](#), [SRS_Rte_00129](#), [SRS_Rte_00134](#))

Requirement [[SWS_Rte_07062](#)] means that all runnable entities with `coherent implicit data accesses` access the same buffers. Please note that it is only supported to group `implicit read accesses` or `implicit write accesses` of

`RunnableEntity`s executed in the same OS Task/ISR2. Therefore a `coherent implicit data access` results in a task local buffer as it was specified in previous AUTOSAR releases. With this means a backward compatible behavior of the RTE can be ensured.

Please note that [SWS_Rte_03955] applies as well for coherent implicit data access. [SWS_Rte_07062] includes already that a single shared read/write buffer shall be used when no runnable entity has `coherent implicit read access` and `coherent implicit write access` belonging to the same `coherency group`.

Implicit Communication buffer handling

The preemption area specific buffer should not be updated or made available more often than required. The following requirements detail how to obtain that for read and write access.

[SWS_Rte_03956] [The content of a `preemption area` specific buffer used for an `incoherent implicit read access` to a data element shall be filled with actual data by a copy action between the beginning of the task/ISR2 and the execution of the first `RunnableEntity` with access to this data element in the task/ISR2.] (SRS_Rte_00128)

[SWS_Rte_07020] [If the `RteImmediateBufferUpdate = TRUE` is configured for an `incoherent implicit read access` to a data element the content of a `preemption area` specific buffer used for that `VariableAccess` shall be filled with actual data by a copy action immediately before the `RunnableEntity` with the related implicit read access to the data element starts.] (SRS_Rte_00128)

[SWS_Rte_07041] [The content of a separate write buffer (see [SWS_Rte_03955]) modified by an `incoherent implicit write access` of a `RunnableEntity` shall be made available to `RunnableEntity`s using an `implicit read access` allocated in the **same** `preemption area` immediately after the execution of the `RunnableEntity` with the related `implicit write access` to the data element.] (SRS_Rte_00129)

[SWS_Rte_03957] [The content of a `preemption area` specific buffer modified by a `incoherent implicit write access` in one task shall be made available to `RunnableEntity`s using an `implicit read access` allocated in **other** `preemption areas` at latest after the execution of the last `RunnableEntity` mapped to the task/ISR2.] (SRS_Rte_00129)

[SWS_Rte_07021] [If the `RteImmediateBufferUpdate = TRUE` is configured for an `incoherent implicit write access` the content of a `preemption area` specific buffer shall be made available to `RunnableEntity`s using an `implicit read access` allocated in **other** `preemption areas` immediately after the execution of the `RunnableEntity` with the related `implicit write access` to the data element.] (SRS_Rte_00129)

Note:

It's the semantic of implicit communication that a `VariableAccess` in the `dataWriteAccess` role is interpreted as writing the whole `dataElement`.

Explicit Schedule Points defined by `RteOsSchedulePoints` are placed between `RunnableEntity`s after the data written with implicit write access by the `RunnableEntity` are propagated to other `RunnableEntity`s and before the `preemption area` specific buffer used for a implicit read access of the successor `RunnableEntity` are filled with actual data by a copy action according [SWS_Rte_07020]. This ensures that the data produced by one `RunnableEntity` is propagated before `RunnableEntity`s assigned to other Os Tasks/ISR2s are activated due to Task scheduling caused by the explicit Schedule Point. See as well [SWS_Rte_07042] and [SWS_Rte_07043].

The requirements regarding buffer handling for implicit communication do not apply in case of filters. Buffer handling of RTE for filters is specified in chapter 4.3.1.9 (requirements: [SWS_Rte_08077] and [SWS_Rte_08079]).

Implicit Communication buffer handling for coherent implicit data access

[SWS_Rte_07063] [The content of a `coherency group` specific buffer used for an `coherent implicit read access` to one or more data elements shall be filled with actual data by a copy action between the beginning of the task and the execution of the first `RunnableEntity` in the task/ISR2 with a `coherent implicit read access` belonging to the `coherency group`.] (SRS_Rte_00128)

[SWS_Rte_07064] [If the `RteImmediateBufferUpdate` = TRUE is configured for `coherent implicit read accesses` the content of a `coherency group` specific buffer used for these `VariableAccesses` shall be filled with actual data by a copy action immediately before the first `RunnableEntity` in the task/ISR2 with a `coherent implicit read access` belonging to the `coherency group` starts.] (SRS_Rte_00128)

[SWS_Rte_07065] [The content of a separate write buffer (see [SWS_Rte_03955]) modified by a `coherent implicit write access` of a `RunnableEntity` shall be made available to `RunnableEntity`s using a `coherent implicit read access` belonging to the same `coherency group` immediately after the execution of the `RunnableEntity` with the related `coherent implicit write access`.] (SRS_Rte_00129)

[SWS_Rte_07066] [The content of a `coherency group` specific buffer modified by `coherent implicit write accesses` in one task/ISR2 shall be made available to other `RunnableEntity`s at earliest after the execution of the last `RunnableEntity` with a `coherent implicit write access` belonging to this `coherency group`.] (SRS_Rte_00129)

[SWS_Rte_07067] [The content of a `coherency group` specific buffer modified by `coherent implicit write accesses` in one task/ISR2 shall be made available to other `RunnableEntity`s at latest after the execution of the last `RunnableEntity` mapped to the task/ISR2.] (SRS_Rte_00129)

[SWS_Rte_07068] [If the `RteImmediateBufferUpdate` = TRUE is configured for a coherent implicit write accesses the content of a coherency group specific buffer modified by coherent implicit write accesses in one task/ISR2 shall be made available to other readers not belonging to this coherency group immediately after the execution of the last `RunnableEntity` with a coherent implicit write access belonging to this coherency group]([SRS_Rte_00129](#))

Direct Access to the RamMirror of a NvBlockComponent

[SWS_Rte_03878] [The RTE Generator shall allow direct accesses to the `ramMirror` of a `NvBlockSwComponent` in the same partition without additional buffering if the accesses in the Data Communication Path cannot interrupt each other. The container `RteExclusiveAccessOptimization` shall be used to specify the BSW entities (`RteAccessingEntityRef`, e. g. to `NvM` main function) as well as the read access (`RteSoftwareComponentReadRef`, e. g. `ApplicationSwComponentType`) and write access (`RteSoftwareComponentWriteRef`, e. g. `Dcm Service Component`) involved in the exclusive access to the RAM mirror.]([SRS_Rte_00128](#), [SRS_Rte_00129](#), [SRS_Rte_00178](#))

Handling of ConsistencyNeeds

`ConsistencyNeeds` are not directly processed by the RTE Generator but providing an important information for the correct configuration of the RTE and OS with respect to preemption, `RteEventToTaskMapping/RteEventToIsrMapping` and `RteImplicitCommunication`. Therefore following constraints apply:

[SWS_Rte_CONSTR_09001] Whole `DataPrototypeGroup` in role `dpgRequiresCoherency` shall be propagated coherently [

All `RunnableEntity`s in a `RunnableEntityGroup` with `dataWriteAccess` to data belonging to the same `DataPrototypeGroup` in the role `dpgRequiresCoherency` shall

- Be mapped to the same OS Task/ISR2
- AND shall
- A) either be scheduled in a way that these `RunnableEntity`s can not be interrupted by `RunnableEntity`s with `dataReadAccess` to (more than one) data belonging to the `DataPrototypeGroup`.
 - B) or the `RteImplicitCommunication` shall be configured to ensure a coherent propagation (`RteCoherentAccess` == true) for reading `RunnableEntity`s⁴.

]()

⁴`RunnableEntity`s with have as well `dataWriteAccess` to data belonging to the `DataPrototypeGroup` are excluded because inside the calculation chain the latest data values are visible

Please note that the interruption of `RunnableEntity`s and between `RunnableEntity`s depends from many factors like the configuration of the OS and the configuration of the RTE (e.g. `RteOsSchedulePoint`).

[SWS_Rte_CONSTR_09002] The whole `DataPrototypeGroup` shall be read stable for the whole `RunnableEntityGroup` in the role `regRequiresStability` [.

All `RunnableEntity`s with `dataReadAccess` to data belonging to the same `DataPrototypeGroup` and which are belonging to the same `RunnableEntityGroup` in the role `regRequiresStability` shall

- either be configured in a way that the chain of `RunnableEntity`s with `dataReadAccess` to the data of the `DataPrototypeGroup` can not be interrupted by any of the `RunnableEntity`(s) with `dataWriteAccess` to data of the `DataPrototypeGroup`
- or the `RteImplicitCommunication` shall be configured to ensure stable data values (`RteCoherentAccess == true`) for reading `RunnableEntity`s belonging to the `RunnableEntityGroup`.

]()

Examples

Following examples shall illustrate how `ConsistencyNeeds` can be implemented with either scheduling or `coherency` groups.

Example 4.6

Common definition of PortInterfaces

In order to simplify the examples all `PortInterfaces` are of type `SenderReceiverInterface` and contain exactly one `VariableDataPrototype` with identical `shortName`. For example `SenderReceiverInterface` "A" contains `VariableDataPrototype` "A"

Additionally the `shortName` of the `SenderReceiverInterface` is identical to the `shortName` of the `PortPrototype`. For example `PPortPrototype` "A" is typed by `SenderReceiverInterface` "A".

Example 4.7

Stability need for received data

Setup of SWCs

`ApplicationSwComponentType` "ASWC_A" with the `PPortPrototypes`: "A","B" and the `RunnableEntity` "ASWC_A_RUN1" which in turn has following `dataWriteAccesses`

- "DWP_ASWC_A_RUN1_A_A" referencing [VariableDataPrototype](#) "A" in [PPortPrototype](#) "A"
- "DWP_ASWC_A_RUN1_B_B" referencing [VariableDataPrototype](#) "B" in [PPortPrototype](#) "B"

[ApplicationSwComponentType](#) "ASWC_B" with the [RPortPrototypes](#): "A","B" and the [RunnableEntity](#) "ASWC_B_RUN1" which in turn has [dataReadAccesses](#)

- "DRP_ASWC_B_RUN1_A_A" referencing [VariableDataPrototype](#) "A" in [RPortPrototype](#) "A"
- "DRP_ASWC_B_RUN1_B_B" referencing [VariableDataPrototype](#) "B" in [RPortPrototype](#) "B"

[ApplicationSwComponentType](#) "ASWC_C" with the [RPortPrototypes](#): "A","B" and the [RunnableEntity](#) "ASWC_C_RUN1" which in turn has [dataReadAccesses](#)

- "DRP_ASWC_C_RUN1_A_A" referencing [VariableDataPrototype](#) "A" in [RPortPrototype](#) "A"
- "DRP_ASWC_C_RUN1_B_B" referencing [VariableDataPrototype](#) "B" in [RPortPrototype](#) "B"

The [ConsistencyNeeds](#) "CN_BC" defines a [RunnableEntityGroup](#) in the role [regRequiresStability](#) with the members "ASWC_B_RUN1", "ASWC_C_RUN1" In addition the [ConsistencyNeeds](#) "CN_BC" defines a [DataPrototypeGroup](#) in the role [dpgDoesNotRequireCoherency](#) to the [VariableDataPrototypes](#) ASWC_B.A.A.A, ASWC_C.A.A.A, ASWC_B.B.B.B and ASWC_C.B.B.B The complete example is listed as ARXML in [Appendix F.2](#).

Assuming now a configuration:

ASWC_A_RUN1 is mapped to [OsTask](#) T10MS

ASWC_B_RUN1 is mapped to [OsTask](#) T100MS

ASWC_C_RUN1 is mapped to [OsTask](#) T100MS

where T10MS can **NOT** interrupt T100MS during the execution of ASWC_B_RUN1 and ASWC_C_RUN1. This configuration fulfills [[SWS_Rte_CONSTR_09002](#)] with respect to "CN_BC" due the scheduling conditions. Since the producer of "A" and "B" can **NOT** interrupt the [RunnableEntities](#) with the [dataReadAccesses](#) it is guaranteed that the value for all accesses of ASWC_B_RUN1 and ASWC_C_RUN1 to the same data is identical (and therefore stable) during one execution of [OsTask](#) T100MS.

Assuming now a configuration:

ASWC_A_RUN1 is mapped to `OsTask` T10MS

ASWC_B_RUN1 is mapped to `OsTask` T100MS + `RteOsSchedulePoint` == UNCONDITIONAL

ASWC_C_RUN1 is mapped to `OsTask` T100MS

where T10MS can interrupt T100MS after the execution of ASWC_B_RUN1. Without further means this configuration would violate [SWS_Rte_CONSTR_09002] due the scheduling conditions. Since the producer of "A" and "B" can interrupt the `RunnableEntity`s with the `dataReadAccesses` it is not guaranteed that the value for all accesses of ASWC_B_RUN1 and ASWC_C_RUN1 to the same data is kept stable during one execution of `OsTask` T100MS.

With the additional configuration `RteImplicitCommunication` "CN_BC_A":

- `RteVariableReadAccessRef` referencing "DRP_ASWC_B_RUN1_A_A"
- `RteVariableReadAccessRef` referencing "DRP_ASWC_C_RUN1_A_A"
- `RteCoherentAccess` = true

and

`RteImplicitCommunication` "CN_BC_B":

- `RteVariableReadAccessRef` referencing "DRP_ASWC_B_RUN1_B_B"
- `RteVariableReadAccessRef` referencing "DRP_ASWC_C_RUN1_B_B"
- `RteCoherentAccess` = true

"ASWC_B_RUN1_A_A" and "ASWC_C_RUN1_A_A" as well as "ASWC_B_RUN1_B_B" and "ASWC_C_RUN1_B_B" are in the same `coherency group`. Therefore the read data values for "A" and "B" are from the same age in one execution of `OsTask` T100MS for ASWC_B_RUN1 and ASWC_C_RUN1.

Please note, since it is not requested that data "A" and "B" are communicated coherently the setup of `RteImplicitCommunication` for "A" and "B" can be handled independently from each other. In particular if there a further `RunnableEntity`s with `dataReadAccesses` to "A" or "B" mapped to the `OsTask` T100MS the buffers for "A" and "B" can be loaded at different points in the execution sequence. Further on it is not requested that "A" and "B" is produced in the same recurrence as it is show in this example.

Example 4.8

Coherency need and stability need for received data

Setup of SWCs

`ApplicationSwComponentType` "ASWC_H" with the `PPortPrototype`: "X"

and the `RunnableEntity` "ASWC_H_RUN1" which in turn has following `dataWriteAccesses`

- "DWP_ASWC_H_RUN1_X_X" referencing `VariableDataPrototype` "X" in `RPortPrototype` "X"

`ApplicationSwComponentType` "ASWC_I" with the `RPortPrototype`: "Y"

and the `RunnableEntity` "ASWC_I_RUN1" which in turn has following `dataWriteAccesses`

- "DWP_ASWC_I_RUN1_Y_Y" referencing `VariableDataPrototype` "Y" in `RPortPrototype` "Y"

`ApplicationSwComponentType` "ASWC_J" with the `RPortPrototypes`: "X","Y"

and the `RunnableEntity` "ASWC_J_RUN1" which in turn has following `dataReadAccesses`

- "DRP_ASWC_J_RUN1_X_X" referencing `VariableDataPrototype` "X" in `RPortPrototype` "X"
- "DRP_ASWC_J_RUN1_Y_Y" referencing `VariableDataPrototype` "Y" in `RPortPrototype` "Y"

`ApplicationSwComponentType` "ASWC_K" with the `RPortPrototype`: "X"

and the `RunnableEntity` "ASWC_K_RUN1" which in turn has following `dataReadAccesses`

- "DRP_ASWC_K_RUN1_X_X" referencing `VariableDataPrototype` "X" in `RPortPrototype` "X"

The `ConsistencyNeeds` "CN_J" defines a `RunnableEntityGroup` in the role `regDoesNotRequireStability` with the member "ASWC_I_RUN1" In addition the `ConsistencyNeeds` "CN_J" defines a `DataPrototypeGroup` in the role `dpgRequiresCoherency` to the `VariableDataPrototypes` ASWC_J.X.X.X, ASWC_K.Y.Y.Y

The `ConsistencyNeeds` "CN_JK" defines a `RunnableEntityGroup` in the role `regRequiresStability` with the member "ASWC_I_RUN1", "ASWC_J_RUN1" In addition the `ConsistencyNeeds` "CN_JK" defines a `DataPrototypeGroup` in the role `dpgDoesNotRequireCoherency` to the `VariableDataPrototypes` ASWC_J.X.X.X, ASWC_K.X.X.X

Assuming now a configuration:

ASWC_H_RUN1 is mapped to `OsTask` T100MS + `RteOsSchedulePoint` == UNCONDITIONAL

ASWC_I_RUN1 is mapped to `OsTask` T100MS

ASWC_J_RUN1 is mapped to `OsTask` T10MS

ASWC_K_RUN1 is mapped to `OsTask` T10MS

where T10MS can interrupt T100MS Without further means this configuration would violate [SWS_Rte_CONSTR_09001] with respect to "CN_J" due to the scheduling conditions. Since the consumer of "X" and "Y" can interrupt the `RunnableEntity`s which are producing "X" and "Y" it is not guaranteed that the value for all accesses of ASWC_J_RUN1 and ASWC_K_RUN1 returning data of the same age during one execution of `OsTask` T10MS. The `ConsistencyNeeds` "CN_JK" is already fulfilled since the consumers "ASWC_J_RUN1" and "ASWC_K_RUN1" can't be interrupted by the producing `RunnableEntity` ASWC_H_RUN1

With the additional configuration `RteImplicitCommunication` "CN_J":

- `RteVariableWriteAccessRef` referencing "DWP_ASWC_H_RUN1_X_X"
- `RteVariableReadAccessRef` referencing "DWP_ASWC_I_RUN1_Y_Y"
- `RteCoherentAccess` = true

the write accesses to "X" and "Y" are in the same `coherency group`. Due to this "CN_J" is fulfilled since the propagation of "X" and "Y" is delayed until the termination of ASWC_I_RUN1.

4.3.1.5.2 Explicit

The behavior of explicit reception depends on the category of the runnable and on the configuration of the according ports.

An explicit API call can be either non-blocking or blocking. If the call is non-blocking (i.e. there is a `VariableAccess` in the `dataReceivePointByValue` or `dataReceivePointByArgument` role referencing the `VariableDataPrototype` for which the API is being generated, but no `WaitPoint` referencing a `DataReceivedEvent` which references the `VariableDataPrototype` for which the API is being generated), the API call immediately returns the next value to be read and, if the communication is queued (event reception), it removes the data from the receiver-side queue, see Section 4.3.1.10

[SWS_Rte_06012] [A non-blocking RTE API "read" call shall indicate if no data is available.] (*SRS_Rte_00109*)

In contrast, a blocking call (i.e. the `VariableDataPrototype`, referenced by a `VariableAccess` in the role `dataReceivePointByArgument`, and for which the API is being generated, is referenced by a `DataReceivedEvent` which is itself referenced by a `WaitPoint`) will suspend execution of the caller until new data arrives (or

a timeout occurs) at the according port. When new data is received, the RTE resumes the execution of the waiting runnable. ([SRS_Rte_00092])

To prevent infinite waiting, a blocking RTE API call can have a timeout applied. The RTE monitors the timeout and if it expires without data being received returns a particular error status.

[SWS_Rte_06013] [A blocking RTE API “read” call shall indicate the expiry of a timeout.] (SRS_Rte_00069)

The “timeout expired” indication also indicates that no data was received before the timeout expired.

Blocking reception of data (“wake up of wait point” receive mode as described in Section 4.3.1.2) is only applicable for category 2 runnables whereas non-blocking reception (“explicit data read access” receive mode) can be employed by runnables of category 2 or 1B. Neither blocking nor non-blocking explicit reception is applicable for category 1A runnable because they must not invoke functions with unknown execution time (see table 4.16).

[SWS_Rte_06016] [The RTE API call for explicit sending (VariableAccess in the dataSendPoint role, [SRS_Rte_00098]) shall be non-blocking.] (SRS_Rte_00098)

Using this API call, the runnable can explicitly send new values of the VariableDataPrototype.

Explicit writing is valid for runnables of category 1b and 2 only. Explicit writing is not allowed for a category 1A runnable since these require API calls with constant execution time (i.e. macros).

Although the API call for explicit sending is non-blocking, it is possible for a category 2 runnable to block waiting for a notification whether the (explicit) send operation was successful. This is specified by the AcknowledgementRequest attribute and occurs by a separate API call Rte_Feedback. If the feedback method is ‘wake_up_of_wait_point’, the runnable will block and be resumed by the RTE either when a positive or negative acknowledgment arrives or when the timeout associated with the WaitPoint expires.

4.3.1.5.3 Concepts of data access

Tables 4.17 and 4.18 summarize the characteristics of implicit versus explicit data reception and transmission.

Implicit Read	Explicit Read
Receiving of data element values is performed only once when runnable starts	Runnable decides when and how often a data element value is received
Values of data elements do not change while runnable is running.	Runnable can always decide to receive the latest value

Several API calls to the same signal always yield the same data element value	Several API calls to the same signal may yield different data element values
Runnable must terminate (all categories)	Runnable is of cat. 1B or 2

Table 4.17: Implicit vs. explicit read

Implicit Write	Explicit Write
Sending of data element values is only done once after runnable returns	Runnable can decide when sending of data element values is done via the API call
Several usages of the API call inside the runnable cause only one data element transmission	Several usages of the API call inside the runnable cause several transmissions of the data element content. (Depending on the behavior of COM, the number of API calls and the number of transmissions are not necessarily equal.)
Runnable must terminate (all categories)	Runnable is cat. 1B or 2

Table 4.18: Implicit vs. explicit write

4.3.1.6 Transmission Acknowledgement

When [TransmissionAcknowledgementRequest](#) is specified, the RTE will inform the sending component if the data has been sent correctly or not. Note that a positive transmission acknowledgement gives no guaranty that the data is actually sent on a physical bus nor that it has been received correctly by the corresponding receiver AUTOSAR software-component. Instead the transmission acknowledgement just confirms that the data was accepted for transmission and subsequent transmissions will not override the sent data.

[SWS_Rte_05504] [The RTE shall support the use of [TransmissionAcknowledgementRequest](#) independently for each data item of an AUTOSAR software-component's AUTOSAR interface.] ([SRS_Rte_00122](#))

[SWS_Rte_08076] [The RTE generator shall reject configurations violating [constr_-3074] in System Template [8].] ([SRS_Rte_00122](#), [SRS_Rte_00018](#))

[SWS_Rte_07927] [The RTE generator shall reject configurations violating [constr_-1256] in Software Component Template [2].] ([SRS_Rte_00122](#), [SRS_Rte_00018](#))

The result of the feedback can be collected using “wake up of wait point”, “explicit data read access”, “implicit data read access” or “activation of runnable entity”.

The [TransmissionAcknowledgementRequest](#) allows to specify a time-out.

[SWS_Rte_03754] [If [TransmissionAcknowledgementRequest](#) is specified, the RTE shall ensure that time-out monitoring is performed, regardless of the receive mode of the acknowledgment.]([SRS_Rte_00069](#), [SRS_Rte_00122](#))

For inter-ECU communication, AUTOSAR COM provides the necessary functionality, for intra-ECU communication, the RTE has to implement the time-out monitoring.

If a [WaitPoint](#) is specified to collect the acknowledgment, two time-out values have to be specified, one for the [TransmissionAcknowledgementRequest](#) and one for the [WaitPoint](#).

[SWS_Rte_03755] [The RTE generator shall reject the configuration, violating the [constr_2033].]([SRS_Rte_00018](#)) The [DataSendCompletedEvent](#) associated with the [VariableAccess](#) in the [dataSendPoint](#) role for a [VariableDataPrototype](#) shall indicate that the transmission was successful or that the transmission was not successful. The status information about the success of the transmission shall be available as the return value of the generated RTE API call.

[SWS_Rte_03756] [For each transmission of a [VariableDataPrototype](#) only one acknowledgment shall be passed to the sending component by the RTE. The acknowledgment indicates either that the transmission was successful or that the transmission was not successful.]([SRS_Rte_00122](#))

[SWS_Rte_03757] [The status information about the success or failure of the transmission shall be available as the return value of the RTE API call to retrieve the acknowledgment.]([SRS_Rte_00122](#))

[SWS_Rte_03604] [The status information about the success or failure of the transmission shall be buffered with last-is-best semantics. When a data item is sent, the status information is reset.]([SRS_Rte_00122](#))

[SWS_Rte_03604] implies that once the [DataSendCompletedEvent](#) has occurred, repeated API calls to retrieve the acknowledgment shall always return the same result until the next data item is sent.

[SWS_Rte_03758] [If the time-out value of the [TransmissionAcknowledgementRequest](#) is 0, no time-out monitoring shall be performed.]([SRS_Rte_00069](#), [SRS_Rte_00122](#))

4.3.1.7 Communication Time-out

When sender-receiver communication is performed using some physical network there is a chance this communication may fail and the receiver does not get an update of data (in time or at all). To allow the receiver of a [data element](#) to react appropriately to such a condition the SW-C template allows the specification of a time-out which the infrastructure shall monitor and indicate to the interested software components.

A data element is the actual information exchanged in case of sender-receiver communication. In the COM specification this is represented by a [ComSignal](#). In the SW-C

template a data element is represented by the instance of a [VariableDataPrototype](#).

When present, the [aliveTimeout](#) attribute⁵ enables the monitoring of the timely reception of the [data element](#) with [data semantics](#) transmitted over the network.

[SWS_Rte_08061] [If the [aliveTimeout](#) attribute is present the RTE shall provide the RTE COM Rx time-out callback (`Rte_COMCbkJRxTOut_<sg>` or `Rte_COMCbkJRxTOut_<sn>`).] ([SRS_Rte_00147](#))

The monitoring functionality is provided by the COM module, the RTE transports the event of reception time-outs to software components as “data element outdated”. The software components can either subscribe to that event (activation of runnable entity) or get that situation passed by the implicit and explicit status information (using API calls).

[SWS_Rte_08062] [If COM indicates a reception time-out (via RTE COM Rx time-out callback) the RTE shall raise an event of reception time-out to software components as “data element outdated”.] ([SRS_Rte_00147](#))

[SWS_Rte_05021] [The RTE shall have time-out monitoring disabled for communications local to the partition, independently of the presence of [aliveTimeout](#).] ([SRS_Rte_00147](#))

In such case, The RTE does not raise events of reception time-out to software components.

Therefore the Software Component shall not rely in its functionality on the time-out notification, because for local communication the notification will never occur. Time-out notification is intended as pure error reporting.

[SWS_Rte_02710] [If [aliveTimeout](#) is present, and the communication is between different partitions of the same ECU, time-out monitoring is disabled. Instead, a time-out notification of the receiver will occur immediately, when the partition of the sender is stopped and the last correctly received value shall be provided to the software components.] ([SRS_Rte_00147](#))

Therefore the Software Component shall not rely in its functionality on the time-out notification, because for local communication the notification will never occur. Time-out notification is intended as pure error reporting.

[SWS_Rte_03759] [If the [aliveTimeout](#) attribute is 0, no time-out monitoring shall be performed.] ([SRS_Rte_00069](#), [SRS_Rte_00147](#))

[SWS_Rte_08004] [If a signal is received, even if the signal is marked as invalid, the time-out for the same signal shall be restarted.] ([SRS_Rte_00078](#), [SRS_Rte_00147](#))

Note: time-out detection may already be implemented by COM. Nevertheless this is the expected behavior towards the software components.

⁵This attribute is called “LIVELIHOOD” in the VFB specification

The time-out support (called “deadline monitoring” in COM) provided by COM has some restrictions which have to be respected when using this mechanism. Since the COM module is configured based on the System Description the restrictions mainly arise from the `data element` to I-PDU mapping. This already has to be considered when developing the System Description and the RTE Generator can only provide warnings when inconsistencies are detected. Therefore the RTE Generator needs to have access to the configuration information of COM.

In case time-out is enabled on a `data element` with update bit, there shall be a separate time-out monitoring for each `data element` with an update bit [SWS_Com_00292].

There shall be an I-PDU based time-out for `data elements` without an update bit [SWS_Com_00290]. For all data elements without update bits within the same I-PDU, the smallest configured time-out of the associated data elements is chosen as time-out for the I-PDU [SWS_Com_00291]. The notification from COM to RTE is performed per data element.

In case one `data element` coming from COM needs to be distributed to several AUTOSAR software-components the AUTOSAR Software Component Template allows to configure different `aliveTimeout` values at each Port. In this case the RTE has to ensure that the time-out notifications for each port will occur according to the configured `aliveTimeout` value in the `NonqueuedReceiverComSpec`.

[SWS_Rte_08103] [The RTE shall pass time-out notifications to the SW-Cs according to the configured `aliveTimeout` values in the `NonqueuedReceiverComSpec`. Depending on the configuration of the COM module following rules shall apply:

- `ComSignal.ComTimeout/ComSignalGroup.ComTimeout` configured to 0: No time-out notifications shall occur.
- `ComSignal.ComTimeout/ComSignalGroup.ComTimeout` not configured to 0 (`ComSignals/ComSignalGroups` with update bits): Time-out notifications shall occur according to the greatest multiple of the `ComSignal.ComTimeout/ComSignalGroup.ComTimeout` value of the associated `ComSignal/ComSignalGroup` lower than or equal to the `aliveTimeout` value in the `NonqueuedReceiverComSpec`.
- I-PDU based time-out not equal to 0 (`ComSignals/ComSignalGroups` without update bits): Time-out notifications shall occur according to the greatest multiple of the I-PDU based time-out value lower than or equal to the `aliveTimeout` value in the `NonqueuedReceiverComSpec`.

]([SRS_Rte_00147](#))

Following example illustrates how the value of the `ComTimeout` parameter of a `ComSignal` is derived and the time-out monitoring in RTE is performed in case one data element coming from COM needs to be distributed to several SW-Cs.

Consider 3 SW-Cs receiving same data element with different `aliveTimeout` values specified in the `NonqueuedReceiverComSpec`:

- SW-C1: `aliveTimeout` = 500ms
- SW-C2: `aliveTimeout` = 0ms (or not specified)
- SW-C3: `aliveTimeout` = 1200ms

The derived `ComTimeout` value of the `ComSignal` the data element is mapped to will be in this case 500ms. I.e. the smallest `aliveTimeout` value of the associated SW-Cs (This value must be bigger or equal to the main function cycle of the COM module).

The RTE will pass time-out notifications to the 3 SW-Cs in case of a reception time-out indicated by COM as follows:

- SW-C1: directly
- SW-C2: no time-out notification
- SW-C3: after 500ms (i.e. the RTE has to count internally further 500ms before notifying SW-C3)

[SWS_Rte_08104] [The RTE shall implement a replacement strategy according to the `handleTimeoutType` attribute defined by the `NonqueuedReceiverComSpec` in each receiving SWC:

- `handleTimeoutType` configured to `none`: SWC observes the latest received value.
- `handleTimeoutType` configured to `replace`: SWC observes the `NonqueuedReceiverComSpec`'s `initValue`.

]([SRS_Rte_00147](#))

Note: In the case of receiving SWCs with different `handleTimeoutType` values it's expected that the related `ComSignal/ComSignalGroup` has attribute `ComSignal.ComRxDataTimeoutAction/ComSignalGroup.ComRxDataTimeoutAction` equal to `NONE` to ensure that the RTE always has access to the last received value.

4.3.1.8 Data Element Invalidation

The Software Component template allows to specify whether a `data element`, defined in an AUTOSAR Interface, can be invalidated by the sender. The communication infrastructure shall provide means to set a data element to invalid and also indicate an invalid data element to the receiving software components. This functionality is called "data element invalidation". For an overview see figure 4.46.

[SWS_Rte_05024] [If the `handleInvalid` attribute of the `InvalidationPolicy` (when present) is set to `keep`, `replace` or `externalReplacement` the invalidation support for this `dataElement` is enabled on sender side. The actual value used to

represent the invalid data element shall be specified in the Data Semantics part of the data element definition defined in [invalidValue](#)⁶.] ([SRS_Rte_00078](#))

For data element invalidation, it is intended that the `Rte_Invalidate()` API is used by the software component. Nevertheless, passing the invalid value as a parameter of the `Rte_Write()` API may intentionally occur. In this case, the `handleInvalid` is only allowed to be set to the value `dontInvalidate` in order to avoid undesired behaviour and additional effort in the RTE implementation (see [TPS_SWCT_01646] and [constr_1390]).

[SWS_Rte_05032] [On receiver side the `handleInvalid` attribute of the associated `InvalidationPolicy` specifies how to handle the reception of the invalid value.] ([SRS_Rte_00078](#))

Data element invalidation is only supported for data elements with a `swImplPolicy` different from 'queued'. Configurations violating this constraint are rejected by the RTE generator, see [[SWS_Rte_06727](#)].

[SWS_Rte_06727] [The RTE generator shall reject configurations which are violating [constr_1219].] ([SRS_Rte_00078](#))

The API to set a `dataElement` to invalid shall be provided to the `RunnableEntitys` on data element level.

In case an invalidated data element is received a software component can be notified using the activation of runnable entity. If an invalidated data element is read by the SW-C the invalid status shall be indicated in the status code of the API.

[SWS_Rte_08005] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `keep` and the `handleNeverReceived` is set to `FALSE`, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_INVALID` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the `invalidValue`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

[SWS_Rte_08008] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `keep` and the `handleNeverReceived` is not defined, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_INVALID` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the `invalidValue`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

[SWS_Rte_08009] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `keep` and the `handleNeverReceived` is set to `TRUE`, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_NEVER_RECEIVED` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the `initValue`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

⁶When `InvalidationPolicy` is set to `keep`, `replace` or `externalReplacement` but there is no `invalidValue` specified it is considered as an invalid configuration.

[SWS_Rte_08007] [The RTE Generator shall reject configurations in which the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `replace`.] ([SRS_Rte_00078](#))

[SWS_Rte_08046] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `dontInvalidate` and the `handleNeverReceived` is set to `FALSE`, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_OK` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the `initValue`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

[SWS_Rte_08047] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `dontInvalidate` and the `handleNeverReceived` is not defined, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_OK` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the `initValue`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

[SWS_Rte_08048] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `dontInvalidate` and the `handleNeverReceived` is set to `TRUE`, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_NEVER_RECEIVED` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the `initValue`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

[SWS_Rte_08096] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `externalReplacement` and the `handleNeverReceived` is set to `FALSE`, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_OK` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the value sourced from the `ReceiverComSpec.replaceWith`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

[SWS_Rte_08097] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `externalReplacement` and the `handleNeverReceived` is not defined, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_OK` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the value sourced from the `ReceiverComSpec.replaceWith`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

[SWS_Rte_08098] [If the `initValue` of an unqueued data element equals the `invalidValue` and `handleInvalid` is set to `externalReplacement` and the `handleNeverReceived` is set to `TRUE`, the RTE APIs `Rte_Read()` and `Rte_IStatus()` shall return `RTE_E_NEVER_RECEIVED` until first reception of data element. In this case the APIs `Rte_Read()` and `Rte_IRead()` shall provide the value sourced from the `ReceiverComSpec.replaceWith`.] ([SRS_Rte_00078](#), [SRS_Rte_00184](#))

4.3.1.8.1 Data Element Invalidation in case of Inter-ECU communication

Sender:

If `data element invalidation` is enabled and the communication is Inter-ECU:

- explicit data transmission:
 - data transformation for this communication enabled: data element invalidation will be performed by RTE.
 - no data transformation enabled: data element invalidation will be performed by COM (COM needs to be configured properly).
- implicit data transmission: the RTE is responsible for flagging the implicit buffer in the case of invalidation. An implicit valid transmission may occur before the write back at the end of the task, resetting the invalidation flag. The actual data element invalidation after runnable termination is done in COM.

Receiver:

If `data element invalidation` is enabled and the communication is Inter-ECU and:

- if all receiving software components requesting the same value for `handleInvalid` attribute of the `InvalidationPolicy` associated to one `dataElement` and no data transformation is configured for the communication: data element invalidation will be performed by COM (COM needs to be configured properly), see [SWS_Rte_05026], [SWS_Rte_05048].
- if the receiving software components requesting different values for `handleInvalid` attribute of the `InvalidationPolicy` associated to one `dataElement` or data transformation is configured for the communication: data element invalidation will be performed by RTE, see [SWS_Rte_07031], [SWS_Rte_07032]. This can occur in case of 1:n communication where for one connector a `VariableAndParameterInterfaceMapping` is applied to two `SenderReceiverInterfaces` with different `InvalidationPolicy`s for the mapped `VariableDataPrototype`.

[SWS_Rte_05026] [If a data element has been received invalidated in case of Inter-ECU communication and the attribute `handleInvalid` is set to `keep` for all receiving software components and no data transformation is configured for the communication – the query of the value shall return the value provided by COM together with an indication of the invalid case.](SRS_Rte_00078)

[SWS_Rte_08405] [In case of Inter-ECU communication with the attribute `handleInvalid` set to `keep` for all receiving software components, the RTE shall raise a `DataReceiveErrorEvent` in case of reception of a data element invalid.](SRS_Rte_00078)

[SWS_Rte_05048] [If a data element has been received invalidated in case of Inter-ECU communication and the attribute `handleInvalid` is set to `replace` for all receiving software components – the query of the value shall return the `initValue` (`ComDataInvalidAction` is `REPLACE` [SWS_Com_00314]).] (*SRS_Rte_00078*)

[SWS_Rte_08406] [In case of Inter-ECU communication with the attribute `handleInvalid` set to `replace` for all receiving software components, in case of reception of a data element invalid, the RTE shall raise a `DataReceivedEvent` as if a valid value would have been received.] (*SRS_Rte_00078*)

[SWS_Rte_07031] [If a data element has been invalidated in case of Inter-ECU communication where receiving software components requesting different values for `handleInvalid` and the attribute `handleInvalid` is set to `keep` for a particular `r-port` – the query of the value shall return for the `r-port` the same value as if COM would have handled the invalidation (copy COM behavior).] (*SRS_Rte_00078*)

[SWS_Rte_08407] [In case of Inter-ECU communication where receiving software components requesting different values for the attribute `handleInvalid` and this attribute is set to `keep` for a particular R-Port, in case of reception of a data element invalid, the RTE shall raise a `DataReceiveErrorEvent`.] (*SRS_Rte_00078*)

[SWS_Rte_07032] [If a data element has been received invalidated in case of Inter-ECU communication where receiving software components requesting different values for `handleInvalid` and the attribute `handleInvalid` is set to `replace` for an particular `r-port` – RTE shall perform the "invalid value substitution" with the `initValue` for the `r-port`. Then the reception will be handled as if a valid value would have been received (activation of runnable entities using the `DataReceivedEvent`).] (*SRS_Rte_00078*)

[SWS_Rte_08049] [If a data element has been received invalidated in case of Inter-ECU communication and the attribute `handleInvalid` is set to `dontInvalidate` – the query of the value shall return the value provided by COM. Then the reception will be handled as if a valid value would have been received (activation of runnable entities using the `DataReceivedEvent`).] (*SRS_Rte_00078*)

[SWS_Rte_08099] [If a data element has been received invalidated in case of Inter-ECU communication and the attribute `handleInvalid` is set to `externalReplacement` for all receiving software components – the query of the value shall return the value sourced from the `ReceiverComSpec.replaceWith` (e.g. constant, NVRAM parameter).] (*SRS_Rte_00078*)

[SWS_Rte_08100] [In case of Inter-ECU communication with the attribute `handleInvalid` set to `externalReplacement` for all receiving software components, in case of reception of a data element invalid, the RTE shall raise a `DataReceivedEvent` as if a valid value would have been received.] (*SRS_Rte_00078*)

[SWS_Rte_08101] [If a data element has been received invalidated in case of Inter-ECU communication where receiving software components requesting different values for `handleInvalid` and the attribute `handleInvalid` is set to `externalReplacement` for an particular `r-port` – RTE shall perform the "invalid value substitution" with

the value sourced from the `ReceiverComSpec.replaceWith` for the `r-port`. Then the reception will be handled as if a valid value would have been received (activation of runnable entities using the `DataReceivedEvent`).] ([SRS_Rte_00078](#))

4.3.1.8.2 Data Element Invalidation in case of Intra-ECU communication

Sender:

[SWS_Rte_05025] [If `data element invalidation` is enabled, and the communication is Intra-ECU, data element invalidation shall be implemented by the RTE.] ([SRS_Rte_00078](#))

The actual invalid value is specified in the SW-C template `invalidValue`.

Receiver:

[SWS_Rte_05030] [If a data element has been invalidated in case of Intra-ECU communication and the attribute `handleInvalid` is set to `keep` – the query of the value shall return the same value as if COM would have handled the invalidation (copy COM behavior). Then the reception of the invalid value will be handled as an error and the activation of runnable entities can be performed using the `DataReceiveErrorEvent`.] ([SRS_Rte_00078](#))

[SWS_Rte_05049] [If a data element has been received invalidated in case of Intra-ECU communication and the attribute `handleInvalid` is set to `replace` – RTE shall perform the "invalid value substitution" with the `initValue`. Then the reception will be handled as if a valid value would have been received (activation of runnable entities using the `DataReceivedEvent`).] ([SRS_Rte_00078](#))

[SWS_Rte_08050] [If a data element has been received invalidated in case of Intra-ECU communication and the attribute `handleInvalid` is set to `dontInvalidate` – the query of the value shall return the received value. Then the reception will be handled as if a valid value would have been received (activation of runnable entities using the `DataReceivedEvent`).] ([SRS_Rte_00078](#))

[SWS_Rte_02308] [If data invalidation is enabled for a composite `VariableDataPrototype`, and the communication is Intra-ECU, the RTE shall invalidate all invalidateable primitive elements of the `VariableDataPrototype`.] ()

[SWS_Rte_02309] [The RTE generator shall reject configurations which are violating `[constr_1302]`.] ([SRS_Rte_00078](#))

[SWS_Rte_08102] [If a data element has been received invalidated in case of Intra-ECU communication and the attribute `handleInvalid` is set to `externalReplacement` – RTE shall perform the "invalid value substitution" with the value sourced from the `ReceiverComSpec.replaceWith` (e.g. constant, NVRAM parameter). Then the reception will be handled as if a valid value would have been received (activation of runnable entities using the `DataReceivedEvent`).] ([SRS_Rte_00078](#))

4.3.1.9 Filters

By means of the `filter` attribute [[SRS_Rte_00121](#)] an additional filter layer can be added on the receiver side of unqueued S/R-Communication. *Value-based* filters can

be defined, i.e. only signal values fulfilling certain conditions are made available for the receiving component. The possible filter algorithms are taken from OSEK COM version 3.0.2. They are listed in the meta model (see [2]. According to the SW-C template [2], filters are only allowed for signals that are compatible to C language unsigned integer types (i.e. characters, unsigned integers and enumerations). Thus, filters cannot be applied to composite data types like for instance [ApplicationRecordDataType](#) or [ApplicationArrayDataType](#).

[SWS_Rte_05503] [The RTE shall provide value-based filters for unqueued S/R-Communication as specified in the SW-C template [2].] ([SRS_Rte_00121](#))

[SWS_Rte_05500] [For inter-ECU communication, the filter implementation is performed/done by the COM module. For intra-ECU and inter-Partition communication, the RTE shall perform the filtering itself.] ([SRS_Rte_00019](#), [SRS_Rte_00121](#))

[SWS_Rte_05501] [The RTE shall support a different filter specification for each [dataElement](#) in a component's AUTOSAR interface.] ([SRS_Rte_00121](#))

[SWS_Rte_04581] [In case that filters are defined both on the sender-side and on the receiver-side then the filter of the sender-side applies before the filter of the receiver-side.] ([SRS_Rte_00121](#))

[SWS_Rte_08077] [In case that filtering applies the input value shall be calculated from the "unfiltered buffer" before the [RunnableEntity](#) starts, the result of the filter calculation shall be stored in a "filtered buffer" and the [RunnableEntity](#) accessing a [dataElement](#) in a Receiver Port with a filter shall get access to the "filtered buffer" instead of the "unfiltered buffer".] ([SRS_Rte_00121](#))

Note: For optimization reasons only a "filtered buffer" should be provided, if filtering applies for a [dataElement](#) and the "unfiltered buffer" is not used at all.

[SWS_Rte_08079] [Separate "filtered buffers" shall be provided, if the same [dataElement](#) is accessed by [RunnableEntity](#)s via different Receiver Ports and filters with different semantics are applied in each Port.] ([SRS_Rte_00121](#))

4.3.1.10 Buffering

[SWS_Rte_02515] [The buffering of sender-receiver communication shall be done on the receiver side. This does not imply that COM does no buffering on the sender side. On the receiver side, two different approaches are taken for the buffering of 'data' and of 'events', depending on the value of the software implementation policy.] ([SRS_Rte_00110](#))

4.3.1.10.1 Last-is-Best-Semantics for ‘data’ Reception

[SWS_Rte_02516] [On the receiver side, the buffering of ‘data’ ([swImplPolicy](#) not [queued](#)) shall be realized by the RTE by a single data set for each data element instance.]([SRS_Rte_00107](#))

The use of a single data set provides the required semantics of a single element queue with overwrite semantics (new data replaces old). Since the RTE is required to ensure data consistency, the generated RTE should ensure that non-atomic reads and writes of the data set (e.g. for composite data types) are protected from conflicting concurrent access. RTE may use lower layers like COM to implement the buffer.

[SWS_Rte_02517] [The RTE shall initialize this data set [\[SWS_Rte_02516\]](#) with a startup value depending on the ports attributes and if the general initialization conditions in [\[SWS_Rte_07046\]](#) are fulfilled.]([SRS_Rte_00068](#), [SRS_Rte_00108](#))

[SWS_Rte_02518] [Implicit or explicit read access shall always return the last received data.]([SRS_Rte_00107](#))

Requirement [\[SWS_Rte_02518\]](#) applies whether or not there is a [DataReceivedEvent](#) referencing the [VariableDataPrototype](#) for which the API is being generated.

[SWS_Rte_02519] [Explicit read access shall be non blocking in the sense that it does not wait for new data to arrive. The RTE shall provide mutual exclusion of read and write accesses to this data, e.g., by [ExclusiveAreas](#).]([SRS_Rte_00109](#))

[SWS_Rte_02520] [When new data is received, the RTE shall silently discard the previous value of the data, regardless of whether it was read or not.]([SRS_Rte_00107](#))

4.3.1.10.2 Queueing for ‘event’ Reception

In case the [swImplPolicy](#) is set to [queued](#) the received ‘events’ have to be buffered in a queue.

Note: A loss of events might occur in inter-ECU communication even if the receiver queue length is sufficient. The timing of the system has to be set up in a way that it is ensured that the COM stack on the sender side is processed before the next event is written by the sender.

[SWS_Rte_02521] [The RTE shall implement a receive queue for each event-like data element ([swImplPolicy](#) = [queued](#)) of a receive port.]([SRS_Rte_00107](#))

The [queueLength](#) attribute of the [QueuedReceiverComSpec](#) referencing the event assigns a constant length to the receive queue.

[SWS_Rte_02522] [The events shall be written to the end of the queue and read (consuming) from the front of the queue (i.e. the queue is first-in-first-out).]([SRS_Rte_00107](#), [SRS_Rte_00110](#))

[SWS_Rte_02523] [If a new event is received when the queue is already filled, the RTE shall discard the received event and set an error flag.]([SRS_Rte_00107](#), [SRS_Rte_00110](#))

[SWS_Rte_02524] [The error flag described in [\[SWS_Rte_02523\]](#) shall be reset during the next explicit read access on the queue. In this case, the status value RTE_E_LOST_DATA shall be presented to the application together with the data.]([SRS_Rte_00107](#), [SRS_Rte_00110](#), [SRS_Rte_00094](#))

[SWS_Rte_02525] [If an empty queue is polled, the RTE shall return with a status RTE_E_NO_DATA to the polling function, (see chap. 5.5.1).]([SRS_Rte_00107](#), [SRS_Rte_00110](#), [SRS_Rte_00094](#))

The minimum size of the queue is 1.

[SWS_Rte_02526] [The RTE generator shall reject a `queueLength` attribute of an `QueuedReceiverComSpec` with a queue length ≤ 0 .]([SRS_Rte_00110](#), [SRS_Rte_00018](#))

4.3.1.10.3 Queueing of mode switches

The communication of [mode switch notifications](#) is typically event driven. Accordingly, RTE offers a similar queueing mechanism as for the 'queued' sender receiver communication, described above.

[SWS_Rte_02718] [The RTE shall implement a receive queue for the [mode switch notifications](#) of each [mode machine instance](#).]([SRS_Rte_00107](#))

The `queueLength` attribute of the `ModeSwitchSenderComSpec` referencing the [mode machine instance](#), assigns a constant length to the receive queue. In contrast to the event communication, for mode switch communication, the length is associated with the sender side, the [mode manager](#), because it is unique for the [mode machine instance](#).

[SWS_Rte_02719] [The [mode switch notification](#) shall be written to the end of the queue and read (consuming) from the front of the queue (i.e. the queue is first-in-first-out).]([SRS_Rte_00107](#), [SRS_Rte_00110](#))

[SWS_Rte_02720] [If a new [mode switch notification](#) is received when the queue is already filled, the RTE shall discard the received notification.]([SRS_Rte_00107](#), [SRS_Rte_00110](#)) In this case, `Rte_Switch` will return an error, see [\[SWS_Rte_02675\]](#).

[SWS_Rte_02721] [RTE shall dequeue a [mode switch notification](#), when the mode switch is completed.]([SRS_Rte_00107](#), [SRS_Rte_00110](#), [SRS_Rte_00094](#))

The minimum size of the queue is 1.

[SWS_Rte_02723] [The RTE generator shall reject a `queueLength` attribute of an `ModeSwitchSenderComSpec` with a queue length ≤ 0 .] ([SRS_Rte_00110](#), [SRS_Rte_00018](#))

In case of a queue length of 1, RTE will reject new mode switch notifications during the mode transition.

4.3.1.11 Operation

4.3.1.11.1 Inter-ECU Mapping

This section describes the mapping from `VariableDataPrototypes` to COM signals or COM signal groups for sender-receiver communication. The mapping is described in the input of the RTE generator, in the `DataMapping` section of the System Template [8].

If a `VariableDataPrototype` is mapped to a COM signal or COM signal group but the communication is local, the RTE generator can use the COM signal/COM signal group for the transmission or it can use its own direct implementation of the communication for the transmission.

[SWS_Rte_04504] [If a sender/receiver communication is inter-ECU, then for each data element the `DataMappings` element shall contain a mapping to at least one COM signal or COM signal group, otherwise the data element shall be treated as if it is part of an unconnected port.] ([SRS_Rte_00091](#))

The mapping defines all aspects of the signal necessary to configure the communication service, for example, the network signal endianness and the communication bus either by the COM configuration or the configured data transformation. The RTE generator only requires the COM signal handle id since this is necessary for invoking the COM API and the configuration of the data transformation to execute it.

4.3.1.11.1.1 Primitive Data Types

[SWS_Rte_04505] [The RTE shall use the `ComHandleId` of the corresponding `ComSignal` when invoking the COM API for signal.] ([SRS_Rte_00091](#))

The actual COM handle id has to be gathered from the ECU configuration of the COM module. The input information `ComSignalHandleId` is used to establish the link between the `ComSignal` of the COM module's configuration and the corresponding `ISignal` of the System Template.

4.3.1.11.1.2 Composite Data Types

When a data prototype has a composite data type the RTE must marshall the data. This can be achieved by two means: Explicit mapping the atomic sub-elements of the

composite type to their own COM signals or mapping of the whole composite type to one COM signal if data transformation is used.

The DataMappings element of the ECU configuration and configuration of the data transformer contain (or references) sufficient information to allow the data item or operation parameters to be transmitted by indicating the COM signals or signal groups to be used. It is not necessary to provide a mapping for each primitive typed leaf element within the composite type.

[SWS_Rte_03863] [The RTE generator shall support the partial mapping to System-Signals of the leaf elements of a VariableDataPrototype (typed by a composite data type) in a PPort.]([SRS_Rte_00091](#))

A partial mapping means that a subset of the composite data type's leaf elements are mapped to SystemSignals in the relevant SystemSignalGroup (e. g. a record with leaf elements A, B, C, D where only B and C are mapped to SystemSignals of the SystemSignalGroup). Elements omitted from the partial mapping are simply ignored by the RTE generator.

For RPorts it is necessary to define how the RTE generator handles the partial mapping of a composite data type, in particular, how elements omitted from the mapping are treated.

[SWS_Rte_03864] [For the included element of a partial mapping from SystemSignals to the leaf elements of a VariableDataPrototype (typed by a composite data type) in a RPort the RTE generator shall use the data provided by COM.]([SRS_Rte_00091](#))

[SWS_Rte_03865] [For the omitted elements from a partial mapping from SystemSignals to the leaf elements of a VariableDataPrototype (typed by a composite data type) in a RPort the RTE generator shall use the initial value when receiving the composite data type.]([SRS_Rte_00091](#))

[SWS_Rte_08793] [If a data element is a composite data type, the communication is inter-ECU and data transformation is used (except COM Based Transformer), the DataMapping element shall map the composite data type directly to one COM signal to use the data transformation.]([SRS_Rte_00091](#), [SRS_Rte_00247](#))

The above requirements for mapping atomic sub-elements for them own to distinct COM signals have two key features; firstly, COM is responsible for endianness conversion (if any is required) of primitive types and, secondly, differing structure member alignment between sender and receiver is irrelevant since the COM signals are packed into I-PDUs by the COM configuration.

The DataMappings shall contain sufficient COM signals to map each primitive element⁷ of the AUTOSAR signal.

The above requirements for mapping the whole composite data type to one COM signal on the other hand leaves those features to the data transformation.

⁷An AUTOSAR signal that is a primitive data type contains exactly one primitive element whereas a signal that is a composite data type one or more primitive elements.

[SWS_Rte_04508] [The RTE generator shall reject configuration violating the constraint [constr_3059].] ([SRS_Rte_00091](#))

[SWS_Rte_02557] [

1. Each signal that is mapped to an element of the same composite data item shall be mapped to the same signal group.
2. If two signals are not mapped to an element of the same composite data item, they shall not be mapped to the same signal group.
3. If a signal is not mapped to an element of a composite data item, it shall not be mapped to a signal group.

] ([SRS_Rte_00091](#))

[SWS_Rte_05081] [The RTE shall use the [ComHandleId](#) of the corresponding [ComSignalGroup](#) when invoking the COM API for signal groups. This also applies for the array based signal group access with the `Com_SendSignalGroupArray()` and `Com_ReceiveSignalGroupArray()`.] ([SRS_Rte_00091](#))

[SWS_Rte_05173] [The RTE shall use the [ComHandleId](#) of the corresponding [ComGroupSignal](#) when invoking the COM API for group signals.] ([SRS_Rte_00091](#))

The actual COM handle id has to be gathered from the ECU configuration of the COM module. The input information [ComHandleId](#) is used to establish the link between the [ComSignalGroup](#) of the COM module's configuration and the corresponding [ISignalGroup](#) of the System Template.

The input information [ComHandleId](#) of group signals is used to establish the link between the [ComGroupSignal](#) of the COM module's configuration and the corresponding [ISignal](#) of the System Template.

4.3.1.11.2 Atomicity

[SWS_Rte_04527] [The RTE is required to treat AUTOSAR signals transmitted using sender-receiver communication atomically [[SRS_Rte_00073](#)]. To achieve this

- either the “signal group” mechanisms provided by COM shall be utilized. See [[SWS_Rte_02557](#)] for the mapping.
- or the “Data Transformation” approach (see section [4.10](#)) shall be utilized.

] ([SRS_Rte_00019](#), [SRS_Rte_00073](#), [SRS_Rte_00091](#))

The RTE decomposes the composite data type into single signals as described above and passes them to the COM module by using the COM API call `Com_SendSignal`. As this set of single signals has to be treated as atomic, it is placed in a “signal group”. A signal group has to be placed always in a single I-PDU. Thus, atomicity is established. When all signals have been updated, the RTE initiates transmission of the signal group by using the COM API call `Com_SendSignalGroup`.

As would be expected, the receiver side is the exact reverse of the transmission side: the RTE must first call `Com_ReceiveSignalGroup` precisely once for the signal group and then call `Com_ReceiveSignal` to extract the value of each signal within the signal group.

A signal group has the additional property that COM guarantees to inform the receiver by invoking a call-back about its arrival only after all signals belonging to the signal group have been unpacked into a buffer.

The Data Transformation approach is described in section 4.10.

4.3.1.11.3 Fan-out

Fan-out can be divided into two scenarios; *PDU fanout* where the same I-PDU is sent to multiple destinations and *signal fan-out* where the same signal, i.e. data element is sent in different I-PDUs to multiple receivers.

For Inter-ECU communication, the RTE does not perform PDU fan-out. Instead, the RTE invokes `Com_SendSignal` once for a primitive data element or for transformed data and expects the fan-out to multiple PDU destinations to occur lower down in the AUTOSAR communication stack. However, it is necessary for the RTE to support *signal fan-out* since this cannot be performed by any lower level layer of the AUTOSAR communication stack.

The data mapping in the System Template[8] is based on the `SystemSignal` and `SystemSignalGroup`. The COM module however uses the `ISignal` and `ISignalGroup` counterparts (`ComSignal`, `ComSignalGroup`, `ComGroupSignal`) to define the COM API. The RTE Generator needs to identify whether there are several `ISignal` or `ISignalGroup` elements defined for the `SystemSignal` or `SystemSignalGroup` and implement the fan-out accordingly. Then the corresponding elements in the COM ecu configuration (`ComSignal`, `ComSignalGroup`, `ComGroupSignal`) are required to establish the interaction between Rte and COM.

Please note that in case of a fan-out only `ISignal` or `ISignalGroup` elements need to be considered that are transmitted by the `EcuInstance` on which the RTE is running.

With the usage of “Data Transformation” a mixture of different serialization technologies for *signal fan-out* in the RTE can be used. This is determined by the `ISignal` or `ISignalGroup` association to `DataTransformation`.

[SWS_Rte_04585] [The RTE needs to perform a RTE signal fan-out for a `SystemSignal` and for a number of connected `ISignals` for which the following conditions apply in an Ecu Extract:

- the `ISignals` reference the `SystemSignal` in the role `systemSignal` and
- a `DataMapping` references the `SystemSignal` and

- the `DataMapping` references an element in a `PPortPrototype` and
- the `ISignals` are transmitted by the `EcuInstance`, i.e. the `ComSignal` that refers with the `ComSystemTemplateSystemSignalRef` in the COM Configuration to the `ISignalToIPduMapping` that in turn refers to the `ISignal` and the `ISignalIPdu` from which the `ComIPdu` is derived that has the `ComIPduDirection = SEND`.

]([SRS_Rte_00019](#), [SRS_Rte_00028](#))

In other words if two `ISignals` reference the same `SystemSignal`, but one of the `ISignals` is received and one is transmitted no RTE signal fan-out is performed. Only if several `ISignals` that are transmitted reference the same `SystemSignal` the RTE signal fan-out is performed.

[SWS_Rte_04586] [The RTE needs to perform a RTE signal fan-out for a `SystemSignalGroup` and for a number of connected `ISignalGroups` for which the following conditions apply in an Ecu Extract:

- the `ISignalGroups` reference the `SystemSignalGroup` in the role `systemSignalGroup` and
- a `DataMapping` references the `SystemSignalGroup` and
- the `DataMapping` references an element in a `PPortPrototype` and
- each of the contained `ISignals` of the `ISignalGroup` refers to its corresponding `SystemSignal` which in turn is part of the `SystemSignalGroup` and
- the `ISignalGroups` are transmitted by the `EcuInstance`, i.e. the `ComSignalGroup` and its respective `ComGroupSignals` that refer with the `ComSystemTemplateSignalGroupRef` resp. `ComSystemTemplateSystemSignalRef` in the COM Configuration to the `ISignalToIPduMapping` that in turn refers to the `ISignalGroup` resp. `ISignals` and the `ISignalIPdu` from which the `ComIPdu` is derived that has the `ComIPduDirection = SEND`.

]([SRS_Rte_00019](#), [SRS_Rte_00028](#))

In other words if two `ISignalGroups` reference the same `SystemSignalGroup`, but one of the `ISignalGroups` is received and one is transmitted no RTE signal fan-out is performed. Only if several `ISignalGroups` that are transmitted reference the same `SystemSignalGroup` the RTE signal fan-out is performed.

[SWS_Rte_06023] [For inter-ECU transmission of a primitive data type, the RTE shall perform for each `ISignal` to which the primitive data element is mapped

- the transformation if the `ISignal` references a `TransformationTechnology`
- the invocation of `Com_SendSignal`

]([SRS_Rte_00019](#), [SRS_Rte_00028](#), [SRS_Rte_00247](#))

For the invocation the `ComHandleId` from the `ComSignal` of COM's ecu configuration shall be used (see [SWS_Rte_04505]).

If the data element is typed by a composite data type several scenarios shall to be considered for each of the signal fan-out based on the `ISignal` or `ISignalGroup` association to `DataTransformation`:

- no “Data Transformation”: RTE invokes `Com_SendSignal` for each primitive element (`ISignal`) in the composite data type and each COM signal to which that primitive element is mapped, and `Com_SendSignalGroup` for each `ISignalGroup` that does not require a “Data Transformation” to which the data element is mapped.
- “Data Transformation” without COM Based Transformer: RTE performs the transformation and then invokes `Com_SendSignal` for each `ISignal` that has the `dataTransformation` association to the `DataTransformation` defined.
- “Data Transformation” with COM Based Transformer: RTE performs the transformation and then invokes `Com_SendSignalGroupArray` for each `ISignalGroup` that has the `comBasedSignalGroupTransformation` association to the `DataTransformation` defined.

Note:

It is also possible to configure the system to use multiple of these scenarios at the same time. Then the RTE executes all configured scenarios.

[SWS_Rte_04526] Inter-ECU transmission of composite data without Data Transformation

[For inter-ECU transmission of composite data type where

- a `SenderReceiverToSignalGroupMapping` to the `VariableDataPrototype` is defined
- and the respective `ISignalGroup` has no `comBasedSignalGroupTransformation` defined

the RTE shall invoke `Com_SendSignal` for each `ISignal` to which an element in the composite data type is mapped and `Com_SendSignalGroup` for each `ISignalGroup` to which the composite data element is mapped.](SRS_Rte_00019, SRS_Rte_00028)

For the invocation the `ComHandleId` from the `ComGroupSignal` and `ComSignalGroup` of COM's ecu configuration shall be used (see [SWS_Rte_05173] and [SWS_Rte_05081]).

[SWS_Rte_08586] Inter-ECU transmission of composite data with COM Based Data Transformation

[For inter-ECU transmission of composite data type where

- a `SenderReceiverToSignalGroupMapping` to the `VariableDataPrototype` is defined
- and the respective `ISignalGroup` has a `comBasedSignalGroupTransformation` reference defined

the RTE shall perform the transformation and then invoke `Com_SendSignalGroupArray` for the `ISignalGroup` to which the composite data type is mapped.]([SRS_Rte_00019](#), [SRS_Rte_00028](#), [SRS_Rte_00251](#))

For the invocation the `ComHandleId` from the `ComSignalGroup` of COM's ecu configuration shall be used (see [[SWS_Rte_05081](#)]).

[SWS_Rte_08587] Inter-ECU transmission of composite data with Data Transformation [For inter-ECU transmission of composite data type where

- a `SenderReceiverToSignalMapping` to the `VariableDataPrototype` is defined
- and the respective `ISignal` has a `dataTransformation` reference defined

the RTE shall perform the transformation and then invoke `Com_SendSignal` for the `ISignal` to which composite data type is mapped.]([SRS_Rte_00019](#), [SRS_Rte_00028](#), [SRS_Rte_00247](#))

Note:

A `SystemSignal` can be added to a `SystemSignalGroup` in the role `transformingSystemSignal` to support the configuration where a complex data element is transferred via Sender/Receiver communication both using transformation and traditional mapping of RTE and COM.

For the invocation the `ComHandleId` from the `ComSignal` of COM's ecu configuration shall be used (see [[SWS_Rte_04505](#)]).

For intra-ECU transmission of data elements, the situation is slightly different; the RTE handles the communication (the lower layers of the AUTOSAR communication stack are not used) and therefore must ensure that the data elements are routed to all receivers. For `inter-partition` communication, RTE may use the IOC.

[SWS_Rte_06024] [For `inter-partition` transmission of data elements, the RTE shall perform the fan-out to each receiver.]([SRS_Rte_00019](#), [SRS_Rte_00028](#))

4.3.1.11.4 Fan-in

When receiving data from multiple senders in inter-ECU communication, either the RTE on the receiver side has to collect data received in different COM signals or COM signal groups and pass it to one receiver or the RTE on the sender side has to provide shared access to a COM signal or COM signal group to multiple senders. The receiver RTE, which has to handle multiple COM signals or signal groups, is notified about incoming data for each COM signal or COM signal group separately but has to ensure data consistency when passing the data to the receiver. The sender RTE, which has to handle multiple senders sharing COM signals or signal groups, has to ensure consistent access to the COM API, since COM API calls for the same signal are not reentrant.

[SWS_Rte_04587] [The RTE needs to perform a RTE signal fan-in for a [SystemSignal](#) and for a number of connected [ISignals](#) for which the following conditions apply in an Ecu Extract:

- the [ISignals](#) reference the [SystemSignal](#) in the role [systemSignal](#) and
- a [DataMapping](#) references the [SystemSignal](#) and
- the [DataMapping](#) references an element in a [RPortPrototype](#) and
- the [ISignals](#) are received by the [EcuInstance](#), i.e. the [ComSignal](#) that refers with the [ComSystemTemplateSystemSignalRef](#) in the COM Configuration to the [ISignalToIPduMapping](#) that in turn refers to the [ISignal](#) and the [ISignalIPdu](#) from which the [ComIPdu](#) is derived that has the [ComIPduDirection](#) = RECEIVE.

]([SRS_Rte_00019](#), [SRS_Rte_00028](#))

In other words if two [ISignals](#) reference the same [SystemSignal](#), but one of the [ISignals](#) is received and one is transmitted no RTE signal fan-in is performed. Only if several [ISignals](#) that are received reference the same [SystemSignal](#) the RTE signal fan-in is performed.

[SWS_Rte_04588] [The RTE needs to perform a RTE signal fan-in for a [SystemSignalGroup](#) and for a number of connected [ISignalGroups](#) for which the following conditions apply in an Ecu Extract:

- the [ISignalGroups](#) reference the [SystemSignalGroup](#) in the role [systemSignalGroup](#) and
- a [DataMapping](#) references the [SystemSignalGroup](#) and
- the [DataMapping](#) references an element in a [RPortPrototype](#) and
- each of the contained [ISignals](#) of the [ISignalGroup](#) refers to its corresponding [SystemSignal](#) which in turn is part of the [SystemSignalGroup](#) and
- the [ISignalGroups](#) are received by the [EcuInstance](#), i.e. the [ComSignalGroup](#) and its respective [ComGroupSignals](#) that refer with the [ComSystemTemplateSignalGroupRef](#) resp. [ComSystemTemplateSystemSignalRef](#) in the COM Configuration to the [ISignalToIPduMapping](#) that in turn refers to the [ISignalGroup](#) resp. [ISignals](#) and the [ISignalIPdu](#) from which the [ComIPdu](#) is derived that has the [ComIPduDirection](#) = RECEIVE.

]([SRS_Rte_00019](#), [SRS_Rte_00028](#))

In other words if two [ISignalGroups](#) reference the same [SystemSignalGroup](#), but one of the [ISignalGroups](#) is received and one is transmitted no RTE signal fan-in is performed. Only if several [ISignalGroups](#) that are received reference the same [SystemSignalGroup](#) the RTE signal fan-in is performed.

[SWS_Rte_03760] [If multiple senders use different COM signals or signal groups for inter-ECU transmission of a data element prototype with [swImplPolicy](#) different

from [queued](#) to a receiver, the RTE on the receiver side has to pass the last received value to the receiver component while ensuring data consistency.]([SRS_Rte_00019](#), [SRS_Rte_00131](#))

[SWS_Rte_03761] [If multiple senders use different COM signals or signal groups for inter-ECU transmission of a data element prototype with [event semantics](#) to a receiver, the RTE on the receiver side has to queue all incoming values while ensuring data consistency.]([SRS_Rte_00019](#), [SRS_Rte_00131](#))

[SWS_Rte_03762] [If multiple senders share COM signals or signal groups for inter-ECU transmission of a data element prototype to a receiver, the RTE on the sender side shall ensure that the COM API for those signals is not invoked concurrently.]([SRS_Rte_00019](#), [SRS_Rte_00131](#))

4.3.1.11.5 Sequence diagrams of Sender Receiver communication

Figure [4.40](#) shows a sequence diagram of how Sender Receiver communication for data transmission and non-blocking reception may be implemented by RTE. The sequence diagram also shows the [Rte_Read](#) API behavior if an [initValue](#) is specified.

In case the COM Based Transformer [\[23\]](#) is used the sequence in figure [4.40](#) is the same, but `Com_SendSignalGroupArray()` is used instead of `Com_SendSignal()` and `Com_ReceiveSignalGroupArray()` is used instead of `Com_ReceiveSignal()`.

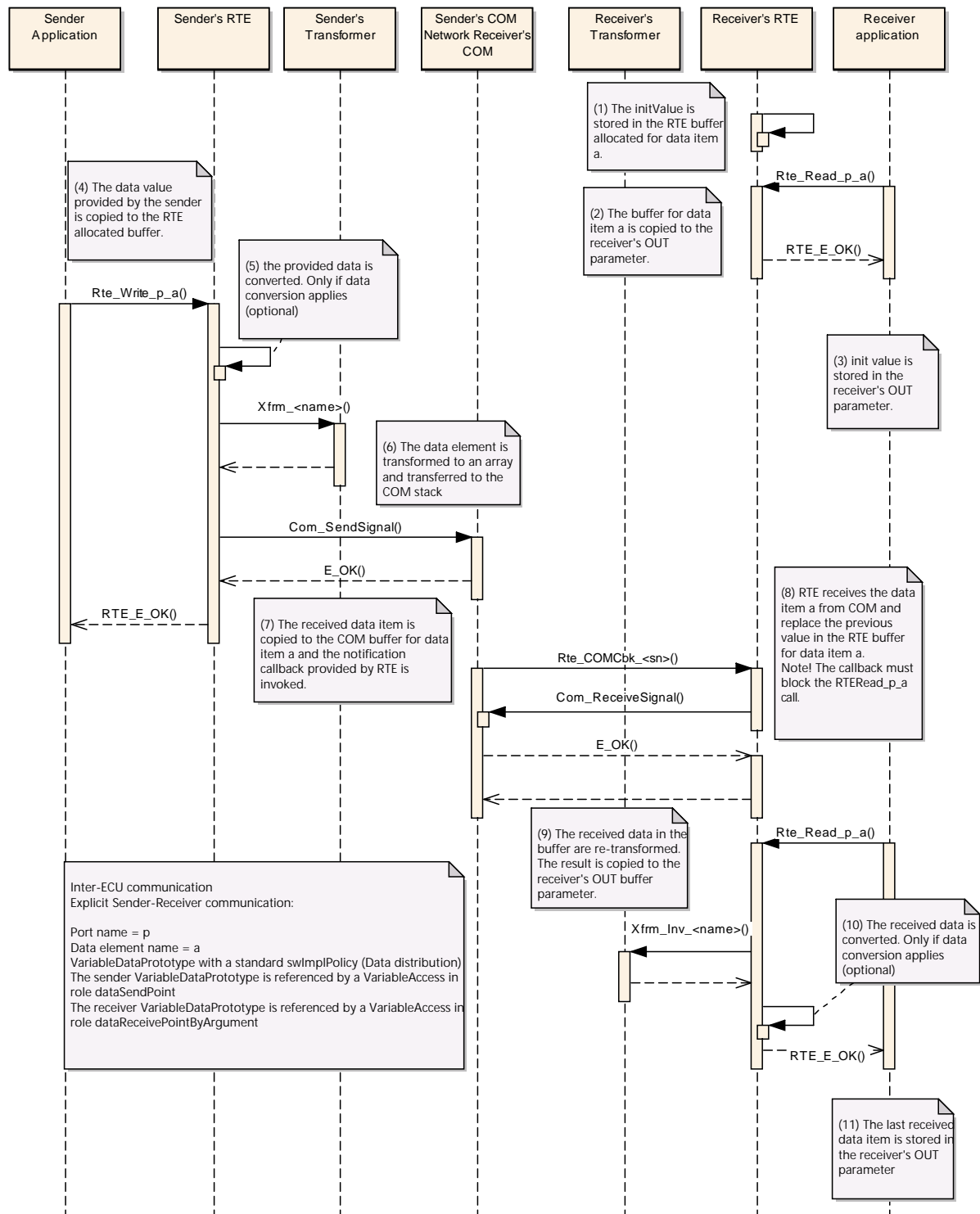


Figure 4.40: Sender Receiver communication with **data semantics and **dataReceivePointByArgument** as reception mechanism**

Figure 4.41 shows a sequence diagram of how Sender Receiver communication for event transmission and non-blocking reception may be implemented by RTE. The sequence diagram shows the `Rte_Receive` API behavior when the queue is empty.

In case the COM Based Transformer [23] is used the sequence in figure 4.41 is the same, but `Com_SendSignalGroupArray()` is used instead of `Com_SendSignal()` and `Com_ReceiveSignalGroupArray()` is used instead of `Com_ReceiveSignal()`.

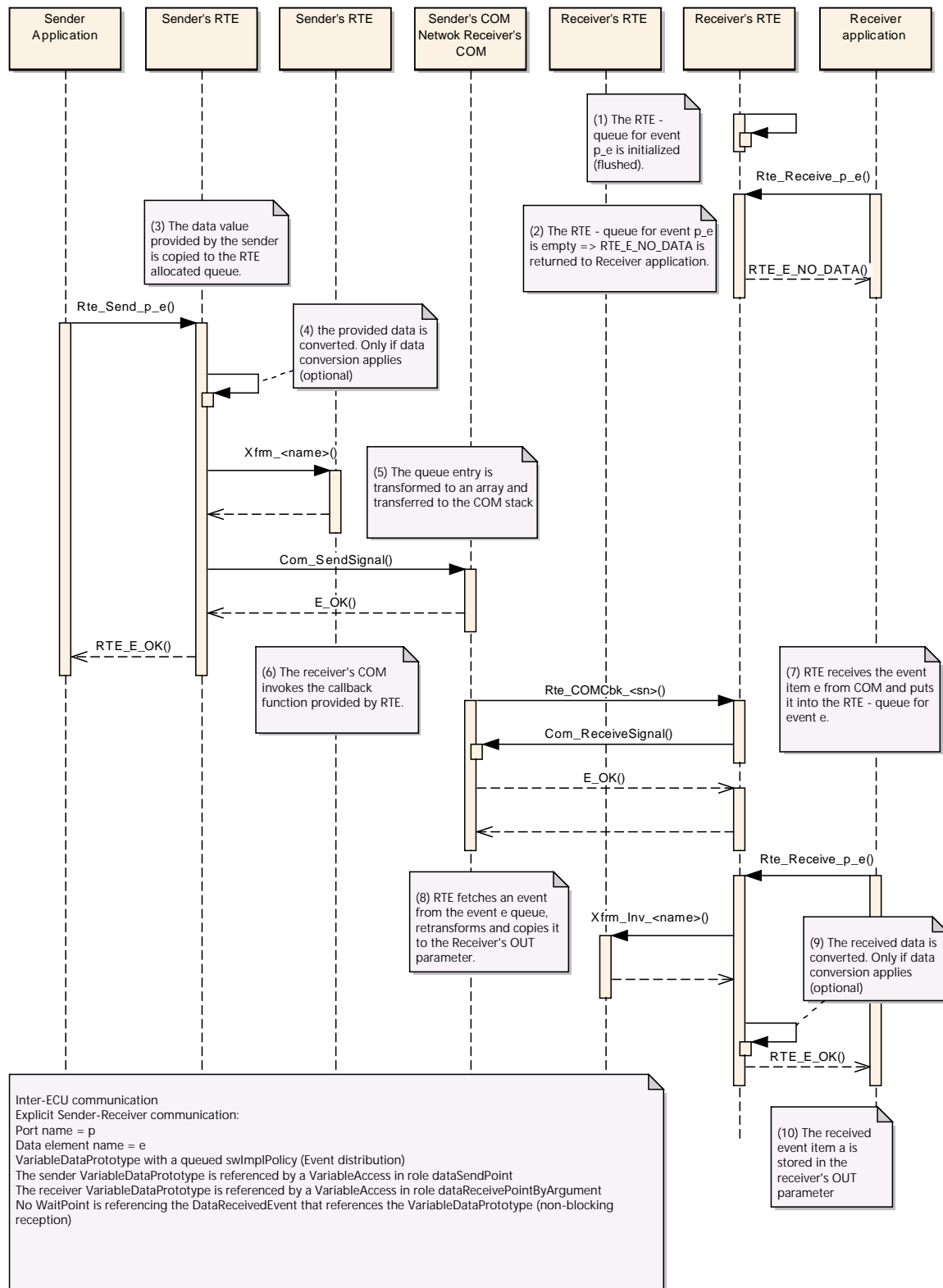


Figure 4.41: Sender Receiver communication with event semantics and dataReceivePointByArgument as reception mechanism

Figure 4.42 shows a sequence diagram of how Sender Receiver communication for event transmission and activation of runnable entity on the receiver side may be implemented by RTE.

In case the COM Based Transformer [23] is used the sequence in figure 4.42 is the same, but `Com_SendSignalGroupArray()` is used instead of `Com_SendSignal()` and `Com_ReceiveSignalGroupArray()` is used instead of `Com_ReceiveSignal()`.

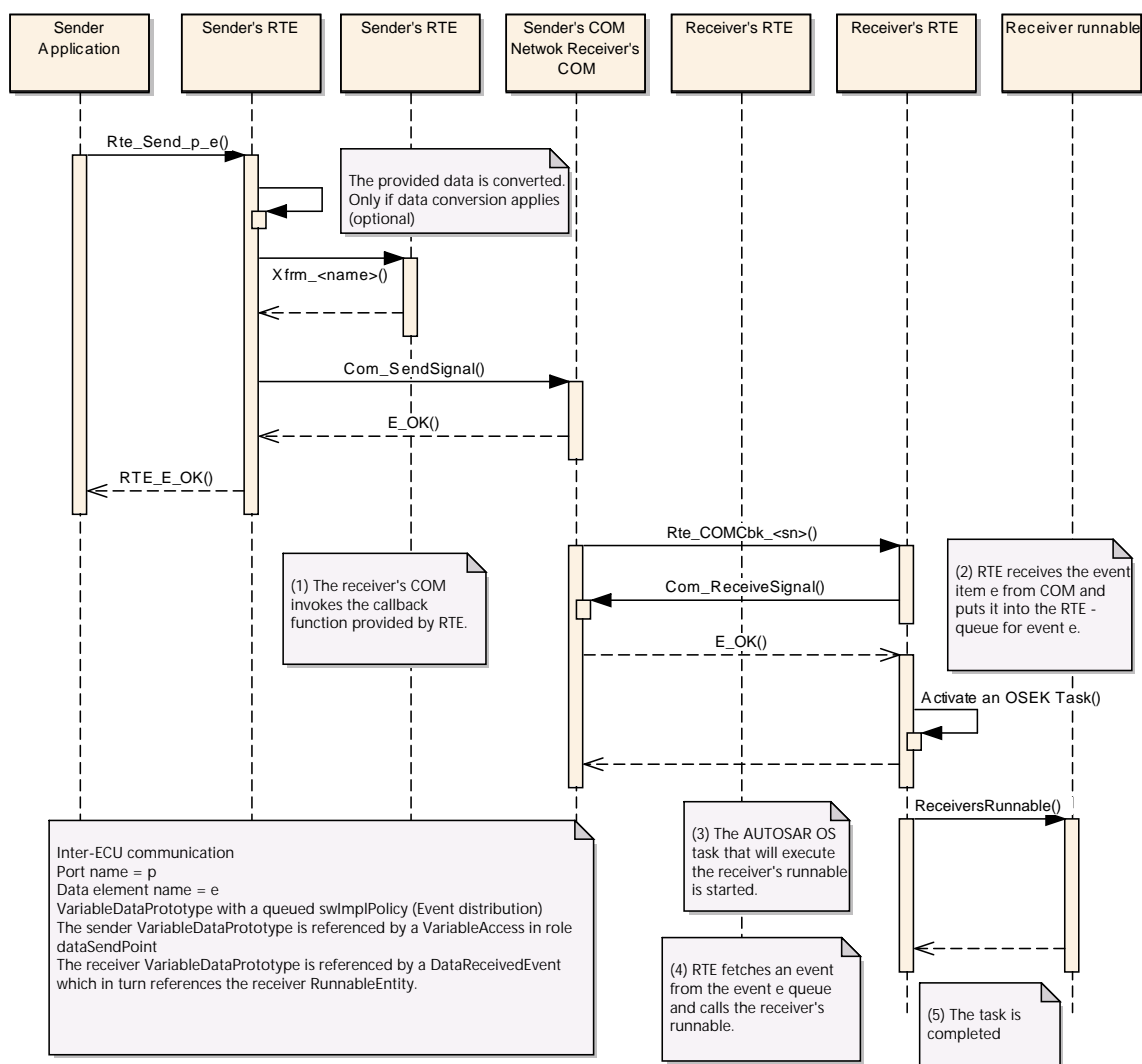


Figure 4.42: Sender Receiver communication with event semantics and activation of runnable entity as reception mechanism

Figure 4.43 shows a sequence diagram of how Sender Receiver communication for data transmission and non-blocking reception may be implemented by RTE when using LdCom.



4.3.1.12 “Never received status” for Data Element

The Software Component template allows specifying whether an unqueued data, defined in an AUTOSAR Interface, has been updated since system start (or partition restart) or not. This additional optional status establishes the possibility to check whether a data element has been changed since system start (or partition restart).

[SWS_Rte_07381] [On receiver side the `handleNeverReceived` attribute of the `NonqueuedReceiverComSpec` shall specify the handling of the never received status.]([SRS_Rte_00184](#))

[SWS_Rte_07382] [The initial status of the data elements with the attribute `handleNeverReceived` set to TRUE shall be `RTE_E_NEVER_RECEIVED`.]([SRS_Rte_00184](#))

[SWS_Rte_07383] [The initial status of the data elements with the attribute `handleNeverReceived` set to TRUE shall be cleared when the first reception occurs.]([SRS_Rte_00184](#))

[SWS_Rte_07645] [The status of data elements shall be reset on the receiver side to `RTE_E_NEVER_RECEIVED` when the receiver’s partition is restarted.]([SRS_Rte_00184](#), [SRS_Rte_00224](#))

[SWS_Rte_04529] [The configuration of the attribute `handleNeverReceived` to TRUE shall have no effect for data elements received from an `NvBlockSwComponentType`, since these data elements are automatically received during initialization of the RTE.]([SRS_Rte_00184](#))

4.3.1.13 “Update flag” for Data Element

The Software Component template allows specifying whether an unqueued data, defined in an AUTOSAR Interface, has been updated since last read or not. This additional optional status establishes the possibility to check, whether a data element has been updated since last read.

On receiver side the “`enableUpdate`” attribute of the `NonqueuedReceiverComSpec` has to activate the handling of the update flag.

[SWS_Rte_07385] [The RTE shall provide one update flag per `dataElement` in a `RPortPrototype` where the “`enableUpdate`” attribute of the `NonqueuedReceiverComSpec` is set to true and where at least one `RunnableEntity` defines a `VariableAccess` in the `dataReceivePointByArgument` or `dataReceivePointByValue` role.]([SRS_Rte_00179](#))

[SWS_Rte_07386] [The update flag of the data elements configured with the “`enableUpdate`” attribute shall be set by receiving new data from COM or from a local software-component (including `NvBlockSwComponentType`).]([SRS_Rte_00179](#))

[SWS_Rte_01413] [In case a data element with configured “enableUpdate” attribute is received as “invalid” the status of it’s update flag shall be determined according to the handling of the [DataReceivedEvent/DataReceiveErrorEvent](#):

- The update flag shall be set, if the [DataReceivedEvent](#) is triggered.
- The update flag shall keep the previous state, if the [DataReceiveErrorEvent](#) is triggered.

]([SRS_Rte_00179](#))

[SWS_Rte_07387] [The update flag of a particular [dataElement](#) in a [RPortPrototype](#) shall be cleared after each read by [Rte_Read](#) or [Rte_DRead](#) of the data element.]([SRS_Rte_00179](#))

Please note that the "UpdateFlag" for [dataElements](#) is only available for explicit communication, see [[SWS_Rte_07391](#)].

[SWS_Rte_07689] [The update flag shall be cleared when the RTE is started or when the partition of the software-component is restarted.]([SRS_Rte_00179](#))

The update flag can be queried by the [Rte_IsUpdated](#) API, see [5.6.37](#).

[SWS_Rte_04528] [Update flags of data elements which are received by an [NvBlockSwComponentType](#) shall be set to TRUE after the data was copied from the NvM module to the NVRAM Block by the execution of the according [Rte_SetMirror](#) callback or after an SW-C has written new data to the NVRAM Block by the execution of the [Rte_Write](#) API.]([SRS_Rte_00179](#))

4.3.1.14 Dynamic data type

Dynamic data are data whose length varies at runtime.

This includes:

- arrays with variable number of elements
- structures including arrays with variable number of elements

This excludes:

- structures including variable number of elements

The length information which specifies how many elements of the dynamic size array are valid has to be provided by the SWC to the RTE. This is achieved by the usage of a dynamic size array with explicit size indicator (see [[2](#)] chapter "ApplicationArray-DataType").

The dynamic size array is represented in the implementation by a structure which contains the size indicator and the dynamic size array with the payload. The size indicator shall be hold consistent to the number of valid elements in the dynamic size array by the SWC.

In case of inter-ECU communication, dynamic data are mapped to dynamic signals and received/transmitted through the TP by the COM stack.

With the current release of SWS_COM, COM limits the dynamic signals to the [Com-SignalType](#) UINT_8DYN (see the requirement COM569).

The usage of dynamic size arrays together with data transformation with inter-ECU communication circumvents these restrictions and allows dynamic size arrays also for other data types because the output of data transformation is of the type uint8[n] which is supported by COM.

In order to respect the VFB concept the capability of inter-ECU and intra-ECU communication should be equal. So it has been decided to extend these limitation from COM also to the intra-ECU communication.

As a consequence dynamic data types different from uint8[n] are only supported by the RTE (independent whether the communication is intra or inter-ECU) if data transformation for inter-ECU communication is used. See [\[SWS_Rte_07810\]](#).

[SWS_Rte_04583] [The RTE shall set the value of the size indicator of the variable-size array to the length of the dynamic length signal, if the value of a data element is retrieved from COM or LdCom and the data element

- is typed by a uint8 variable-size Array and
- is mapped by a [SenderReceiverToSignalMapping](#) to a [SystemSignal](#) and
- the corresponding [ISignal\(s\)](#) do not reference a [DataTransformation](#)

]([SRS_Rte_00231](#))

[SWS_Rte_04584] [The RTE shall set the length value of the dynamic length signal to the value of the defined size indicator in the variable-size array, if the value of a data element is transmitted from COM or LdCom and the data element

- is typed by a uint8 variable-size Array and
- is mapped by a [SenderReceiverToSignalMapping](#) to a [SystemSignal](#) and
- the corresponding [ISignal\(s\)](#) do not reference a [DataTransformation](#)

]([SRS_Rte_00231](#))

[SWS_Rte_CONSTR_04584] Data type of size indicator in the variable-size array
 [If [\[SWS_Rte_04583\]](#) or [\[SWS_Rte_04584\]](#) applies, the data type of the size indicator of the variable-size array must match the data type of the length of the dynamic length signal.]([SRS_Rte_00231](#))

4.3.1.15 Inter-ECU communication through TP

Inter-ECU communication can be configured in COM to be supported by the TP. This is especially necessary if:

- Size of the signal exceed the size of the L-PDU (large signals)
- Size of the signal group exceed the size of the L-PDU

In the current release of SWS_COM, COM APIs to access signal values might return the error code COM_BUSY for the signals mapped to N-PDU. This error code indicates that the access to the signal value has failed (internally rejected by COM) and should be retried later. This situation might only be possible when the transmission or the reception of the corresponding PDU is in progress in COM at the time the access to the signal value is requested.

This is a problem for the handling of data with `data semantic` (last is best behavior) because:

- "COM_BUSY like" errors are not compatible with real time systems that should have predictable response time.
- Forwarding this error code to the application implies that every applications should handle it (implement a retry) even if it will never comes (data is not be mapped to N-PDU).
- Error code can not be forwarded to the application in case of direct read or implicit write.

This is not a problem for the handling of data with `event semantic` (queued behavior) because:

- The COM_BUSY error should not be possible during the execution of COM callbacks (Rx indication and Tx confirmation) that can be used by the RTE to handle the queue.
- Data are queued internally by RTE and accessible at any time by the application.

Note: First point is especially true if the `ComIPduSignalProcessing` is configured as IMMEDIATE. But if the `ComIPduSignalProcessing` is configured as DEFERRED and 2 events are closely received, it is possible that at the time the RTE tries to access the corresponding COM signal the second event reception has already started. In this case the RTE will received COM_BUSY and the event will be lost but it is more a problem of configuration than a limitation from COM.

As a consequence it has been decided to limit the data mapped to N-PDU to the `event semantic` (queued behavior). See [SWS_Rte_07811].

Note: As the data mapping is not mandatory for the RTE contract phase, it is possible that a configuration is accepted at contract phase but rejected at generation phase when the data mapping is known.

Dynamic data are always mapped to N-PDU in case of inter-ECU communication. So in order to avoid such situation (late rejection at generation phase) and in order to respect the VFB concept (intra and inter-ECU should be equal) it has been decided to extend this limitation to every dynamic data whatever the communication is intra or inter-ECU. See [SWS_Rte_07812].

4.3.1.16 Inter-ECU communication of arrays of bytes

4.3.1.16.1 COM

Generally the communication of arrays in the case of inter-ECU communication must make use of the signal group mechanisms to send an array to COM. This implies sending each array element to a buffer in COM (with `Com_SendSignal()` API, and in the end send the signal group (with `Com_SendSignalGroup()` API).

An exception to this general rule is for arrays of bytes. In this case, the RTE shall use the native COM interface to send directly the data.

[SWS_Rte_07408] [The RTE shall use the `Com_SendSignal` or `Com_ReceiveSignal` APIs to send or receive fixed-length arrays of bytes if the according `VariableDataPrototype` is mapped to a `SystemSignal`.] (*SRS_Rte_00231*)

[SWS_Rte_07817] [The RTE shall use the `Com_SendDynSignal` or `Com_ReceiveDynSignal` APIs to send or receive variable-length arrays of bytes if the according `VariableDataPrototype` is mapped to a `SystemSignal`.] (*SRS_Rte_00231*)

If the `VariableDataPrototype` of a fixed-length or variable-length array is mapped to a `SystemSignalGroup` then requirement **[SWS_Rte_04526]** applies.

4.3.1.16.2 Efficient COM for large data

The rules for the decision whether to use Efficient COM for large data (`LdCom`) are described in System Template [8], chapter 6.2.

[SWS_Rte_01376] [The RTE shall use `LdCom` for sending/receiving arrays of bytes if the corresponding `ISignal` is mapped to `LdComIPdu`.] (*SRS_Rte_00246*)

Transmission

[SWS_Rte_01377] [The RTE shall use the `LdCom_Transmit` API if `LdComApiType` is set to `LDCOM_IF` in `LdComIPdu`.] (*SRS_Rte_00231*)

In case `If`-API is used upon `LdCom_Transmit`, the transmit request is passed immediately to the lower layer. After return of the API the data does not need to be locked.

[SWS_Rte_01378] [The RTE shall use the `LdCom_Transmit` API if `LdComApiType` is set to `LDCOM_TP` in `LdComIPdu`.] (*SRS_Rte_00231*)

In case `TP`-API is used, after `LdCom_Transmit` one or more invocations of `Rte_LdComCbCopyTxData_<sn>` by `LdCom` will occur asynchronously. The Transmission is finalized by `Rte_LdComCbTpTxConfirmation_<sn>`.

During this time the data has to be available for being passed to `LdCom`.

[SWS_Rte_01379] [The RTE shall lock the signal buffer after it initiated a `Tp` Transmission (`LdCom_Transmit` returned `E_OK`).] (*SRS_Rte_00246*)

During the signal buffer is locked no further transmit requests are permitted on that item. For [data semantics](#) this means that [Rte_Write/Rte_Call](#) will return `RTE_E_COM_BUSY`.

[SWS_Rte_01380] [The RTE shall unlock the signal buffer after `Rte_LdComCbkJpTxConfirmation_<sn>` has been invoked (independent of the result).] ([SRS_Rte_00246](#))

[SWS_Rte_01381] [The RTE shall copy the indicated number of bytes to the provided destination in each invocation of `Rte_LdComCbkJpCopyTxData_<sn>`.] ([SRS_Rte_00246](#))

[SWS_Rte_01382] [For signals for which the `Rte_LdComCbkJpTriggerTransmit_<sn>` API is configured the data of the corresponding signal has to be available during the whole runtime of the RTE.] ([SRS_Rte_00246](#))

Rationale: A call to `TriggerTransmit` may happen at any time, since it originates from lower BSW layers.

Hint: Main use case for [\[SWS_Rte_01382\]](#) is the transmission of the current value for newly (late) subscribed receivers in `ServiceDiscovery`.

[SWS_Rte_01383] [If `Rte_LdComCbkJpTriggerTransmit_<sn>` is invoked, data shall be copied to the provided destination.] ([SRS_Rte_00246](#))

Reception

[SWS_Rte_01384] [If `Rte_LdComCbkJpRxIndication_<sn>` is invoked RTE shall provide the following steps:

- copy the passed signal data to the buffer
- fire a [DataReceivedEvent](#) (if configured)
- return

] ([SRS_Rte_00246](#))

[SWS_Rte_01385] [If `Rte_LdComCbkJpStartOfReception_<sn>` is invoked RTE shall lock the corresponding reception buffer.] ([SRS_Rte_00246](#))

[SWS_Rte_01386] [If `Rte_LdComCbkJpCopyRxData_<sn>` is invoked RTE shall copy the passed signal data (or the indicated portion) to the previously locked reception buffer.] ([SRS_Rte_00246](#))

[SWS_Rte_01387] [If `Rte_LdComCbkJpTpRxIndication_<sn>` is invoked RTE shall unlock the previously locked reception buffer.] ([SRS_Rte_00246](#))

[SWS_Rte_01388] [When `Rte_LdComCbkJpTpRxIndication_<sn>` is invoked and the passed result code is `RTE_E_OK`, it shall fire the [DataReceivedEvent](#). For other result codes, the signal value shall be set to the `invalidValue` for data elements if `invalidValue` was configured.] ([SRS_Rte_00246](#))

4.3.1.17 Handling of acknowledgment events

As a general rule, the acknowledgment events `DataWriteCompletedEvent` and `DataSendCompletedEvent` shall be raised immediately after the sending to all receivers has been performed and in case of Inter-ECU communication all acknowledgments from COM or LdCom have been received. As part of the implementation detailed rules for the following communication scenarios have to be considered:

Intra-Partition communication

[SWS_Rte_08017] [For intra-partition communication with implicit `dataWriteAccess` the `DataWriteCompletedEvent` shall be fired if and only if a task/ISR2 terminates and the write-back copy actions to the global RTE-buffer are completed. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_IFeedback` API.] (*SRS_Rte_00122*)

[SWS_Rte_08043] [For intra-partition communication with incoherent implicit `dataWriteAccess` no write-back copy actions to a global RTE-buffer will be performed, if the involved runnables are all running in one preemption area. In this case the `DataWriteCompletedEvent` shall be fired after the termination of the last sending runnable in the sending task/ISR2. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_IFeedback` API.] (*SRS_Rte_00122*)

[SWS_Rte_08018] [For intra-partition communication with explicit `dataSendPoint` the `DataSendCompletedEvent` shall be fired if and only if the sending to all receivers has been performed. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_Feedback` API.] (*SRS_Rte_00122*)

Inter-Partition communication

[SWS_Rte_08020] [For inter-partition communication with implicit `dataWriteAccess` the `DataWriteCompletedEvent` shall be fired if and only if a task/ISR2 terminates and the write-back copy actions to the global RTE-buffer are completed. In addition the execution of the data write operations at the data receiver partitions must have taken place. Thereby the return status of the `IOC` for the different write operations can be neglected. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_IFeedback` API.] (*SRS_Rte_00122*)

[SWS_Rte_08044] [For inter-partition communication with incoherent implicit `dataWriteAccess` no write-back copy actions to a global RTE-buffer will be performed, if the involved runnables are all running in one preemption area. In this case the `DataWriteCompletedEvent` shall be fired after the termination of the last sending runnable in the sending task/ISR2 and after the execution of the data write operations at the data receiver partitions have taken place. Thereby the return status of the `IOC` for the different write operations can be neglected. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_IFeedback` API.] (*SRS_Rte_00122*)

[SWS_Rte_08021] [For inter-partition communication with explicit `dataSendPoint` the `DataSendCompletedEvent` shall be fired if and only if the sending to all receivers has been performed and the execution of the data write operations at the data receiver partitions have taken place. Thereby the return status of the IOC for the different write operations can be neglected. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_Feedback` API.]([SRS_Rte_00122](#))

Inter-ECU communication

[SWS_Rte_08022] [For inter-ECU communication with implicit `dataWriteAccess` the `DataWriteCompletedEvent` shall be fired if and only if a task/ISR2 terminates and the write-back copy actions to the global RTE-buffer are completed. In addition the transmission acknowledgment from COM or LdCom must be complete, i.e. the acknowledgment has been received and in case of RTE-fanout all acknowledgments have been received. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_IFeedback` API.]([SRS_Rte_00122](#))

[SWS_Rte_08045] [For inter-ECU communication with incoherent implicit `dataWriteAccess` no write-back copy actions to a global RTE-buffer will be performed, if the involved runnables are all running in one preemption area. In this case the `DataWriteCompletedEvent` shall be fired after the termination of the last sending runnable in the sending task/ISR2 and after the transmission acknowledgment from COM or LdCom is complete, i.e. the acknowledgment has been received and in case of RTE-fanout all acknowledgments have been received. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_IFeedback` API.]([SRS_Rte_00122](#))

[SWS_Rte_08023] [For inter-ECU communication with explicit `dataSendPoint` the `DataSendCompletedEvent` shall be fired if and only if the sending to all receivers has been performed and the transmission acknowledgment from COM or LdCom is complete, i.e. the acknowledgment has been received and in case of RTE-fanout all acknowledgments have been received. The transmission status shall be `RTE_E_TRANSMIT_ACK` and can be collected with `Rte_Feedback` API.]([SRS_Rte_00122](#))

4.3.1.18 Meta data for application

[SWS_Rte_03620] [The RTE shall forward meta data of a data element to/from COM or LdCom to/from the application if a data element

- is used for inter-ECU communication
- and it is referenced by a `MetaDataItemSet` of its `SenderReceiverInterface`

] ([SRS_Rte_00322](#))

Note: If the data element data is buffered by the Rte, then the meta data must be buffered as well.

The Software Component Template Specification [2] describes the modeling of meta data in the context of a `SenderReceiverInterface`. The specification of AUTOSAR COM [3] describes the extended COM APIs while for LdCom the already existing `SduMeta-DataPtr` struct member of `PduInfoType` shall be used.

[SWS_Rte_03621] [The RTE shall provide access to single meta data items if a data element is referenced by a `MetaDataItemSet` of its `SenderReceiverInterface`] (*SRS_Rte_00322*)

4.3.2 Client-Server

4.3.2.1 Introduction

Client-server communication involves two entities, the `client` which is the requirer (or user) of a service and the `server` that provides the service.

The `client` initiates the communication, requesting that the `server` performs a service, transferring a parameter set if necessary. The `server`, in the form of the RTE, waits for incoming communication requests from a `client`, performs the requested service and dispatches a response to the `client`'s request. So, the direction of initiation is used to categorize whether a AUTOSAR software-component is a `client` or a `server`.

A single component can be both a `client` and a `server` depending on the software realization.

The invocation of a `server` is performed by the RTE itself when a request is made by a `client`. The invocation occurs synchronously with respect to the RTE (typically via a function call) however the `client`'s invocation can be either synchronous (wait for `server` to complete) or asynchronous with respect to the `server`.

Note: `servers` which have an asynchronous operation (i.e. they accept a request and another provide a feedback by invoking a `server` of the caller) should be avoided as the RTE does not know the link between these 2 client-server communications. In particular, the `server` should have no OUT (or INOUT) parameters because the RTE cannot perform the copy of the result in the caller's environment when the request was processed.

[SWS_Rte_06019] [The only mechanism through which a `server` can be invoked is through a client-server invocation request from a `client`.] (*SRS_Rte_00029*)

The above requirement means that *direct invocation* of the function implementing the `server` outside the scope of the RTE is not permitted.

A `server` has a dedicated provide port and a `client` has a dedicated require port. To be able to connect a `client` and a `server`, both ports must be categorized by the same interface.

The `client` can be blocked (synchronous communication) respectively non-blocked (asynchronous communication) after the service request is initiated until the response of the `server` is received.

A `server` implemented by a `RunnableEntity` with attribute `canBeInvokedConcurrently` set to FALSE is not allowed to be invoked concurrently and since a `server` can have one or more `clients` the `server` may have to handle concurrent service calls (n:1 communication) the RTE must ensure that concurrent calls do not interfere.

[SWS_Rte_04515] [The RTE shall ensure that call serialization⁸ of the operation is enforced when the `server` runnable attribute `canBeInvokedConcurrently` is FALSE.]([SRS_Rte_00019](#), [SRS_Rte_00033](#))

Note that the same `server` may be called using both synchronous and asynchronous communication.

Note also that even when `canBeInvokedConcurrently` is FALSE, an `Atomic-SwComponentType` might be instantiated multiple times. In this case, the implementation of the `RunnableEntity` can still be invoked concurrently from several tasks. However, there will be no concurrent invocations of the implementation with the same instance handle.

[SWS_Rte_04516] [The RTE's implementation of the client-server communication shall ensure that a service result is dispatched to the correct `client` if more than one `client` uses a service.]([SRS_Rte_00019](#), [SRS_Rte_00080](#))

The result of the client/server operation can be collected using “wake up of wait point”, “explicit data read access” or “activation of runnable entity”.

[SWS_Rte_07409] [If all the following conditions are satisfied:

- the `server` runnable's property `canBeInvokedConcurrently` is set to TRUE
- the `client` and `server` execute in the same partition, i.e. `intra-partition` Client-Server communication
- the `ServerCallPoint` is Synchronous
- the `OperationInvokedEvent` is not mapped to an `OsTask`

⁸Call Serialization ensures at most one thread of control is executing an instance of a runnable entity at any one time. An AUTOSAR software-component can have multiple instances (and therefore a runnable entity can also have multiple instances). Each instance represents a different `server` and can be executed in parallel by different threads of control thus serialization only applies to an individual instance of a runnable entity – multiple runnable entities within the same component instance may also be executed in parallel.

the RTE Generator shall implement the Client-Server communication as a `direct function call.()`

[SWS_Rte_08904] [If all the following conditions are satisfied:

- the `server` runnable's property `canBeInvokedConcurrently` is set to TRUE
- the `client` and `server` execute in different partitions, i.e. `inter-partition` Client-Server communication
- the `ServerCallPoint` is Synchronous
- the `OperationInvokedEvent` is not mapped to an `OsTask`

the RTE Generator shall implement the Client-Server communication as a `trusted function call.()`

Note: In case the conditions in **[SWS_Rte_04522]** are fulfilled the RTE Generator may implement a client-server call with a direct or trusted function call, even when the server runnable's property `canBeInvokedConcurrently` is set to FALSE.

Since the communication occurs conceptually via the RTE (it is initiated via an RTE API call) the optimization does not violate the requirement that servers are only invoked via client-server requests (see Sect. 5.6.13, **[SWS_Rte_06019]**).

[SWS_Rte_07662] [The RTE Generator shall reject configurations where an `ClientServerOperation` has an `ArgumentDataPrototype` whose `ImplementationDataType` is of category `DATA_REFERENCE` and whose `direction` is `INOUT` or `OUT`.] (**SRS_Rte_00018**, **SRS_Rte_00019**)

[SWS_Rte_08731] [If the return value of the serialization call is not equal to `E_OK` the RTE shall not call `Com_SendSignal`] (**SRS_Rte_00091**)

4.3.2.2 Multiplicity

Client-server interfaces contain two dimensions of multiplicity; multiple clients invoking a single server and multiple operations within a client-server interface.

4.3.2.2.1 Multiple Clients Single Server

Client-server communication involves an AUTOSAR software-component invoking a defined “server” operation in another AUTOSAR software-component which may or may not return a reply.

[SWS_Rte_04519] [The RTE shall support multiple clients invoking the same server operation ('n:1' communication where $n \geq 1$).] (**SRS_Rte_00029**)

4.3.2.2.2 Multiple operations

A client-server interface contains one or more operations. A port of a AUTOSAR software-component that *requires* an AUTOSAR client-server interface to the component can independently invoke any of the operations defined in the interface [[SRS_Rte_00089](#)].

[SWS_Rte_04517] [The RTE API shall support independent access to operations in a client-server interface.] ([SRS_Rte_00029](#))

Example 4.9

Consider a client-server interface that has two operations, `op1` and `op2` and that an AUTOSAR software-component definition requires a port typed by the interface. As a result, the RTE generator will create two API calls; one to invoke `op1` and another to invoke `op2`. The calls can invoke the server operations either synchronously or asynchronously depending on the configuration.

Recall that each data element in a sender-receiver interface is transmitted independently (see Section [4.3.1.3](#)) and that the coherent transmission of multiple data items is achieved through combining multiple items into a single composite data type. The transmission of the parameters of an operation in a client-server interface is similar to a record since the RTE guarantees that all parameters are handled atomically [[SRS_Rte_00073](#)].

[SWS_Rte_04518] [The RTE shall treat the parameters and the results of a client-server operation atomically.] ([SRS_Rte_00033](#))

However, unlike a sender-receiver interface, there is no facility to combine multiple client-server operations so that they are invoked as a group.

4.3.2.2.3 Single Client Multiple Server

The RTE is *not* required to support multiple server operations invoked by a single client component request ('1:n' communication where $n > 1$) (see [[constr_1037](#)] in [\[2\]](#)).

4.3.2.2.4 Call Serialization

Each client can invoke the server simultaneously and therefore the RTE is required to support multiple requests of servers. If the server requires call serialization, the RTE has to ensure it.

[SWS_Rte_04520] [The RTE shall support simultaneous invocation requests of a server operation.] ([SRS_Rte_00019](#), [SRS_Rte_00080](#))

[SWS_Rte_04522] [The RTE shall ensure that the `RunnableEntity` implementing a server operation has completed the processing of a request before it begins processing the next request, if serialization is required by the server operation, i.e. `canBeInvokedConcurrently` attribute of the server is set to FALSE and client `RunnableEntities` to `OsTask` mapping (`RteEventToTaskMapping`) may lead to concurrent invocations of the server.]([SRS_Rte_00019](#), [SRS_Rte_00033](#))

When this requirement is met the operation is said to be “call serialized”. A call serialized server only accepts and processes requests atomically and thus avoids the potential for conflicting concurrent access.

Client requests that cannot be serviced immediately due to a server operation being “busy” are required to be queued pending processing. The presence and depth of the queue is configurable.

If the `RunnableEntity` implementing the server operation is reentrant, i.e. `canBeInvokedConcurrently` attribute set to TRUE, no serialization is necessary. This allows to implement invocations of reentrant server operations as direct or trusted function calls without involving the RTE.

But even when the `canBeInvokedConcurrently` attribute is set to FALSE the RTE Generator still can utilize a direct or trusted function call, if the mapping of the client `RunnableEntities` to `OsTasks` will not imply a concurrent execution of the server.

[SWS_Rte_08001] [If multiple operations are mapped to the same `RunnableEntity`, and [\[SWS_Rte_04522\]](#) requires a call serialization, then the operation invoked events shall be mapped to same task and they shall have the same position in task. Otherwise the RTE Generator shall reject configuration.]([SRS_Rte_00019](#), [SRS_Rte_00033](#))

[SWS_Rte_08002] [If multiple operations are mapped to the same `RunnableEntity`, and [\[SWS_Rte_04522\]](#) requires a call serialization, then a single queue is implemented for invocations coming from any of the operations.]([SRS_Rte_00019](#), [SRS_Rte_00033](#))

4.3.2.3 Communication Time-out

The `ServerCallPoint` allows to specify a timeout so that the client can be notified that the server is not responding and can react accordingly. If the client invokes the server synchronously, the RTE API call to invoke the server reports the timeout. If the client invokes the server asynchronously, the timeout notification is passed to the client by the RTE as a return value of the API call that collects the result of the server operation.

[SWS_Rte_03763] [The RTE shall ensure that timeout monitoring is performed for client-server communication, regardless of the receive mode for the result.]([SRS_Rte_00069](#), [SRS_Rte_00029](#))

If the server is invoked asynchronously and a [WaitPoint](#) is specified to collect the result, two timeout values have to be specified, one for the [ServerCallPoint](#) and one for the [WaitPoint](#).

[SWS_Rte_03764] [The RTE generator shall reject the configuration if different timeout values are specified for the [AsynchronousServerCallPoint](#) and for the [WaitPoint](#) associated with the [AsynchronousServerCallReturnsEvent](#) for this [AsynchronousServerCallPoint](#).] ([SRS_Rte_00018](#))

In asynchronous client-server communication the [AsynchronousServerCallReturnsEvent](#) associated with the [AsynchronousServerCallPoint](#) for an [ClientServerOperation](#) indicates that the server communication is finished or that a timeout occurred. The status information about the success of the server operation is available as the return value of the RTE API call generated to collect the result.

[SWS_Rte_03765] [For each asynchronous invocation of an operation prototype only one [AsynchronousServerCallReturnsEvent](#) shall be passed to the client component by the RTE. The [AsynchronousServerCallReturnsEvent](#) shall indicate either that the transmission was successful or that the transmission was not successful.] ([SRS_Rte_00079](#))

[SWS_Rte_03766] [The status information about the success or failure of the asynchronous server invocation shall be available as the return value of the RTE API call to retrieve the result.] ([SRS_Rte_00079](#))

After a timeout was detected, no result shall be passed to the client.

[SWS_Rte_03770] [In case [Rte_Call](#) API returns [RTE_E_LIMIT](#), [RTE_E_TRANSFORMER_LIMIT](#), [RTE_E_COM_STOPPED](#), [RTE_E_TIMEOUT](#), [RTE_E_UNCONNECTED](#), [RTE_E_IN_EXCLUSIVE_AREA](#) or [RTE_E_SEG_FAULT](#), the RTE shall not modify the OUT and INOUT parameters.] ([SRS_Rte_00069](#), [SRS_Rte_00029](#))

[SWS_Rte_08310] [In case [Rte_Result](#) API returns [RTE_E_NO_DATA](#), [RTE_E_HARD_TRANSFORMER_ERROR](#), [RTE_E_COM_STOPPED](#), [RTE_E_TIMEOUT](#), [RTE_E_UNCONNECTED](#), [RTE_E_IN_EXCLUSIVE_AREA](#) or [RTE_E_SEG_FAULT](#), the RTE shall not modify the OUT and INOUT parameters.] ([SRS_Rte_00069](#), [SRS_Rte_00029](#))

Since an asynchronous client can have only one outstanding server invocation at a time, the RTE has to monitor when the server can be safely invoked again.

If a server is invoked asynchronously, no timeout occurs and an [AsynchronousServerCallResultPoint](#) exists then the RTE returns [RTE_E_LIMIT](#) for subsequent invocations of the [Rte_Call](#) API until the server's result has been successfully passed to the client (See [\[SWS_Rte_01105\]](#)).

If a server is invoked asynchronously, no timeout occurs and no [AsynchronousServerCallResultPoint](#) exists then the RTE returns [RTE_E_LIMIT](#) for subsequent invocations of the [Rte_Call](#) API until the server has finished to process the last request of the client (See [\[SWS_Rte_01105\]](#)).

In intra-partition client-server communication, the RTE can determine whether the server runnable is still running or not.

[SWS_Rte_03771] [If a timeout was detected in asynchronous intra-partition client-server communication, the RTE shall ensure that the server is not invoked again by the same client until the server runnable has terminated.]([SRS_Rte_00069](#), [SRS_Rte_00079](#))

In inter-ECU communication, the client RTE has no knowledge about the actual status of the server. The response of the server could have been lost because of a communication error or because the server itself did not respond. Since the client-side RTE cannot distinguish the two cases, the client must be able to invoke the server again after a timeout expired. As partitions in one ECU are decoupled in a similar way like separate ECUs, and can be restarted separately, client server communication should behave similar for inter-ECU and intra-partition communication.

[SWS_Rte_03772] [If a timeout was detected in asynchronous [inter-ECU](#) or [inter-partition](#) client-server communication, the RTE shall ensure that the server can be invoked again by the same client after the timeout notification was passed to the client.]([SRS_Rte_00069](#), [SRS_Rte_00079](#))

Note that this might lead to client and server running out of sync, i.e. the response of the server belongs to the previous, timed-out invocation of the client. The application has to handle the synchronization of client and server after a timeout occurred.

[SWS_Rte_03767] [If the timeout value of the [ServerCallPoint](#) is 0, no timeout monitoring shall be performed.]([SRS_Rte_00069](#), [SRS_Rte_00029](#))

[SWS_Rte_03768] [If the [canBeInvokedConcurrently](#) attribute of the server runnable is set to TRUE, no timeout monitoring shall be performed if the RTE API call to invoke the server is implemented as a direct or trusted function call.]([SRS_Rte_00069](#), [SRS_Rte_00029](#))

[SWS_Rte_02709] [In case of inter partition communication, if the partition of the server is stopped or restarting at the invocation time of the server call or during the operation of the server call, the RTE shall immediately provide a timeout indication to the client.]([SRS_Rte_00069](#), [SRS_Rte_00029](#))

Note: In case of inter-ECU or interpartition client-server communication it is recommended to always specify a timeout>0 when synchronous server calls are used. Otherwise in case of a full server queue the client would wait for the server response infinitely.

4.3.2.4 Port-Defined argument values

Port-defined argument values exist in order to support interaction between Application Software Components and Basic Software Modules.

Several Basic Software Modules use an integer identifier to represent an object that should be acted upon. For instance, the NVRAM Manager uses an integer identifier to represent the `NVRAM block` to access. This identifier is not known to the client, as the client must be location independent, and the `NVRAM block` to access for a given application software component cannot be identified until components have been mapped onto ECUs.

There is therefore a mismatch between the information available to the client and that required by the server. Port-defined argument values bridge that gap.

The required port-defined arguments (the fact that they are required, their data type and their values) are specified within the input to the RTE generator.

[SWS_Rte_01360] [When invoking the runnable entity specified for an `OperationInvokedEvent`, the RTE shall include the port-defined argument values between the instance handle (if it is included) and the operation-specific parameters, in the order they are given in the Software Component Template Specification [2].] ([SRS_Rte_00152](#))

Requirement [\[SWS_Rte_01360\]](#) means that a client will make a request for an operation on a require (Client-Server) port including only its instance handle (if required) and the explicit operation parameters, yet the server will be passed the implicit parameters as it requires.

Note that the values of implicit parameters are constant for a particular server runnable entity; it is therefore expected that using port-defined argument values imposes no RAM overhead (beyond any extra stack required to store the additional parameters).

4.3.2.5 Buffering

Client-Server-Communication is a two-way-communication. A request is sent from the client to the server and a response is sent back.

The buffering mechanisms described here also apply to the serialization of server calls in the Basic Software Scheduler.

Unless a server call is implemented as direct or trusted function call, the RTE has to store or buffer the communication on the corresponding receiving sides, requests on server side and responses on client side, respectively:

- **[SWS_Rte_02527]** [Unless a server call is implemented as a direct or trusted function call, the RTE shall buffer a request on the server side in a first-in-first-out queue as described in chapter [4.3.1.10.2](#) for queued data elements.

Note: The data that shall be buffered is implementation specific but at least RTE should store the IN parameters, the IN/OUT parameters and a client identifier.] ([SRS_Rte_00019](#), [SRS_Rte_00033](#), [SRS_Rte_00110](#))

- **[SWS_Rte_02528]** [Unless a server call is implemented as a direct or trusted function call, RTE shall keep the response on the client side in a queue with queue length 1.

Note: The data that shall be buffered is implementation specific but at least RTE should store the IN/OUT parameters, the OUT parameters and the error code.] ([SRS_Rte_00019](#), [SRS_Rte_00033](#))

[SWS_Rte_02314] [The RTE shall determine the queue length for the server side according to the following priority rules (highest priority first):

1. value of the ECU-C parameter `RteServerQueueLength`
2. value of the `queueLength` attribute of the `ServerComSpec`

]()

[SWS_Rte_02315] [The Basic Software Scheduler shall take the queue length for the server from the ECU-C parameter `RteBswServerQueueLength`.]()

[SWS_Rte_02529] [The RTE generator shall reject a `queueLength` attribute of a `ServerComSpec` with a queue length ≤ 0 .] ([SRS_Rte_00033](#), [SRS_Rte_00110](#), [SRS_Rte_00018](#))

[SWS_Rte_02530] [The RTE shall use the queue of requests to call serialise access to a server.] ([SRS_Rte_00033](#), [SRS_Rte_00110](#))

A buffer overflow of the server is not reported to the client. The client will receive a time out.

[SWS_Rte_07008] [If a server call is implemented by direct function call the RTE shall not create any copy for parameters passed by reference.] ([SRS_Rte_00033](#), [SRS_Rte_00110](#))

Therefore, it is the responsibility of the application to provide consistency mechanisms for referenced parameters if necessary.

4.3.2.6 Inter-ECU and Inter-Partition Response to Request Mapping

RTE is responsible to map a response to the corresponding request. With this mapping, RTE can activate or resume the corresponding runnable and provide the response to the correct client. The following situations can be distinguished:

- Mapping of a response to the correct request within one ECU. In general, this is solved already by the call stack. The details are implementation specific and will not be discussed in this document.
- Mapping of a response coming from a different partition or a different ECU.

The problem of request to response mapping in inter-ECU and inter-Partition communication can be split into:

- Mapping of a response to the correct client. This is discussed in [4.3.2.6.1](#).
- Mapping of a response to the correct request within of one client. This is discussed in [4.3.2.6.2](#).

The general approach for the inter-ECU and inter-Partition request response mapping is to use transaction handles.

[SWS_Rte_02649] [In case of inter-ECU client-server communication, the transaction handle shall contain two parts of unsigned integer type:

- Client Identifier
- Client Sequence Counter

]([SRS_Rte_00027](#), [SRS_Rte_00082](#))

[SWS_Rte_08711] [The Client Identifier of the transaction handle used for an inter-ECU client server communication shall be of type `uint16`.]([SRS_Rte_00082](#), [SRS_Rte_00091](#))

[SWS_Rte_07413] [The Client Identifier of the transaction handle used for an inter-ECU client server communication may be defined at the `ClientIdDefinition` belonging to the Ecu Extract and referring the operation instance. If defined the RTE generator shall take the `clientId` from the `ClientIdDefinition`. If not defined the RTE generator shall set the `clientId` to 0.]([SRS_Rte_00082](#), [SRS_Rte_00091](#))

[SWS_Rte_08712] [The Client Sequence Counter part of the transaction handle used for an inter-ECU client server communication shall be of type `uint16`.]([SRS_Rte_00082](#), [SRS_Rte_00091](#))

[SWS_Rte_07346] [In case of inter-Partition client-server communication, the RTE shall not communicate any response to the client if the client is part of a partition that was restarted since the request was sent.]([SRS_Rte_00027](#), [SRS_Rte_00082](#))

[\[SWS_Rte_07346\]](#) could be implemented with a transaction handle that contains a sequence counter.

[SWS_Rte_02651] [In case of inter-ECU client-server communication, the transaction handle shall be used for the identification of client server transactions communicated via COM or LdCom.]([SRS_Rte_00027](#), [SRS_Rte_00082](#))

[SWS_Rte_02653] [The RTE on the server side shall return the transaction handle of the request without modification together with the response.]([SRS_Rte_00027](#), [SRS_Rte_00082](#))

Since there is always at most one open request per client (see [\[SWS_Rte_02658\]](#)), the transaction handle and meta data can be kept within the RTE and does not have to be exposed to the *AUTOSAR SW-C*.

[SWS_Rte_03629] [In case of inter-ECU client-server communication, where meta data is configured for the PDU, the RTE on the server side shall preserve the meta data

of the request and pass the meta data along with the response without modification.]
([SRS_Rte_00322](#))

Since the meta data for C/S operation is neither required for the Application SW-C nor for transformer operations it can be kept within the RTE.

4.3.2.6.1 Client Identifier

In case of a server on one ECU with clients on other ECUs, the inter-ECU client-server communication is using one [SystemSignal](#) for the Call and one [SystemSignal](#) for the Response. Meta data is used for distinction of calling ECUs. Please note that in former AUTOSAR releases the usage of different [SystemSignals](#) for each client-ECU was used for the identification of the client-ECU. This is no longer supported by the AUTOSAR System Template [8] and the usage of meta data for distinction of calling ECUs is mandatory.

With this mechanism, the server-side RTE must handle the fan-in. This is done in the same way as for sender-receiver communication.

However it is allowed to have several clients in one client-ECU communicating using inter-ECU client-server communication with a server on a different ECU, if the client identifier is used to distinguish the different clients (see [constr_3264]).

[SWS_Rte_03769] [If multiple clients have access to one server, the RTE on the server side has to queue all incoming server invocations while ensuring data consistency.]
([SRS_Rte_00019](#), [SRS_Rte_00029](#), [SRS_Rte_00080](#))

4.3.2.6.2 SequenceCounter

The purpose of sequence counters is to map a response to the correct request of a known client.

[SWS_Rte_02658] [In case of inter-ECU and inter-Partition communication, RTE shall allow only one request per client and server operation at any time.] ([SRS_Rte_00079](#))

[\[SWS_Rte_02658\]](#) does not apply to intra-partition communication because there can be several [execution-instances](#).

[\[SWS_Rte_02658\]](#) implies under normal operation that a response can be mapped to the previous request. But, when a request or response is lost or delayed, this order can get out of phase. To allow a recovery from lost or delayed signals, a sequence counter is used. The sequence counter can also be used to detect stale responses after a restart of the client side RTE and SW-C.

[SWS_Rte_02654] [RTE shall support a sequence counter for the inter ECU client server connection where configured in the input information.] ([SRS_Rte_00027](#), [SRS_Rte_00082](#))

[SWS_Rte_02655] [RTE shall initialize all sequence counters with zero during `Rte_Start.`]([SRS_Rte_00082](#))

[SWS_Rte_02656] [RTE shall increase each sequence counter in a cyclic manner after a client server operation has finished successfully or with a timeout.]([SRS_Rte_00082](#))

[SWS_Rte_02657] [RTE shall ignore incoming responses that do not match the sequence counter.]([SRS_Rte_00027](#), [SRS_Rte_00082](#))

4.3.2.7 Parameter Serialization

Within an input configuration an unconnected or an `intra-ECU` client will have zero `ClientServerToSignalMapping` and an `inter-ECU` client will have exactly one such mapping (since a client can connect to exactly one server). Fan-out is not supported for clients and therefore multiple mappings are not permitted.

[SWS_Rte_08700] [The RTE generator shall reject an input configuration where a `ClientServerOperation` owned by an `RPortPrototype` is referenced by more than one `ClientServerToSignalMapping` with identical values of the attribute `ClientServerOperation`.]([SRS_Rte_00018](#), [SRS_Rte_00027](#), [SRS_Rte_00082](#), [SRS_Rte_00091](#))

[SWS_Rte_08703] [For an inter-ECU client-server communication, the RTE of the client ECU shall communicate the request to a remote server using the `callSignal` of the `ClientServerToSignalMapping` which references the operation instance.]([SRS_Rte_00027](#), [SRS_Rte_00082](#), [SRS_Rte_00091](#))

[SWS_Rte_08705] [For an inter-ECU client-server communication, the RTE of the client ECU shall receive the results of a remote server using the `returnSignal` of the `ClientServerToSignalMapping` which references the operation instance.]([SRS_Rte_00027](#), [SRS_Rte_00082](#), [SRS_Rte_00091](#), [SRS_Rte_00123](#))

[SWS_Rte_08707] [For an inter-ECU client-server communication, the RTE of the server ECU shall receive a request of a remote client using the `callSignal` of the `ClientServerToSignalMapping` which references the operation instance.]([SRS_Rte_00027](#), [SRS_Rte_00082](#), [SRS_Rte_00091](#))

[SWS_Rte_08709] [For inter-ECU client-server communication, the RTE of the server ECU shall communicate the results to a remote client using the `returnSignal` of the `ClientServerToSignalMapping` which references the operation instance.]([SRS_Rte_00027](#), [SRS_Rte_00082](#), [SRS_Rte_00091](#), [SRS_Rte_00123](#))

4.3.2.8 Operation

4.3.2.8.1 Inter-ECU Mapping

The client server protocol defines how a client call and the server response are mapped onto the communication infrastructure of AUTOSAR in case of inter-ECU communication. This allows RTE implementations from different vendors to interpret the client server communication in the same way.

The AUTOSAR System Template [8] does specify a protocol for the client server communication in AUTOSAR.

4.3.2.8.2 Atomicity

The requirements for atomicity from Section 4.3.1.11.2 also apply for the composite data types described in Section 4.3.2.8.1.

4.3.2.8.3 Fault detection and reporting

Client Server communication may encounter interruption like:

- Buffer overflow at transformation
- Buffer overflow at the server side.
- Communication interruption.
- Server might be inaccessible for some reason.

The client specifies a timeout that will expire in case the server or communication fails to complete within the specified time. The reporting method of an expired timeout depends on the communication attributes:

- If the C/S communication is synchronous the RTE returns `RTE_E_TIMEOUT` on the `Rte_Call` function (see section 5.6.13).
- If the C/S communication is asynchronous the RTE returns `RTE_E_TIMEOUT` on the `Rte_Result` function (see section 5.6.14).

In the case that RTE detects that the COM service is not available when forwarding signals to COM, the RTE returns `RTE_E_COM_STOPPED` on the `Rte_Call` (see section 5.6.13).

In the case a transmission is ongoing (e.g. `LdCom` transmission using `TP-API` with pending `TxConfirmation`) when forwarding signals to `LdCom`, the RTE returns `RTE_E_COM_BUSY` on the `Rte_Call` (see section 5.6.13).

If the client still has an outstanding server invocation when the server is invoked again, the RTE returns `RTE_E_LIMIT` on the `Rte_Call` (see chapter 5.6.13).

In the absence of structural errors, application errors will be reported if present.

4.3.2.8.4 Asynchronous Client Server communication

Figure [4.44](#) shows a sequence diagram of how asynchronous client server communication may be implemented by RTE.

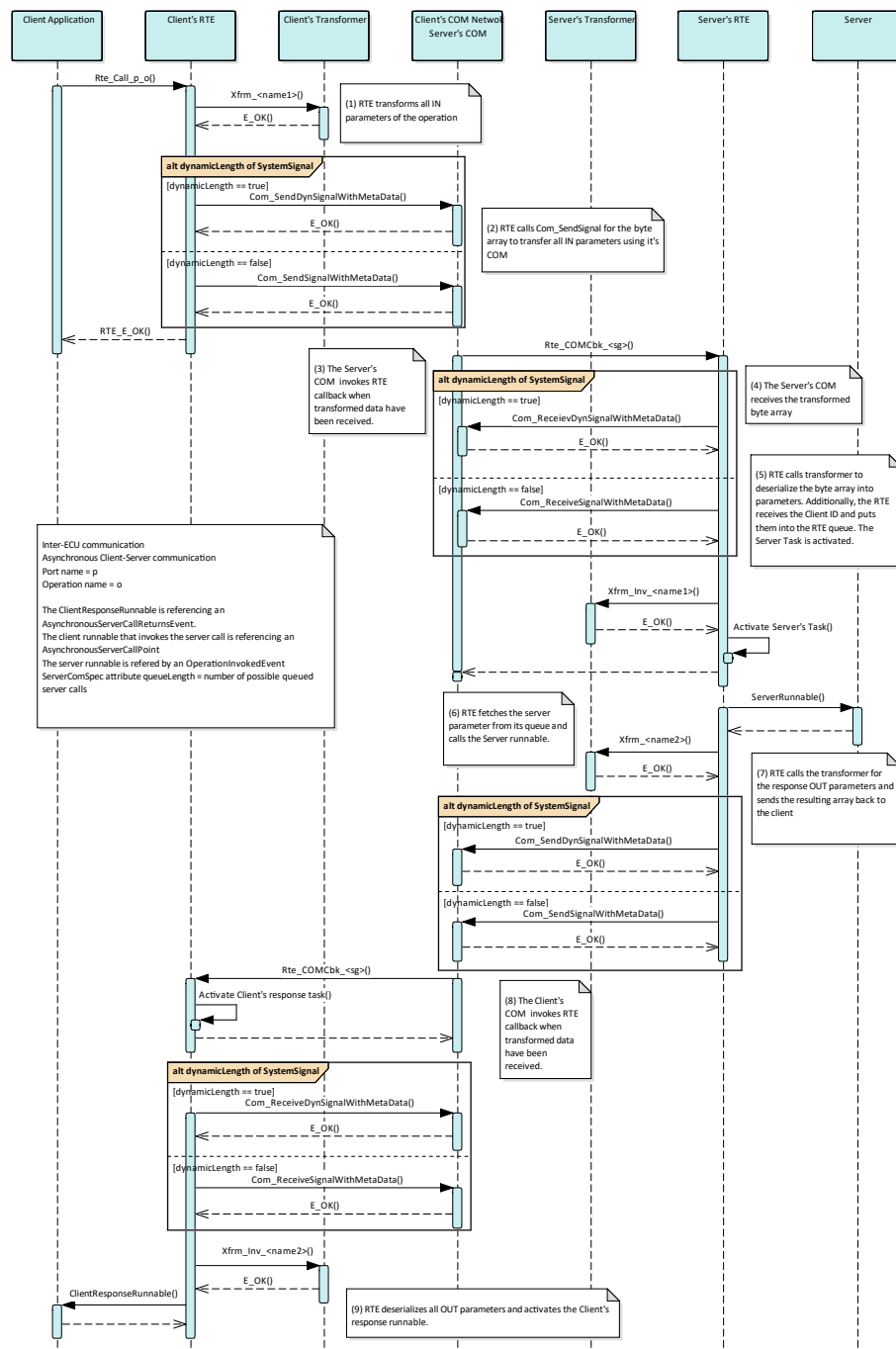


Figure 4.44: Client Server asynchronous

4.3.2.8.5 Synchronous Client Server communication

Figure 4.45 shows a sequence diagram of how synchronous client server communication may be implemented by RTE.

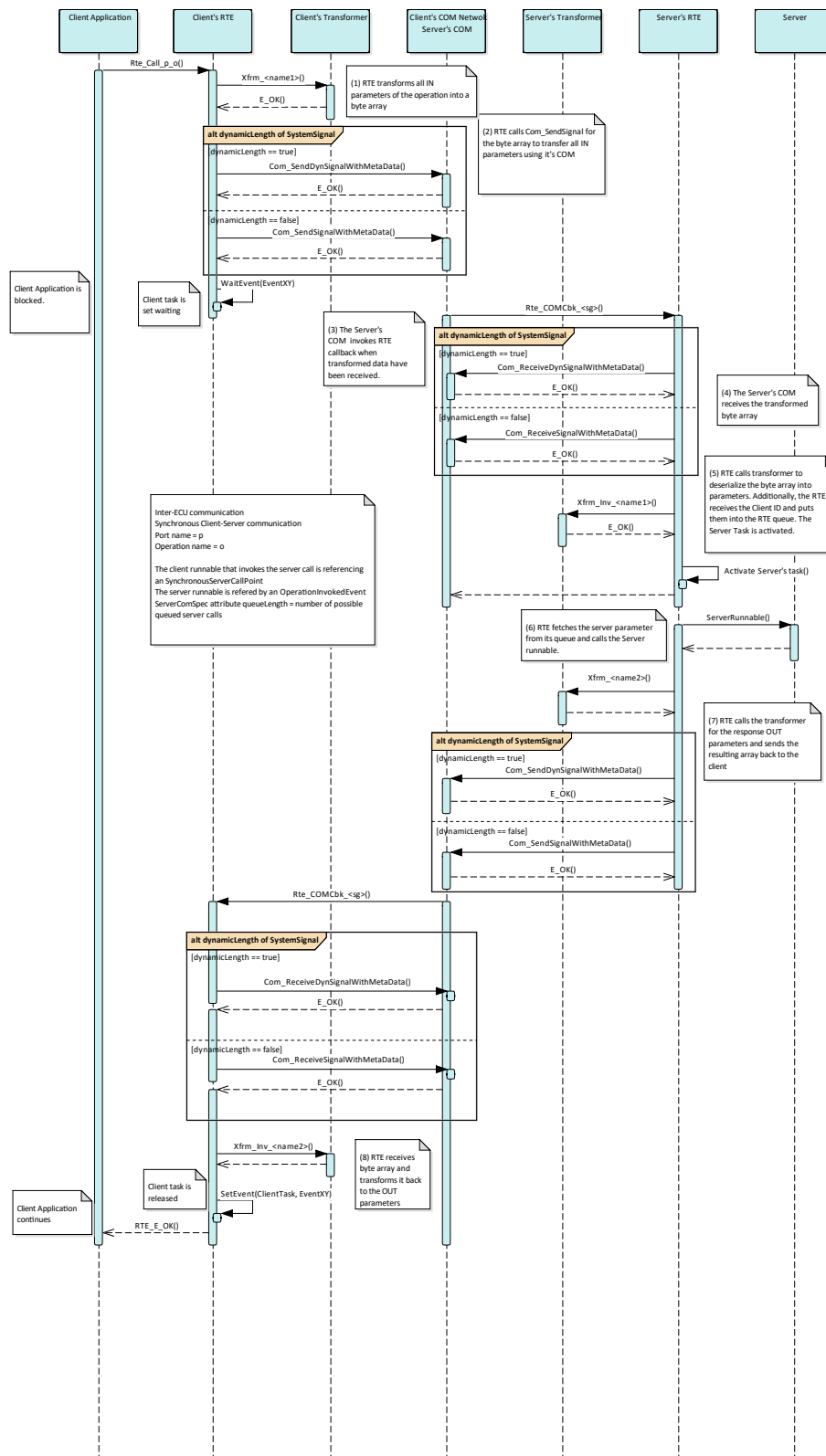


Figure 4.45: Client Server synchronous

4.3.3 SWC internal communication

4.3.3.1 Inter Runnable Variables

Sender/Receiver and Client/Server communication through AUTOSAR ports are the model for communication between AUTOSAR SW-Cs.

For communication between Runnables inside of an AUTOSAR SW-C the AUTOSAR SW-C Template [2] establishes a separate mechanism. AtomicSwComponents (except for NvBlockComponents) can reserve InterRunnableVariables which can only be accessed by the Runnables of this one AtomicSwComponent. The Runnables might be running in the same or in different task/ISR2 contexts. Read and write accesses are possible.

[SWS_Rte_03589] [The RTE shall support *Inter Runnable Variables* for single and multiple instances of AUTOSAR SW-Cs.] ([SRS_Rte_00142](#))

[SWS_Rte_07187] [The generated RTE shall initialize a defined `implicitInterRunnableVariable` and `explicitInterRunnableVariable` according to the [ValueSpecification](#) of the [VariableDataPrototype](#) defining the `implicitInterRunnableVariable` respectively `explicitInterRunnableVariable` if the general initialization conditions in [\[SWS_Rte_07046\]](#) and [\[SWS_Rte_03852\]](#) are fulfilled.] ([SRS_Rte_00142](#))

InterRunnableVariables have a behavior corresponding to Sender/Receiver communication *between* AUTOSAR SW-Cs (or rather between Runnables of different AUTOSAR SW-Cs).

But why not use Sender/Receiver communication directly instead? Purpose is data encapsulation / data hiding. Access to InterRunnableVariables of an AUTOSAR SW-C from other AUTOSAR SW-Cs is not possible and not supported by RTE. InterRunnableVariable content stays SW-C internal and so no other SW-C can use it. Especially not misuse it without understanding how the data behaves.

Like in Sender/Receiver (S/R) communication between AUTOSAR SW-Cs two different behaviors exist:

1. *Inter Runnable Variables* with *implicit* behavior (`implicitInterRunnableVariable`)

This behavior corresponds with [VariableAccesses](#) in the [dataReadAccess](#) and [dataWriteAccess](#) roles of Sender/Receiver communication and is supported by *implicit S/R API* in this specification.

Note:

If a [VariableAccess](#) in the [writtenLocalVariable](#) role referring to a [VariableDataPrototype](#) in the `implicitInterRunnableVariable` role is specified for a certain interrunnable variable, but no RTE API for implicit write of this interrunnable variable is called during an execution of the runnable, an undefined value is written back when the runnable terminates.

For more details see section [4.2.6.6.1](#).
For APIs see sections [5.6.24](#) and [5.6.26](#).

Note 2:

As for the Implicit Sender/Receiver communication, the implicit concept for Inter-RunnableVariables implies that the runnable does terminate. For runnable entities of category 2, the behavior is guaranteed only if it has a finite execution time. A category 2 runnable that runs forever will not have its data updated.

2. *Inter Runnable Variables* with *explicit* behavior (`explicitInterRunnableVariable`)

This behavior corresponds with `VariableAccesses` in the `dataSendPoint`, `dataReceivePointByValue`, or `dataReceivePointByArgument` roles of Sender/Receiver communication and is supported by *explicit S/R API* in this specification.

For more details see section [4.2.6.6.2](#)
For APIs see sections [5.6.28](#) and [5.6.29](#).

4.3.4 Inter-Partition communication

`Partitions` are used to decompose an ECU into functional units. Partitions can contain both SW-Cs and BSW modules. The partitioning is done to protect the software contained in the partitions against each other or to increase the performance by running the partitions on different cores of a multi core controller.

Since the partitions may be separated by core boundaries or memory boundaries and since the partitions can be stopped and restarted independently, the observable behavior to the SW-Cs for the communication between different partitions is rather similar to the inter ECU communication than to the intra partition communication. The RTE needs to use special mechanisms to communicate from one partition to another.

Like for the inter ECU communication, inter partition communication uses the connectionless communication paradigm. This means, that a send operation is successful for the sender, even if the receiving partition is stopped. A receiver will only, by means of a timeout, be notified if the partition of the sender is stopped.

Unlike most basic software, the RTE does not have a main processing function. The execution logic of the RTE is contained in the generated task bodies, the wrapper code around the runnables whose execution RTE manages.

As the tasks that contain the SW-Cs runnables are uniquely assigned to partitions (see page 11EER of [15]), the execution logic of the RTE is split among the partitions. It can not be expected that the RTE generated wrapper code running in one partition can directly access the memory objects assigned to the RTE part of another partition.

In this sense, there is one RTE per partition, that contains runnable entities.

Still, RTE is responsible to support the communication between SW-Cs allocated to the different partitions. According to the AUTOSAR software layered architecture, RTE has to be independent of the micro controller architecture. AUTOSAR supports a wide variety of multi core and memory protection architectures.

[SWS_Rte_02734] [The RTE generator shall support a mode in which the generated code is independent of the micro controller.] ([SRS_BSW_00161](#))

It can not be generally assumed that a cache coherent, shared memory is available for the communication between partitions. Direct memory access and function calls across partition boundaries are generally not possible. In the extreme case, communication might even be limited to a message passing interface.

To allow memory protection and multi core support in spite of [\[SWS_Rte_02734\]](#), the AUTOSAR OS provides a list of mechanisms, that can be used for the communication across cores (see [\[4\]](#)). Especially, the IOC has been designed to support the communication needs of RTE in a way that should not introduce additional run time overhead.

If a communication between Basic Software Modules is necessary for which the IOC does not suffice, for example Sender-Receiver or Client-Server communication, there are also mechanisms provided by the Basic Software Scheduler. These mechanisms follow the Client-Server communication pattern or the Sender-Receiver communication pattern of the VFB but cannot be used for inter-ECU communication. The Basic Software Scheduler can internally use the IOC to cross the partition boundaries. See [\[24\]](#).

The following sections describe the use of some OS mechanisms that are designed for inter partition communication.

4.3.4.1 Inter partition data communication using IOC

The general idea to allow the data communication between partitions in a most efficient way and still be independent of the micro controller implementation is to take the buffers and queues from the intra partition communication case and replace them with so called IOC communication objects in the inter partition communication case.

In the ideal case, the access macros to the IOC communication object resolve to a direct access to shared memory.

The IOC (Inter OS-Application Communication) is a feature of the AUTOSAR OS, which provides a data oriented communication mechanism between partitions. The IOC provides communication buffers, queues, and protected access functions/macros to these buffers that can be used from any pre-configured partitions concurrently.

The IOC offers communication of data to another core or between memory protected partitions with guarantee of data consistency.

All data communications including the passing of parameters and return values in client server communication, can be implemented by using the IOC. The basic principle for using the IOC is to replace the RTE internal communication buffers by IOC buffers.

The IOC supports 1:1 and N:1 communication. For 1:N communication, N IOC communication objects have to be used. The IOC is configured and provides generated APIs for each IOC communication object. In case of N:1 communication, each sender has a separate API.

The IOC API is not reentrant.

[SWS_Rte_02737] [RTE shall prevent concurrent access to the same IOC API from different `ExecutableEntity execution-instances`.]()

The IOC will use the appropriate mechanism to communicate between the partitions, whether it requires communicating with another core, communicating with a partition with a different level of trust, or communicating with another memory partition.

The IOC channels are configured in the OS Configuration. Their configurations has to be provided as inputs for the RTE generator when the external configuration switch `strictConfigurationCheck` [SWS_Rte_05148] is set to true, and can be provided by the RTE Generator or RTE Configuration Editor when `strictConfigurationCheck` is set to false (see [SWS_Rte_05150]).

The IOC APIs use:

1. types declared by user on input to RTE (sender-receiver communication across OsApplication boundaries).
2. types created by RTE to collect client-server operation arguments into single data structure.

For the second item, RTE uses internal types that have to be described as `ImplementationDataTypes` (see [SWS_Rte_08400]).

The signaling between partitions is not covered by the IOC. The callbacks of IOC are in interrupt context and are mainly intended for direct use by BSW. For the signaling between partitions, RTE can use the activation of tasks or setting of events, see section 4.3.4.4.

[SWS_Rte_02736] [The RTE shall not execute `ExecutableEntities` in the context of IOC callbacks.]()

This is necessary to ensure that `ExecutableEntities` will not be executed in interrupt context or when a partition is terminated or restarted.

4.3.4.2 Inter partition data communication using Basic Software Scheduler

The Basic Software Scheduler provides Sender-Receiver and Client-Server communications mechanisms for communication between Basic Software Modules in different

partitions. Therefore these communication paradigms can be used by Basic Software Modules in a multi core environment.

The usage is described in [9].

For Sender-Receiver communication currently only "explicit" transmission of data elements with "event" semantic (queued) is supported.

[SWS_Rte_08763] [For inter-ECU Sender-Receiver communication the length of the queue is specified by the attribute `queueLength` of the `BswQueuedDataReceptionPolicy` which references through `receivedData` the `VariableDataProtocol` of the Sender-Receiver communication.]([SRS_Rte_00243](#))

[SWS_Rte_08764] [The RTE generator shall reject a `queueLength` attribute of a `BswQueuedDataReceptionPolicy` with a queue length ≤ 0 .]([SRS_Rte_00243](#))

4.3.4.3 Accessing (Ld)Com and Det in multicore/multipartition configuration

In a multi-core ECU it might be possible for a software component to send data to another ECU via the communication stack which might be located in a different partition than the sending software component. Likewise, Det might have to be called but is located in a different partition.

For LdCom and Det different approaches for the Rte are possible:

1. It is assumed that LdCom and Det can be called from everywhere—they are in every partition—in case shared buffer is available for the ECU.
2. **LdCom and Det are called via a `trusted function call`.**
It is assumed they can be called from each core, but they are in different partitions. In this case, the LdCom or Det are in a trusted `OsApplication`. This approach requires an MPU configuration.
3. **LdCom and Det are only in one partition.**
Here, the Rte could first transmit the data to the LdCom partition and then calls the required LdCom APIs in the context of the LdCom partition e.g. via an `OsTask`.

The following scenarios are possible for inter-ECU communication in sending direction:

1. **The data producer and the COM instance responsible for the signal related to this data are in different partitions on different cores.**
The RTE has to transmit the data to the COM instance's partition. It can use the IOC to do so. There it has to pass the data to COM using the COM APIs. One option is to call the COM APIs on each data production. In cases where the data production rate is bursty or higher than the COM TX frequency, this leads to high resource consumption. To reduce the load the COM instance offers to configure a transmission preparation callback (`Rte_COMCbkTxPrep_mn`), which

it calls just before it starts signal evaluation and handing over the data to PduR. The RTE can call the COM APIs from there if new data is available.

2. **The data producer and the COM instance responsible for the signal related to this data are in different partitions on the same core.**

The RTE can use the same mechanisms as above. It could also use a [trusted function call](#) (see section 4.3.4.5) to call the COM APIs.

3. **The data producer and the COM instance responsible for the signal related to this data are in the same partition.**

The RTE can call the COM APIs directly. But it can also use the transmission preparation callback ([Rte_COMCbktTxPrep_mn](#)) for runtime optimization.

The following scenarios are possible for inter-ECU communication in receiving direction:

1. **The data consumer and the COM instance responsible for the signal related to this data are in different partitions on different cores.**

The RTE can be informed via the notification callback ([Rte_COMCbksn/Rte_COMCbks_g](#)) about the reception of the signal or signal group. This callback is called by the COM instance responsible for this signal or signal group. If [ComIPduSignalProcessing](#) is configured to DEFERRED, the notification callback is called by the related [ComMainFunctionRx](#) (see [SWS_Com_00301]). If [ComIPduSignalProcessing](#) is configured to IMMEDIATE the notification callback is called by the related [Com_RxIndication](#) from COM instance's partition (see [SWS_Com_00300]). The RTE can call the COM APIs to receive the signal data directly in the callback. It can then use the IOC to pass the data into the consumer's partition.

2. **The data consumer and the COM instance responsible for the signal related to this data are in different partitions on the same core.**

The RTE can use the same mechanism as above. It could also use a [trusted function call](#) (see section 4.3.4.5) to call the COM APIs from arbitrary positions in the data consumer's partition.

3. **The data consumer and the COM instance responsible for the signal related to this data are in the same partition.**

The RTE can call the COM APIs directly from arbitrary positions in the data consumer's partition. But it can also use the COM notification callback ([Rte_COMCbksn/Rte_COMCbks_g](#)) for runtime optimization.

4.3.4.4 Signaling and control flow support for inter partition communication

The OS representation of a partition is an OS Application.

This is a (non-exhaustive) summary of OS features that can be used for signaling and control flow across partition boundaries:

- activation of tasks
- start and stop of schedule tables
- event signaling
- alarms
- spin locks (for inter core synchronization)

The following are not available for inter core signaling:

- OS Resource
- DisableAllInterrupts

For inter core synchronization, spin locks are provided. But, for efficiency reasons they should be used with care.

4.3.4.5 Trusted Functions

The call-trusted-function mechanism of AUTOSAR OS can be used in a memory protected controller to implement a function call from a trusted or untrusted to a trusted partition on the same core.

Beware that this mechanism can not be used between two untrusted partitions or between cores. Also note that because of uncertainties in SWS_OS there might be differing implementations of trusted functions amongst OS vendors. The resulting possible constraints on certain properties or capabilities have to be considered carefully by the integrator before deciding to make use of trusted functions.

The trusted functions are configured in the OS Configuration. Their configurations shall be provided as inputs for the RTE generator when the external configuration switch `strictConfigurationCheck` [SWS_Rte_05148] is set to true, and can be provided by the RTE Generator or RTE Configuration Editor when `strictConfigurationCheck` is set to false (see [SWS_Rte_05150]).

[SWS_Rte_08903] [The RTE Generator shall use a trusted function to call an `ExecutableEntity` of a `RteSwComponentInstance` or `RteBswModuleInstance` of a different partition than the `ExecutableEntity`'s call context (`OsTask`, `OsIsr` or RTE API) when both partitions are on the same core.] (SRS_Rte_00036, SRS_Rte_00018)

Please note that the word "use" in the requirement above means that the RTE has to use the OS mechanism of a trusted function call and has to implement the used trusted function. In case `strictConfigurationCheck` is set to `FALSE` it additionally has to configure the used trusted function in the OS.

Note that it is not strictly necessary to use a dedicated trusted function per `ExecutableEntity` callpoint. An RTE implementation could also decide to use the same trusted function for many callpoints of the same `ExecutableEntity` or even the same trusted function for multiple `ExecutableEntity`s. This could especially be used to reduce the runtime overhead in cases where multiple `ExecutableEntity`s of the same partition are executed in a row. As the complete callpoint is moved into the trusted function, also the VFB Tracing hooks have to be executed there and potentially also related RTE implementation specific flag manipulation (e.g. for `Rte_IsUpdated`) or implicit buffering code.

[SWS_Rte_07606] [Direct start of an `ExecutableEntity` execution-instance by the mean of a trusted function shall only be used for the start of an `ExecutableEntity` in a Trusted Partition.] ([SRS_Rte_00195](#), [SRS_Rte_00210](#))

The OS ensures that the partition of the caller is not terminated or restarted when a trusted function is executed unless the termination of the partition calling the trusted function is caused by another TRUSTED partition. If needed, the termination or restart of the caller's partition is delayed after the trusted function returns.

RTE has to ensure, that the OS does not kill an RTE-generated task due to stopping or restarting a partition while this task is executing a function call to BSW or to the software component of another partition when this call is not a pure function.

For this purpose, RTE can use either the OS mechanism of trusted function call, or it can allocate the callee to a different task than the caller.

[SWS_Rte_02761] [In a partitioned system that supports stop or restart of partitions, the RTE shall not use a direct function call (without use of OS call trusted function) from a task of an untrusted partition to BSW or to the SW-C of another partition.] ([SRS_Rte_00196](#))

Please note that [\[SWS_Rte_02761\]](#) might require the use of OS call trusted function for a partitioned system even without memory protection.

4.3.4.6 Memory Protection and Pointer Type Parameters in RTE API

In a memory protected ECU, a SW-C from an untrusted partition might misuse the transition to the trusted context to modify memory in another partition. This can occur when a pointer to a different memory partition is passed from the untrusted partition to the trusted context. The RTE shall avoid this misuse by at least checking the validity of the address of the pointer, and, where possible, also checking the integrity of the associated memory object.

[SWS_Rte_02752] [When a SW-C in an untrusted partition receives (OUT parameter) or provides (IN parameter with composite data type) an [ArgumentDataPrototype](#) or [VariableDataPrototype](#), it hands over a pointer to a memory object to an RTE API. The RTE shall only forward this pointer to a trusted SW-C after it has checked that the whole memory object is owned by the caller's partition.]([SRS_Rte_00210](#))

[SWS_Rte_02753] [When a SW-C in an untrusted partition passes an [ArgumentDataPrototype](#) or [VariableDataPrototype](#), as a reference type to a SW-C in a trusted partition (DATA_REFERENCE as an IN parameter), the RTE shall only check that the caller's partition owns the start address of the referenced memory.]([SRS_Rte_00210](#))

Note to [\[SWS_Rte_02753\]](#): The RTE only checks whether the start address referenced directly by the [DataPrototypes](#) belongs to the calling partition. Because the RTE is not aware of the semantic of the pointed reference, it cannot check if the referenced object is completely contained in the calling partition (e.g. the RTE does not know the size and does not know if the referenced object also contains references to other objects). The BSW is responsible to make sure that the referenced memory object does not cross memory section boundaries.

The OS API `CheckTaskMemoryAccess` can be used to fulfill [\[SWS_Rte_02752\]](#) and [\[SWS_Rte_02753\]](#).

4.3.5 PortInterface Element Mapping and Data Conversion

AUTOSAR supports the connection of an R-port to a P-port with an interface that is not compatible in the sense of the AUTOSAR compatibility rules. In addition, for sender-receiver communication it is possible to specify how data elements are represented given that the communication requires the usage of a dedicated communication bus. In these cases the generated RTE has to support the conversion and re-scaling of data.

4.3.5.1 PortInterface Element Mapping

Per default the [shortNames](#) of [PortInterface](#) elements are used to identify the matching element pairs of connected ports. In case of non fitting names — might be caused due to distributed development, off-the-shelf development, or re-use of software components — it is required to explicitly specify which [PortInterface](#) elements shall correlate. This is modelled with [PortInterfaceMappings](#). A connection of two ports can be associated with a set of [PortInterfaceMappings](#). If two ports are connected and a [PortInterfaceMapping](#) for the pair of interfaces of the two ports is associated with the connection, the interface elements are mapped and converted as specified in the [PortInterfaceMapping](#). If no [PortInterfaceMapping](#) for the respective pair of interfaces is associated with the connection, the ordinary interface compatibility rules are applied.

The general approach is to perform the data conversion in the RTE of the ECU implementing the R-port. The reason for this design decision is that in case of 1:n sender-receiver communication it is inefficient to perform all the data conversions for the multiple receivers on the sender side and then send multiple sets of the same data just in different representations over the communication bus.

[SWS_Rte_03815] [The RTE shall support the mapping of sender-receiver interfaces, parameter interfaces, non-volatile data interface elements, and `NvBlockDescriptors`.] ([SRS_Rte_00182](#))

[SWS_Rte_03816] [If a P-port specified by a `SenderReceiverInterface` or `NvDataInterface` is connected to an R-port with an incompatible interface and a `VariableAndParameterInterfaceMapping` for both interfaces is associated with the connection, the RTE of the ECU implementing the R-port shall map and convert the data elements of the sender's interface to the data elements of the receiver's interface.] ([SRS_Rte_00182](#))

[SWS_Rte_07091] [The RTE shall support the *Mapping of elements of composite data types* in the context of a mapping of `SenderReceiverInterface`, `NvDataInterface` or `ParameterInterface` elements.] ([SRS_Rte_00182](#), [SRS_Rte_00234](#))

[SWS_Rte_07092] [The RTE of the ECU implementing the R-port shall map and convert the composite data type elements of `DataPrototypes` of the sender's interface to the composite data type elements of `DataPrototypes` of the receiver's interface according the `SubElementMapping`

if a P-port specified by a `SenderReceiverInterface`, `NvDataInterface` or `ParameterInterface` is connected to an R-port with an incompatible interface and a `VariableAndParameterInterfaceMapping` exists for both interfaces and is associated with the connection and

the `SubElementMapping` maps composite data type elements of the provided interface to composite data type elements of the required interface.] ([SRS_Rte_00182](#), [SRS_Rte_00234](#))

[SWS_Rte_07099] [The RTE of the ECU implementing the R-port shall map and convert the composite data type elements of `DataPrototype` of the sender's interface to the primitive `DataPrototype` of the receiver's interface according the `SubElementMapping`

if a P-port specified by a `SenderReceiverInterface`, `NvDataInterface` or `ParameterInterface` is connected to a R-port with an incompatible interface and a `VariableAndParameterInterfaceMapping` exists for both interfaces and is associated with the connection and the `SubElementMapping` exclusively maps one composite data type element of the provided interface] ([SRS_Rte_00182](#), [SRS_Rte_00234](#))

According to [TPS_SWCT_01551], incomplete `SubElementMappings` are allowed for unqueued communication, when unmapped `dataElements` on the receiver side have an `initValue`.

Please note that the [DataPrototypes](#) of the provide port and [DataPrototypes](#) of the require port might use exclusively [ApplicationDataTypes](#), exclusively [ImplementationDataTypes](#) or both kinds of [AutosarDataTypes](#) in a mixed manner.

[SWS_Rte_02307] [The RTE generator shall reject configurations that violate [constr_1300].]()

[SWS_Rte_03817] [If a P-port specified by a [SenderReceiverInterface](#) or [NvDataInterface](#) is connected to an R-port with an incompatible interface and no [VariableAndParameterInterfaceMapping](#) for this pair of interfaces is associated with the connection, the RTE generator shall reject the input as an invalid configuration.]([SRS_Rte_00182](#), [SRS_Rte_00018](#))

[SWS_Rte_03818] [The RTE shall support the mapping of client-server interface elements.]([SRS_Rte_00182](#))

[SWS_Rte_03819] [If a P-port specified by a [ClientServerInterface](#) is connected to an R-port with an incompatible interface and a [ClientServerInterfaceMapping](#) for both interfaces is associated with the connection, the RTE of the ECU implementing the R-port, i. e. the client, shall map the operation and map and convert the operation arguments of the client's interface to the operation arguments of the server's interface.]([SRS_Rte_00182](#))

[SWS_Rte_07925] [If a [ClientServerApplicationErrorMapping](#) exists, the RTE shall translate the error codes of the server into the corresponding error codes described by the mapping.]([SRS_Rte_00182](#), [SRS_Rte_00123](#))

[SWS_Rte_07926] [If a [ClientServerApplicationErrorMapping](#) exists and a particular error of the server is not mapped, this error shall be translated to RTE_E_OK.]([SRS_Rte_00182](#), [SRS_Rte_00123](#))

[SWS_Rte_03820] [If a P-port specified by a [ClientServerInterface](#) is connected to an R-port with an incompatible interface and no [ClientServerInterfaceMapping](#) for this pair of interfaces is associated with the connection, the RTE generator shall reject the input as an invalid configuration.]([SRS_Rte_00182](#), [SRS_Rte_00018](#))

[SWS_Rte_03821] [The RTE shall support the mapping of [ModeSwitchInterface](#) elements.]([SRS_Rte_00182](#))

[SWS_Rte_03822] [If a P-port specified by a [ModeSwitchInterface](#) is connected to an R-port with an incompatible interface and a [ModeInterfaceMapping](#) for both interfaces is associated with the connection, the RTE of the ECU implementing the R-port shall map and convert the mode elements of the sender's interface to the mode elements of the receiver's interface.]([SRS_Rte_00182](#))

[SWS_Rte_03823] [If a P-port specified by a [ModeSwitchInterface](#) is connected to an R-port with an incompatible interface and no [ModeInterfaceMapping](#) for this pair of interfaces is associated with the connection, the RTE generator shall reject the input as an invalid configuration.]([SRS_Rte_00182](#), [SRS_Rte_00018](#))

[SWS_Rte_03824] [The RTE shall support the mapping of trigger interface elements.]
()

[SWS_Rte_03825] [If a P-port specified by a [TriggerInterface](#) is connected to an R-port with an incompatible interface and a [TriggerInterfaceMapping](#) for both interfaces is associated with the connection, the RTE of the ECU implementing the R-port shall map the trigger of the sender's interface to the trigger of the receiver's interface.]()

[SWS_Rte_03826] [If a P-port specified by a [TriggerInterface](#) is connected to an R-port with an incompatible interface and no [TriggerInterfaceMapping](#) for this pair of interfaces is associated with the connection, the RTE generator shall reject the input as an invalid configuration.]([SRS_Rte_00018](#))

[SWS_Rte_03875] [If a [PPortPrototype](#) specified by a [NvDataInterface](#) is mapped to a [NvBlockDescriptor.ramBlock](#) and the respective [NvBlock-DataMapping](#) defines a mapping of bitfields (see [TPS_SWCT_01799]), the RTE shall convert the data element of the [NvBlockDescriptor.ramBlock](#) to the data element of the [NvDataInterface](#).]([SRS_Rte_00018](#))

[SWS_Rte_03876] [If an [RPortPrototype](#) specified by a [NvDataInterface](#) is mapped to a [NvBlockDescriptor.ramBlock](#) and the respective [NvBlock-DataMapping](#) defines a mapping of bitfields (see [TPS_SWCT_01799]), the RTE shall convert the data element of the [NvDataInterface](#) to the data element of the [NvBlockDescriptor.ramBlock](#).]([SRS_Rte_00018](#))

[SWS_Rte_03877] [If a [PRPortPrototype](#) specified by a [NvDataInterface](#) is mapped to a [NvBlockDescriptor.ramBlock](#) and the respective [NvBlock-DataMapping](#) defines a mapping of bitfields (see [TPS_SWCT_01799]), the RTE shall convert the data element of the [NvBlockDescriptor.ramBlock](#) to the data element of the [NvDataInterface](#), and convert the data element of the [NvDataInterface](#) to the data element of [NvBlockDescriptor.ramBlock](#).]([SRS_Rte_00018](#))

In order to generate the RTE for the ECU implementing the R-ports, the RTE generator has to know the interfaces of the P-ports that are connected over the bus. This information is provided in the ECU extract via the [networkRepresentationProps](#) (see section 4.3.6) specified at the [ISignal](#) representing the data element.

4.3.6 Network Representation

The [networkRepresentationProps](#) and [physicalProps](#) specified at the [ISignal](#) respectively [SystemSignal](#), describing the representation of the data element on the communication bus via the attributes [baseType](#) and [compuMethod](#), are where the RTE finds the network representation to be considered for conversions and transformations. Other places like ComSpecs or the PortInterfaces of the [outerPorts](#) (except the special case of conversion with data transformation, see chapter 4.3.6.2) are not relevant for the RTE. However, the [outerPorts](#) and potentially existing [Port-InterfaceMappings](#) at the [DelegationSwConnectors](#) referencing them still have

to be considered by the RTE to find the communication graph from/to the communication element (e.g. a `VariableDataPrototype`) of the `innerPort` to/from the related bus signal(s). It is also important to note that at the time of the RTE generation phase an Inter-ECU communication will always involve an `outerPort` and never connect an `innerPort` to a `SystemSignal(Group)` directly (see System Template [8], chapter "External Communication"). The potentially existing `senderToSignalTextTableMappings` or `signalToReceiverTextTableMappings` related to a `SystemSignal(Group)` have to be considered for the conversion.

4.3.6.1 Network Representation with no data transformation

For sender-receiver communication where no data transformation applies, it is possible to specify how data elements are represented given that the communication requires the usage of a dedicated communication bus. For this purpose `networkRepresentationProps` and `physicalProps` can be specified at the `ISignal` respectively `SystemSignal`, describing the representation of the data element on the communication bus via the attributes `baseType` and `compuMethod`.

[SWS_Rte_07842] [The RTE generator shall reject any input that violates [TPS_SYST_02001] as an invalid configuration.] (*SRS_Rte_00018*)

[SWS_Rte_03827] [The RTE of the transmitting ECU shall perform the conversion of the data element that has to be sent over a communication bus to the representation specified by the `baseType` of the `networkRepresentationProps` of the `ISignal` and the `compuMethod` of the `physicalProps` of the respective `SystemSignal` if the `dataPolicy` of the `ISignal` is not set to `transformingISignal`.] (*SRS_Rte_00181*)

[SWS_Rte_03828] [The RTE of the receiving ECU shall perform the conversion of the data element that is received over a communication bus from the representation specified by the `baseType` of the `networkRepresentationProps` of the `ISignal` and the `compuMethod` of the `physicalProps` of the respective `SystemSignal` to the data element's application data type if the `dataPolicy` of the `ISignal` is not set to `transformingISignal`. In this case [SWS_Rte_03816] shall not be applied.] (*SRS_Rte_00181*)

4.3.6.2 Network Representation with data transformation

For sender-receiver communication where data transformation applies, it is possible, to specify how data elements are represented given that the communication requires the usage of a dedicated communication bus. For this purpose `ISignal.TransformationISignalProps`. `DataPrototypeTransformationProps.networkRepresentationProps` can be specified describing the representation of the data element on the communication bus via the attributes `baseType` and `compuMethod`.

[SWS_Rte_04536] [The RTE of the transmitting ECU shall perform the conversion of each primitive element, which belongs to the data to be transformed and sent over a communication bus to the representation specified by the `baseType` and `computeMethod` of the `ISignal.TransformationISignalProps`. `DataPrototypeTransformationProps.networkRepresentationProps` for the respective primitive element, if the `dataTypePolicy` of the `ISignal` is set to `transformingISignal`. The converted data shall be passed to the first transformer in the chain.]([SRS_Rte_00181](#))

[SWS_Rte_04538] [The RTE of the receiving ECU shall pass the data received over a communication bus to the retransformers and then perform the conversion of each primitive element from the representation specified by the `baseType` and the `computeMethod` of the `ISignal.TransformationISignalProps`. `DataPrototypeTransformationProps.networkRepresentationProps`, if the `dataTypePolicy` of the `ISignal` is set to `transformingISignal`.]([SRS_Rte_00181](#))

4.3.7 Data Conversion

[SWS_Rte_03829] [The RTE shall support the conversion of an identical or linear scaled data representation to another identical or linear scaled data representation. In this context, the term "linear scaled data representation" also includes floating-point data representations.]([SRS_Rte_00182](#))

Please note that AUTOSAR supports configurations where the initial value is determined from the sender side. In such case the data conversion is also applicable for the initial values.

[SWS_Rte_08801] [The RTE shall support the conversion integer-to-float and float-to-integer. It is recommended to consider implication of MISRA-C rule 10.3, in particular, the requirement for no implicit conversion.]([SRS_Rte_00182](#))

Today the RTE Specification does not define any specific behavior supporting float to integer and integer to float conversions. This enables the RTE implementers to develop the most efficient, stable and robust solution.

[SWS_Rte_03830] [The RTE shall support the conversion of a texttable data representation (enumeration or bitfield) to another texttable data representation.]([SRS_Rte_00182](#))

[SWS_Rte_03855] [The RTE shall support the conversion of a mixed linear scaled and texttable data representation to another mixed linear scaled and texttable data representation.]([SRS_Rte_00182](#))

[SWS_Rte_03856] [The RTE shall support the conversion between a texttable data representation (enumeration) and a mixed linear scaled and texttable data representation. In this case only the enumeration part of the data representation shall be converted, the linear scaled part shall be handled as out of range data.]([SRS_Rte_00182](#))

[SWS_Rte_03857] [The RTE shall support the conversion between an identical or linear scaled data representation and a mixed linear scaled and texttable data representation. A scale with a [compuConst](#) shall be handled as out of range data if the mapping to a value is not defined by a [TextTableMapping](#).] ([SRS_Rte_00182](#))

[SWS_Rte_03860] [The RTE shall support the conversion of composite data representations. In this case, the respective requirements [\[SWS_Rte_03829\]](#), [\[SWS_Rte_03830\]](#), [\[SWS_Rte_03855\]](#), [\[SWS_Rte_03856\]](#), [\[SWS_Rte_03857\]](#), [\[SWS_Rte_03831\]](#), [\[SWS_Rte_03832\]](#), and [\[SWS_Rte_03833\]](#) are applicable to the individual composite elements.] ([SRS_Rte_00182](#))

[SWS_Rte_03831] [The RTE generator shall reject any input that requires a conversion which is not supported according to [\[SWS_Rte_03829\]](#), [\[SWS_Rte_03830\]](#), [\[SWS_Rte_03855\]](#), [\[SWS_Rte_03856\]](#), or [\[SWS_Rte_03860\]](#) as an invalid configuration.] ([SRS_Rte_00182](#), [SRS_Rte_00018](#))

[SWS_Rte_07928] [The data conversion shall be supported for data types that refer to [CompuMethods](#) of category `LINEAR`, `IDENTICAL`, `SCALE_LINEAR_AND_TEXTTABLE`, `TEXTTABLE`, `BITFIELD_TEXTTABLE` and [CompuMethods](#) of category `RAT_FUNC` with a reciprocal linear data scaling.] ([SRS_Rte_00182](#))

Note: The definition of a reciprocal linear data scaling is given in Software Component Template [2], [\[TPS_SWCT_01550\]](#)

[SWS_Rte_03832] [For the conversion between two data representations with linear scaling described either by an [ApplicationDataType](#) or a combination of [BaseType](#) and [CompuMethod](#) (used for the specification of the network representation at the `ComSpec` respectively the [SystemSignal](#)) the RTE generator shall derive the data conversion code automatically from the referred [CompuMethods](#) of the two representations. In this context the scaling of a data representation is linear if the referred [CompuMethod](#) is of category `IDENTICAL`, `LINEAR`, `RAT_FUNC` or `SCALE_LINEAR_AND_TEXTTABLE`. In case of a [CompuMethod](#) of category `SCALE_LINEAR_AND_TEXTTABLE` this requirement applies to the linear scaled part only.] ([SRS_Rte_00182](#))

For a linear conversion the linear conversion factor can be calculated out of the [factorSiToUnit](#) and [offsetSiToUnit](#) attributes of the referred [Units](#) and the [CompuRationalCoeffs](#) of a [compuInternalToPhys](#) of the referred [CompuMethods](#).

Further information about Linear Data Scaling is given in document Software Component Template [2].

Example 4.10

A software component `SwcA` on an ECU `EcuA` sends a data element `u` of a `uint16` type `t_VoltageAtSender` via its port `SenderPort`. The referenced [CompuMethod](#) is `cm_VoltageAtSender`, describing a fixpoint representation with offset 0 and LSB

$\frac{1}{4} = 2^{-2}$. The port `SenderPort` is connected to the port `ReceiverPort` of a software component `SwcB` that is deployed on a different ECU `EcuB`. The sent data element `u` is mapped to a data element `u` of a uint16 type `t_VoltageAtReceiver` on the receiving side that references a [CompuMethod](#) named `cm_VoltageAtReceiver`. `cm_VoltageAtReceiver` describes a fixpoint representation with offset $\frac{16}{8} = 2$ and LSB $\frac{1}{8} = 2^{-3}$. For transportation over the bus a `networkRepresentation` that references a uint8 type `t_VoltageOnNetwork` is specified, using a fixpoint representation described by the [CompuMethod](#) `cm_VoltageOnNetwork` with offset $\frac{1}{2} = 0.5$ and LSB $\frac{1}{2} = 2^{-1}$.

Definition of the [CompuMethods](#) in XML:

```
<COMPU-METHOD>
  <SHORT-NAME>cm_VoltageAtSender</SHORT-NAME>
  <CATEGORY>LINEAR</CATEGORY>
  <COMPU-INTERNAL-TO-PHYS>
    <COMPU-SCALES>
      <COMPU-SCALE>
        <COMPU-RATIONAL-COEFFS>
          <COMPU-NUMERATOR><V>0</V><V>1</V></COMPU-NUMERATOR>
          <COMPU-DENOMINATOR><V>4</V></COMPU-DENOMINATOR>
        </COMPU-RATIONAL-COEFFS>
      </COMPU-SCALE>
    </COMPU-SCALES>
  </COMPU-INTERNAL-TO-PHYS>
</COMPU-METHOD>

<COMPU-METHOD>
  <SHORT-NAME>cm_VoltageAtReceiver</SHORT-NAME>
  <CATEGORY>LINEAR</CATEGORY>
  <COMPU-INTERNAL-TO-PHYS>
    <COMPU-SCALES>
      <COMPU-SCALE>
        <COMPU-RATIONAL-COEFFS>
          <COMPU-NUMERATOR><V>16</V><V>1</V></COMPU-NUMERATOR>
          <COMPU-DENOMINATOR><V>8</V></COMPU-DENOMINATOR>
        </COMPU-RATIONAL-COEFFS>
      </COMPU-SCALE>
    </COMPU-SCALES>
  </COMPU-INTERNAL-TO-PHYS>
</COMPU-METHOD>

<COMPU-METHOD>
  <SHORT-NAME>cm_VoltageOnNetwork</SHORT-NAME>
  <CATEGORY>LINEAR</CATEGORY>
  <COMPU-INTERNAL-TO-PHYS>
    <COMPU-SCALES>
      <COMPU-SCALE>
        <COMPU-RATIONAL-COEFFS>
          <COMPU-NUMERATOR><V>1</V><V>1</V></COMPU-NUMERATOR>
          <COMPU-DENOMINATOR><V>2</V></COMPU-DENOMINATOR>
        </COMPU-RATIONAL-COEFFS>
      </COMPU-SCALE>
    </COMPU-SCALES>
  </COMPU-INTERNAL-TO-PHYS>
</COMPU-METHOD>
```

</COMPU-METHOD>

Implementation of `Rte_Send` on the sending ECU `EcuA`:

```

1 Std_ReturnType
2 Rte_Send_SwcA_SenderPort_u(t_voltageAtSender u)
3 {
4     ...
5     /*
6     u_NetworkRepresentation
7     = ((u * LSB_sender + off_sender) - off_network) / LSB_network
8     = ((u / 4          + 0          ) - 0.5          ) * 2
9     = (u / 2          ) - 1
10    */
11    u_NetworkRepresentation = (uint8) ((u >> 1) - 1);
12    ...
13 }
```

Implementation of `Rte_Receive` on the receiving ECU `EcuB`:

```

1 Std_ReturnType
2 Rte_Receive_SwcB_ReceiverPort_u(t_voltageAtReceiver * u)
3 {
4     ...
5     /*
6     *u
7     *u = ((u_NetworkRepresentation * LSB_network + off_network)
8           - off_receiver) / LSB_receiver
9           = ((u_NetworkRepresentation / 2          + 0.5          )
10              - 2          ) * 8
11           = (u_NetworkRepresentation * 4          + 4          )
12              - 16
13           = u_NetworkRepresentation * 4          - 12
14     */
15     *u = (uint16) ((u_NetworkRepresentation << 2) - 12);
16     ...
17 }
```

Following examples show possible implementations for a table conversion where `DataPrototypes` with a `CompuMethod` of category `BITFIELD_TEXTTABLE` are involved.

Example 4.11

Conversion between a `DataPrototype` with a `CompuMethod` of category `TEXT-TABLE` (in this case describing a Boolean) and a `DataPrototype` with a `CompuMethod` of category `BITFIELD_TEXTTABLE`:

Definition of the `TextTableMapping` in XML:

```

<PORT-INTERFACE-MAPPING-SET>
  <SHORT-NAME>PortMappingSet</SHORT-NAME>
  <PORT-INTERFACE-MAPPINGS>
    <VARIABLE-AND-PARAMETER-INTERFACE-MAPPING>
      <SHORT-NAME>Mapping_LDW_BF</SHORT-NAME>
```

```

<DATA-MAPPINGS>
  <DATA-PROTOTYPE-MAPPING>
    <FIRST-DATA-PROTOTYPE-REF DEST="VARIABLE-DATA-PROTOTYPE">
      /Example/Interfaces/One/LDW
    </FIRST-DATA-PROTOTYPE-REF>
    <SECOND-DATA-PROTOTYPE-REF DEST="VARIABLE-DATA-PROTOTYPE">
      /Example/Interfaces/Two/bitfield
    </SECOND-DATA-PROTOTYPE-REF>
    <TEXT-TABLE-MAPPINGS>
      <TEXT-TABLE-MAPPING>
        <IDENTICAL-MAPPING>false</IDENTICAL-MAPPING>
        <MAPPING-DIRECTION>bidirectional</MAPPING-DIRECTION>
        <BITFIELD-TEXTTABLE-MASK-SECOND>
          0b000000100
        </BITFIELD-TEXTTABLE-MASK-SECOND>
        <VALUE-PAIRS>
          <TEXT-TABLE-VALUE-PAIR>
            <FIRST-VALUE>0</FIRST-VALUE>
            <SECOND-VALUE>0</SECOND-VALUE>
          </TEXT-TABLE-VALUE-PAIR>
          <TEXT-TABLE-VALUE-PAIR>
            <FIRST-VALUE>1</FIRST-VALUE>
            <SECOND-VALUE>4</SECOND-VALUE>
          </TEXT-TABLE-VALUE-PAIR>
        </VALUE-PAIRS>
      </TEXT-TABLE-MAPPING>
    </TEXT-TABLE-MAPPINGS>
  </DATA-PROTOTYPE-MAPPING>
</DATA-MAPPINGS>
</VARIABLE-AND-PARAMETER-INTERFACE-MAPPING>
</PORT-INTERFACE-MAPPINGS>
</PORT-INTERFACE-MAPPING-SET>

```

C code for Implementation of [Rte_Write](#):

```

1 Std_ReturnType Rte_Write_<p>_<o>(boolean v) {
2   /* fetch the bit field from the RAM Block */
3   uint32 *bitfield = Rte_RamBlk_<BlkNr>.bitfield;
4   /* data consistency block on */
5   /* bit operation (masking & conversion) - bit position 6 is deduced
6    from BITFIELD-TEXTTABLE-MASK-SECOND */
7   if(v == 0) Bfx_ClrBit_u8u8(*bitfield, 6);
8   else Bfx_SetBit_u8u8(*bitfield, 6);
9   /* data consistency block off */
10  }

```

C code for Implementation of [Rte_Read](#):

```

1 Std_ReturnType Rte_Read_<p>_<o>(boolean *v) {
2   /* fetch the bit field from the RAM Block */
3   uint32 bitfield = Rte_RamBlk_<BlkNr>.bitfield;
4   /* bit operation (masking & conversion) - bit position 6 is deduced
5    from BITFIELD-TEXTTABLE-MASK-SECOND */
6   *v = Bfx_GetBit_u8u8u8(bitfield, 6);
7   }

```


Strategies how to handle the conversion of values that are out of range of the target representation are described in section 4.3.8.

[SWS_Rte_03833] [For the conversion between two texttable data representations (enumerations or bitfields) described either by an [ApplicationDataType](#) or an [ImplementationDataType](#) (used for the specification of the network representation) the RTE generator shall generate the data conversion code according to the [Text-TableMapping](#). This requirement also applies to the texttable part of a mixed linear scaled and texttable data representation.] ([SRS_Rte_00182](#))

4.3.8 Range Checks during Runtime

A software component might try to send a value that is outside the range that is specified at a [dataElement](#) or [ISignal](#). In case of different ranges the result of a data conversion might also be a value that is out of range of the target representation. For a safe handling of these use cases the RTE provides range checks during runtime. For an overview see figure 4.46.

[SWS_Rte_08024] [Range checks during runtime shall occur after data invalidation, i.e. first the [handleNeverReceived](#) check, then the invalidation check and lastly the range check shall be effected.] ([SRS_Rte_00180](#))

[SWS_Rte_03861] [The range check is intended to be performed according to the following rule: If a upper/lower limit is specified at the [DataConstr](#), this value shall be taken for the range check. If it is not specified at the [DataConstr](#), the highest/lowest representable value of the datatype shall be used.] ([SRS_Rte_00180](#))

Whether a range check is required is specified in case of intra ECU communication at the [handleOutOfRange](#) attribute of the respective [SenderComSpec](#) or [ReceiverComSpec](#) and in case of inter ECU communication at the [handleOutOfRange](#) attribute of [ISignalProps](#) of the sending or receiving [ISignal](#).

Range checks at sender's side

Range checks during runtime for intra ECU communication at the sender's side are described in the following requirements:

[SWS_Rte_08026] [The RTE shall implement a range check of sent data in the sending path of a particular component if the [handleOutOfRange](#) is defined at the [SenderComSpec](#) and has any value other than [none](#). In this case all receivers receive the value after the range check was applied.] ([SRS_Rte_00180](#))

[SWS_Rte_08039] [The RTE shall use the preceding limits ([\[SWS_Rte_07196\]](#)) from the [DataPrototype](#) in the [PPortPrototype](#) or [PRPortPrototype](#) for the range check of sent data in the sending path of a particular component if the [handleOutOfRange](#) is defined at the [SenderComSpec](#).] ([SRS_Rte_00180](#))

[SWS_Rte_03839] [If for a `dataElement` to be sent a `SenderComSpec` with `handleOutOfRange=ignore` is provided, a range check shall be implemented in the sending component. If the value is out of bounds, the sending of the `dataElement` shall not be propagated. This means for a non-queued communication that the last valid value will be propagated and for a queued communication that no value will be enqueued.

In case of a composite datatype the sending of the whole `dataElement` shall not be propagated, if any of the composite elements is out of bounds.]([SRS_Rte_00180](#))

[SWS_Rte_03840] [If for a `dataElement` to be sent a `SenderComSpec` with `handleOutOfRange=saturate` is provided, a range check shall be implemented in the sending component. If the value is out of bounds, the value actually sent shall be set to the lower respectively the upper limit.

In case of a composite datatype each composite element whose actual value is out of bounds shall be saturated.]([SRS_Rte_00180](#))

[SWS_Rte_03841] [If for a `dataElement` to be sent a `NonqueuedSenderComSpec` with `handleOutOfRange=default` is provided, a range check shall be implemented in the sending component. If the value is out of bounds and the `initValue` is not equal to the `invalidValue`, the value actually sent shall be set to the `initValue`.

In case of a composite datatype each composite element whose actual value is out of bounds shall be set to the `initValue`.]([SRS_Rte_00180](#))

[SWS_Rte_03842] [If for a `dataElement` to be sent a `NonqueuedSenderComSpec` with `handleOutOfRange=invalid` is provided, a range check shall be implemented in the sending component. If the value is out of bounds, the value actually sent shall be set to the `invalidValue`.

In case of a composite datatype each composite element whose actual value is out of bounds shall be set to the `invalidValue`.]([SRS_Rte_00180](#))

[SWS_Rte_03843] [If for a `dataElement` to be sent a `QueuedSenderComSpec` with `handleOutOfRange` set to `default` or `invalid` is provided, the RTE generator shall reject the input as an invalid configuration, since for a `QueuedSenderComSpec` the attribute `initValue` is not defined (see SW-C Template [2]) and data invalidation is not supported (see [\[SWS_Rte_06727\]](#)).]([SRS_Rte_00180](#))

Range checks during runtime for inter ECU communication at the sender's side are described in the following requirements:

[SWS_Rte_08027] [The RTE shall implement a range check of sent data in the sending path of a particular signal if the `handleOutOfRange` is defined at the `ISignalProps` and has any value other than `none`. In this case only receivers of the specific `ISignal` receive the value after the range check was applied.]([SRS_Rte_00180](#))

[SWS_Rte_08040] [The RTE shall use the limits from the `ISignal` for the range check of sent data in the sending path of a particular signal if the `handleOutOfRange` is defined at the `ISignalProps`.]([SRS_Rte_00180](#))

[SWS_Rte_08030] [If for an `ISignal` to be sent an `ISignalProps` with `handleOutOfRange=ignore` is provided, a range check shall be implemented in the sending signal. If the value is out of bounds, the sending of the `ISignal` shall not be propagated. In this case the RTE shall behave as if no sending occurred.]([SRS_Rte_00180](#))

[SWS_Rte_08031] [If for an `ISignal` to be sent an `ISignalProps` with `handleOutOfRange=saturate` is provided, a range check shall be implemented in the sending signal. If the value is out of bounds, the value actually sent shall be set to the lower respectively the upper limit.]([SRS_Rte_00180](#))

[SWS_Rte_08032] [If for an `ISignal` to be sent an `ISignalProps` with `handleOutOfRange=default` is provided, a range check shall be implemented in the sending signal. If the value is out of bounds and the `initValue` is not equal to the `invalidValue`, the value actually sent shall be set to the `initValue`.]([SRS_Rte_00180](#))

[SWS_Rte_08033] [If for an `ISignal` to be sent an `ISignalProps` with `handleOutOfRange=invalid` is provided, a range check shall be implemented in the sending signal. If the value is out of bounds, the value actually sent shall be set to the `invalidValue`.]([SRS_Rte_00180](#))

Range checks at receiver's side

Range checks during runtime for intra ECU communication at the receiver's side are described in the following requirements:

[SWS_Rte_08028] [The RTE shall implement a range check in the receiving path of a particular component if the `handleOutOfRange` is defined at the `ReceiverComSpec` and has any value other than `none`. In this case the range check applies only for data received by the particular component.]([SRS_Rte_00180](#))

[SWS_Rte_08041] [The RTE shall use the preceding limits ([\[SWS_Rte_07196\]](#)) from the `DataPrototype` in the `rPort` for the range check of received data in the receiving path of a particular component if the `handleOutOfRange` is defined at the `ReceiverComSpec`.]([SRS_Rte_00180](#))

[SWS_Rte_03845] [If for a `dataElement` to be received a `ReceiverComSpec` with `handleOutOfRange=ignore` is provided, a range check shall be implemented in the receiving component. If the value is out of bounds, the reception of the `dataElement` shall not be propagated. This means for a non-queued communication that the last valid value will be propagated and for a queued communication that no value will be enqueued.

If the value of the received `dataElement` is out of bounds and a `NonqueuedReceiverComSpec` with `handleOutOfRangeStatus=indicate` is provided, the return value of the RTE shall be `RTE_E_OUT_OF_RANGE`.

In case of a composite datatype the reception of the whole `dataElement` shall not be propagated, if any of the composite elements is out of bounds. If the `handleOutOfRangeStatus` attribute is set to `indicate`, the return value of the RTE shall be `RTE_E_OUT_OF_RANGE`.] (*SRS_Rte_00180*)

[SWS_Rte_03846] [If for a `dataElement` to be received a `ReceiverComSpec` with `handleOutOfRange=saturate` is provided, a range check shall be implemented in the receiving component. If the value is out of bounds, the value actually received shall be set to the lower respectively the upper limit.

If the value of the received `dataElement` is out of bounds and a `NonqueuedReceiverComSpec` with `handleOutOfRangeStatus=indicate` is provided, the return value of the RTE shall be `RTE_E_OUT_OF_RANGE`.

In case of a composite datatype each composite element whose actual value is out of bounds shall be saturated. If the `handleOutOfRangeStatus` attribute is set to `indicate`, the return value of the RTE shall be `RTE_E_OUT_OF_RANGE`, if any of the composite elements is out of bounds.] (*SRS_Rte_00180*)

[SWS_Rte_03847] [If for a `dataElement` to be received a `NonqueuedReceiverComSpec` with `handleOutOfRange=default` is provided, a range check shall be implemented in the receiving component. If the value is out of bounds and the `initValue` is not equal to the `invalidValue`, the value actually received shall be set to the `initValue`.

If the value of the received `dataElement` is out of bounds and a `NonqueuedReceiverComSpec` with `handleOutOfRangeStatus=indicate` is provided, the return value of the RTE shall be `RTE_E_OUT_OF_RANGE`.

In case of a composite datatype each composite element whose actual value is out of bounds shall be set to the `initValue`. If the `handleOutOfRangeStatus` attribute is set to `indicate`, the return value of the RTE shall be `RTE_E_OUT_OF_RANGE`, if any of the composite elements is out of bounds.] (*SRS_Rte_00180*)

[SWS_Rte_03848] [If for a `dataElement` to be received a `NonqueuedReceiverComSpec` with `handleOutOfRange=invalid` is provided, a range check shall be implemented in the receiving component. If the value is out of bounds, the value actually received shall be set to the `invalidValue`.

If the value of the received `dataElement` is out of bounds and a `ReceiverComSpec` with `handleOutOfRangeStatus=indicate` is provided, the return value of the RTE shall be `RTE_E_INVALID`.

In case of a composite datatype each composite element whose actual value is out of bounds shall be set to the `invalidValue`. If the `handleOutOfRangeStatus` attribute is set to `indicate`, the return value of the RTE shall be `RTE_E_INVALID`, if any of the composite elements is out of bounds.] (*SRS_Rte_00180*)

[SWS_Rte_08016] [If for a `dataElement` to be received a `ReceiverComSpec` with `handleOutOfRange=externalReplacement` is provided, a range check shall be

implemented in the receiving component. If the value is out of bounds, the value actually received shall be replaced by the value sourced from the `ReceiverComSpec.replaceWith` (e.g. constant, NVRAM parameter).

If the value of the received `dataElement` is out of bounds and a `NonqueuedReceiverComSpec` with `handleOutOfRangeStatus=indicate` is provided, the return value of the RTE shall be `RTE_E_OUT_OF_RANGE`.

In case of a composite datatype the value actually received shall be completely replaced by the external value, if any of the composite elements is out of bounds. If the `handleOutOfRangeStatus` attribute is set to `indicate`, the return value of the RTE shall be `RTE_E_OUT_OF_RANGE`.] ([SRS_Rte_00180](#))

[SWS_Rte_03849] [If for a `dataElement` to be received a `QueuedReceiverComSpec` with `handleOutOfRange` set to `default` or `invalid` is provided, the RTE generator shall reject the input as an invalid configuration, since for a `QueuedReceiverComSpec` the attribute `initValue` is not defined (see SW-C Template [2]) and data invalidation is not supported (see [\[SWS_Rte_06727\]](#)).] ([SRS_Rte_00180](#))

[SWS_Rte_08025] [If for a `dataElement` to be received a `QueuedReceiverComSpec` is provided and the `handleOutOfRangeStatus` attribute is set to `indicate`, the RTE generator shall reject the input as an invalid configuration.] ([SRS_Rte_00180](#))

Range checks during runtime for inter ECU communication at the receiver's side are described in the following requirements:

[SWS_Rte_08029] [The RTE shall implement a range check in the receiving path of a particular signal if the `handleOutOfRange` is defined at the `ISignalProps` and has any value other than `none`. In this case all receivers of the specific `ISignal` on that ECU receive the value after the range check was applied.] ([SRS_Rte_00180](#))

[SWS_Rte_08042] [The RTE shall use the limits from the `ISignal` for the range check of received data in the receiving path of a particular signal if the `handleOutOfRange` is defined at the `ISignalProps`.] ([SRS_Rte_00180](#))

[SWS_Rte_08034] [If for an `ISignal` to be received an `ISignalProps` with `handleOutOfRange=ignore` is provided, a range check shall be implemented in the receiving signal. If the value is out of bounds, the reception of the `ISignal` shall not be propagated. In this case the RTE shall behave as if no reception occurred.] ([SRS_Rte_00180](#))

[SWS_Rte_08035] [If for an `ISignal` to be received an `ISignalProps` with `handleOutOfRange=saturate` is provided, a range check shall be implemented in the receiving signal. If the value is out of bounds, the value actually received shall be set to the lower respectively the upper limit.] ([SRS_Rte_00180](#))

[SWS_Rte_08036] [If for an `ISignal` to be received an `ISignalProps` with `handleOutOfRange=default` is provided, a range check shall be implemented in the receiving signal. If the value is out of bounds and the `initValue` is not equal to the `invalidValue`, the value actually received shall be set to the `initValue`.] ([SRS_Rte_00180](#))

[SWS_Rte_08037] [If for an `ISignal` to be received an `ISignalProps` with `handleOutOfRange=invalid` is provided, a range check shall be implemented in the receiving signal. If the value is out of bounds, the value actually received shall be set to the `invalidValue`.] ([SRS_Rte_00180](#))

[SWS_Rte_08038] [If for an `ISignal` to be received an `ISignalProps` with `handleOutOfRange=externalReplacement` is provided, a range check shall be implemented in the receiving signal. If the value is out of bounds, the value actually received shall be replaced by the value sourced from the `ReceiverComSpec.replaceWith` (e.g. constant, NVRAM parameter).] ([SRS_Rte_00180](#))

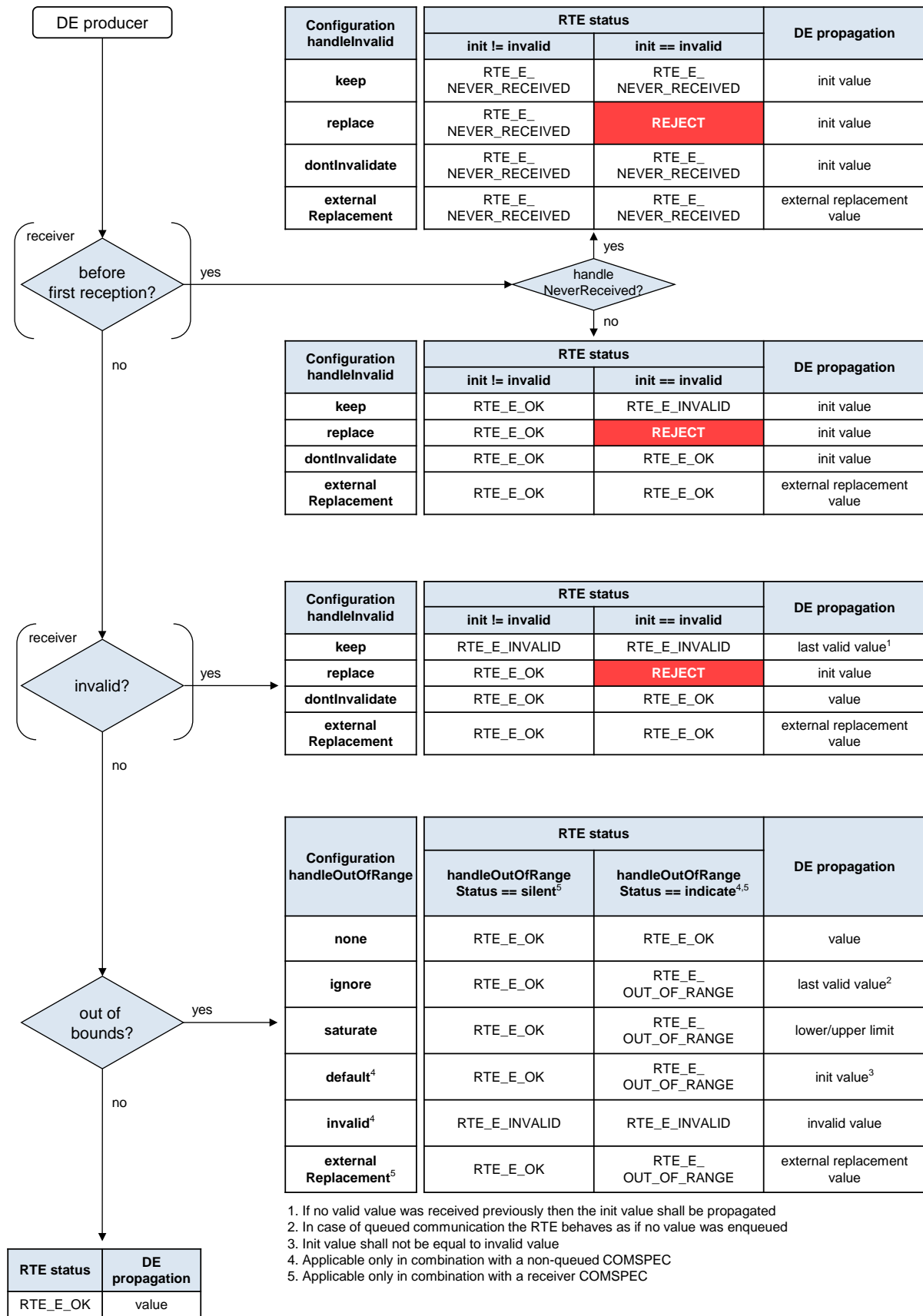


Figure 4.46: Overview for data invalidation and range checks

The status of the modes will be notified to the AUTOSAR software-component `mode user` by mode communication - `mode switch notifications` - as described in the subsection 4.4.7. The port for receiving (or sending) a `mode switch notification` is called

`mode switch port`.

A *Basic Software Module* `mode users` and the *Basic Software Module* `mode manager` are not necessarily using ports. *Basic Software Modules* without *AUTOSAR Interfaces* are connected via the configuration of the *Basic Software Scheduler*.

4.4.1 Mode User

To use modes, an AUTOSAR software-component (`mode user`) has to reference a `ModeDeclarationGroup` by a `ModeDeclarationGroupPrototype` of a `require mode switch port`, see section 4.4.7. The `ModeDeclarationGroup` contains the required modes. Alternatively the `mode manager` can also contain a `ModeAccessPoint` for a provided `mode switch port` and can combine the roles of `mode user` and `mode manager` for the same `ModeDeclarationGroupPrototype`.

An *Basic Software Module* (`mode user`) has to define a `requiredModeGroup ModeDeclarationGroupPrototype`. The `ModeDeclarationGroup` referred by these `ModeDeclarationGroupPrototype` contains the required modes. Similar to a software-component `mode user`, the *Basic Software Module* `mode manager` can also contain a `accessedModeGroup` for a `providedModeGroup ModeDeclarationGroupPrototype`. By this it combines the roles of `mode user` and `mode manager` for the same `ModeDeclarationGroupPrototype`.

The `ModeDeclarations` can be used in two ways by the `mode user` (see also figure 4.47):

1. Modes can be used to trigger runnables: The `SwcInternalBehavior` of the AUTOSAR SW-C or the `BswInternalBehavior` of the BSW module can define a `SwcModeSwitchEvent` respectively a `BswModeSwitchEvent` referencing the required `ModeDeclaration`. This `SwcModeSwitchEvent` or `BswModeSwitchEvent` can then be used as trigger for a `RunnableEntity` / `BswSchedulableEntity`. Both `SwcModeSwitchEvent` and `BswModeSwitchEvent` carry an attribute `ModeActivationKind` which can be 'exit', 'entry', or 'transition'.

A `RunnableEntity` or `BswSchedulableEntity` that is triggered by a `SwcModeSwitchEvent` or a `BswModeSwitchEvent` with `ModeActivationKind` 'exit' is triggered on exiting the mode. For simplicity it will be called

`on-exit ExecutableEntity`. Correspondingly, an `on-transition ExecutableEntity` is triggered by a `SwcModeSwitchEvent` or a `BswModeSwitchEvent` with `ModeActivationKind` 'transition' and will be executed during the transition between two modes, and an

`on-entry ExecutableEntity` is triggered by a `SwcModeSwitchEvent` or a `BswModeSwitchEvent` with `ModeActivationKind` 'entry' and will be executed when the mode is entered.

Since a `RunnableEntity` as well as a `BswSchedulableEntity` can be triggered by multiple `RTEEvents` respectively `BswEvents`, both can be an *on-exit*-, *on-transition* and *on-entry ExecutableEntity* at the same time.

RTE does not support a `WaitPoint` for a `SwcModeSwitchEvent` (see [SWS_Rte_01358]).

2. An `RTEEvent` or `BswEvent` that starts an `ExecutableEntity` can contain a *mode disabling dependency*.

[SWS_Rte_02503] [If a `RunnableEntity` *r* is referenced with `startOnEvent` by an `RTEEvent` *e* that has a *mode disabling dependency* on a mode *m*, then

RTE shall not `activate runnable` *r* on any occurrence of *e* while the mode *m* is active.

](SRS_Rte_00143, SRS_Rte_00052)

[SWS_Rte_07530] [If a `BswSchedulableEntity` *r* is referenced with `startOnEvent` by an `BswEvent` *e* that has a *mode disabling dependency* on a mode *m*, then *Basic Software Scheduler* shall not `activate BswSchedulableEntity` *r* on any occurrence of *e* while the mode *m* is active.](SRS_Rte_00213)

Note: As a consequence of [SWS_Rte_02503] and [SWS_Rte_07530] in combination with [SWS_Rte_02661], RTE or *Basic Software Scheduler* will not `start runnable` or `BswSchedulableEntity` *r* on any occurrence of *e* while the mode *m* is active.

The *mode disabling* is active during the transition to a mode, during the mode itself and during the transition for exiting the mode. For a precise definition see section 4.4.4.

The existence of a *mode disabling dependency* prevents the RTE to start the *mode disabling dependent ExecutableEntity* by the disabled `RTEEvent` / `BswEvent` during the mode, referenced by the *mode disabling dependency*, and during the transitions from and to that mode. *mode disabling dependencies* override any activation of a `RunnableEntity` and `BswSchedulableEntity` by the disabled `RTEEvents` / `BswEvents`. This is also true for the `SwcModeSwitchEvent` and `BswModeSwitchEvent`.

A `RunnableEntity` as well as a `BswSchedulableEntity` can not be 'enabled' explicitly. `RunnableEntity`s are *Basic Software Schedulable Entities* are only 'enabled' by the absence of any active *mode disabling dependencies*.

Note that *mode disabling dependencies* do not prevent the wake up from a `WaitPoint` by the 'disabled' `RTEEvent`. This allows the wake-uped

`RunnableEntity` to run until completion if a transition occurred during the `RunnableEntity`s execution.

[SWS_Rte_02504] [The existence of a `mode disabling dependency` shall not instruct the RTE to kill a running runnable at a mode switch.]([SRS_Rte_00143](#))

[SWS_Rte_07531] [The existence of a `mode disabling dependency` shall not instruct the *Basic Software Scheduler* to kill a running `BswSchedulableEntity` at a mode switch.]([SRS_Rte_00213](#))

The RTE and the *Basic Software Scheduler* can be configured to switch schedule tables to implement mode disabling dependencies for cyclic triggers of `RunnableEntity`s or *Basic Software Schedulable Entities*. Sets of mutual exclusive modes can be mapped to different schedule tables. The RTE shall implement the switch between schedule tables according to the mapping of modes to schedule tables in `RteModeScheduleTableRef`, see [\[SWS_Rte_05146\]](#).

The mode user can specify in the `ModeSwitchReceiverComSpec` (software components) or `BswModeReceiverPolicy` (BSW modules) that it is able to deal with asynchronous mode switch behavior (`supportsAsynchronousModeSwitch == TRUE`). If all `mode users` connected to the same `ModeDeclarationGroupPrototype` of the `mode manager` support the asynchronous mode switch behavior, the related `mode machine instance` can be implemented with the asynchronous mode switching procedure. Otherwise, the synchronous mode switching procedure has to be applied (see [\[SWS_Rte_07150\]](#)).

4.4.2 Mode Manager

Entering and leaving modes is initiated by a `mode manager`. A `mode manager` might be a basic software module, for example the Basic Software Mode Manager (BswM), the communication manager (ComM), or the ECU state manager (EcuM). The `mode manager` may also be an AUTOSAR SW-C. In this case, it is called an `application mode manager`.

The `mode manager` contains the master state machine to represent the modes.

To provide modes, an AUTOSAR software-component (`mode manager`) has to reference a `ModeDeclarationGroup` by a `ModeDeclarationGroupPrototype` of a provide `mode switch port`, see section 4.4.7. The `ModeDeclarationGroup` contains the provided modes.

An *Basic Software Module* (`mode manager`) has to define a `providedModeGroup ModeDeclarationGroupPrototype`. The `ModeDeclarationGroup` referred by these `ModeDeclarationGroupPrototype` contains the provided modes.

The RTE / *Basic Software Scheduler* will take the actions necessary to switch between the modes. This includes the termination and execution of several *ExecutableEntities*

from all `mode users` that are connected to the same `ModeDeclarationGroupPrototype` of the `mode manager`. To do so, the RTE / *Basic Software Scheduler* needs a state machine to keep track of the currently active modes and transitions initiated by the `mode manager`. The RTE's / *Basic Software Scheduler*'s mode machine is called `mode machine instance`. There is exactly one `mode machine instance` for each `ModeDeclarationGroupPrototype` of a `mode manager`'s `provide mode switch port` respectively `providedModeGroup ModeDeclarationGroupPrototype`.

It is the responsibility of the `mode manager` to advance the RTE's / *Basic Software Scheduler*'s `mode machine instance` by sending `mode switch notifications` to the `mode users`. The `mode switch notifications` are implemented by a non blocking API (see 5.6.6 / 6.5.7). So, the `mode switch notifications` alone provide only a loose coupling between the state machine of the `mode manager` and the `mode machine instance` of the RTE / *Basic Software Scheduler*. To prevent, that the `mode machine instance` lags behind and the states of the `mode manager` and the RTE / *Basic Software Scheduler* get out of phase, the `mode manager` can use acknowledgment feedback for the `mode switch notification`. RTE / *Basic Software Scheduler* can be configured to send an acknowledgment of the `mode switch notification` to the `mode manager` when the requested transition is completed.

At the `mode manager`, the acknowledgment results in an `ModeSwitchedAckEvent`. As with `DataSendCompletedEvents`, this event can be picked up with the polling or blocking `Rte_SwitchAck` API. And the event can be used to trigger a `ModeSwitchAck ExecutableEntity` to pick up the status. Note: The *Basic Software Scheduler* do not support `WaitPoints`. Therefore the `SchM_SwitchAck` never blocks.

Some possible usage patterns for the acknowledgement are:

- The most straight forward method is to use a sequence of `Rte_Switch` and a blocking `Rte_SwitchAck` to send the `mode switch notification` and wait for the completion. This requires the use of an extended task.
- Another possibility is to have a cyclic `RunnableEntity` / `BswSchedulableEntity` (maybe the same that switches the modes via `Rte_Switch` / `SchM_Switch`) to poll for the acknowledgement using `Rte_SwitchAck` / `SchM_SwitchAck`.
- The acknowledgement can also be polled from a `RunnableEntity` or `BswSchedulableEntity` that is started by the `ModeSwitchedAckEvent`.

The `mode manager` can also use the `Rte_Mode` / `SchM_Mode` API to read the currently active mode from the RTE's / *Basic Software Scheduler*'s perspective.

4.4.3 Refinement of the semantics of **ModeDeclarations** and **ModeDeclarationGroups**

To implement the logic of mode switches, the RTE / *Basic Software Scheduler* needs some basic information about the available modes. For this reason, RTE / *Basic Software Scheduler* will make the following additional assumptions about the modes of one **ModeDeclarationGroup**:

1. **[SWS_Rte_CONSTR_09013] Exactly one mode or one mode transition shall be active** [Whenever any **RunnableEntity** or **BswSchedulableEntity** is running, there shall always be exactly one mode or one mode transition active of each **ModeDeclarationGroupPrototype**.]()
2. Immediately after initialization of a **mode machine instance**, RTE / *Basic Software Scheduler* will execute a transition to the initial mode of each **ModeDeclarationGroupPrototype** (see [SWS_Rte_02544]).

RTE / *Basic Software Scheduler* will enforce the **mode disablings** of the initial modes and trigger the **on-entry ExecutableEntities** (if any defined) of the initial modes of every **ModeDeclarationGroupPrototype** immediately after initialization of the RTE / *Basic Software Scheduler*.

In other words, RTE / *Basic Software Scheduler* assumes, that the modes of one **ModeDeclarationGroupPrototype** belong to exactly one state machine without nested states. The state machines cover the whole lifetime of the atomic AUTOSAR SW-Cs⁹ and mode dependent AUTOSAR Basic Software Modules¹⁰.

4.4.4 Order of actions taken by the RTE / *Basic Software Scheduler* upon interception of a mode switch notification

This section describes what the ‘communication’ of a mode switch to a **mode user** actually does. What does the RTE *Basic Software Scheduler* do to switch a mode and especially in which order.

Mode switch procedures

Depending on the needs of mode users for synchronicity, the mode machine instance can be implemented with two different realizations.

- synchronous mode switching procedure
- asynchronous mode switching procedure

The differences between these two realizations are the omitted waiting conditions in case of asynchronous mode switching procedure. For instance with asynchronous

⁹The lifetime of an atomic AUTOSAR SW-C is considered to be the time span in which the SW-C's runnables are being executed.

¹⁰The lifetime of an mode dependent AUTOSAR Basic Software Module is considered to be the time span in which the *Basic Software Schedulable Entities* are being executed.

behavior a software component can not rely that all *mode disabling dependent ExecutableEntities* of the previous mode are terminated before *on-entry ExecutableEntities* and *on-exit ExecutableEntities* are started. On one hand this might put some effort to the software component designer to enable the components implementation to support this kind of scheduling but on the other hand it enables fast and lean mode switching.

[SWS_Rte_07150] [The RTE generator shall use the synchronous mode switching procedure if at least one *mode user* of the *mode machine instance* does not support the asynchronous mode switch behavior.](*SRS_Rte_00143*, *SRS_Rte_00213*)

[SWS_Rte_07151] [The RTE generator shall apply the asynchronous mode switch behavior, if all *mode users* support the asynchronous mode switch behavior and if it is configured for the related *mode machine instance*.](*SRS_Rte_00143*, *SRS_Rte_00213*)

Typical usage of modes to protect resources

RTE / *Basic Software Scheduler* can start and prevent the execution of *RunnableEntities* and *BswSchedulableEntity*. In the context of mode switches,

- RTE / *Basic Software Scheduler* starts *on-exit ExecutableEntities* for leaving the previous mode. This is typically used by 'clean up *ExecutableEntities*' to free resources that were used during the previous mode.
- RTE / *Basic Software Scheduler* starts *on-entry ExecutableEntities* for entering the next mode. This is typically used by 'initialization *ExecutableEntities*' to allocate resources that are used in the next mode.
- And RTE / *Basic Software Scheduler* can prevent the execution of *mode disabling dependent ExecutableEntities* within a mode. This is typically used with time triggered 'work *ExecutableEntity*' that use a resource which is not available in a certain mode.

According to this use case, during the execution of 'clean up *ExecutableEntities*' and 'initialization *ExecutableEntities*' the 'work *ExecutableEntities*' should be disabled to protect the resource. Also, if the same resource is used (by different SW-C's) in two successive modes, the 'clean up *ExecutableEntities*' should be safely terminated before the 'initialization *ExecutableEntities*' of the next mode are executed (synchronous mode switching procedure). In summary, this would lead to the following sequence of actions by the RTE / *Basic Software Scheduler* upon reception of the *mode switch notification*:

1. activate *mode disabling* for the next mode
2. wait for the newly disabled *ExecutableEntities* to terminate in case of synchronous mode switching procedure
3. execute 'clean up *ExecutableEntities*'
4. wait for the 'clean up *ExecutableEntities*' to terminate in case of synchronous mode switching procedure

5. execute 'initialization `ExecutableEntities`'
6. wait for the 'initialization `ExecutableEntities`' to terminate in case of synchronous mode switching procedure
7. deactivate `mode disables` for the previous modes and enable `ExecutableEntities` that have been disabled in the previous mode.

RTE / *Basic Software Scheduler* can also start `on-transition ExecutableEntities` on a transition between two modes which is not shown in this use case example.

Often, only a fraction of the SW-Cs, Runnable Entities, Basic Software modules and Basic Software Schedulable Entities of one ECU depends on the modes that are switched. Consequently, it should be possible to design the system in a way, that the mode switch does not influence the performance of the remaining software.

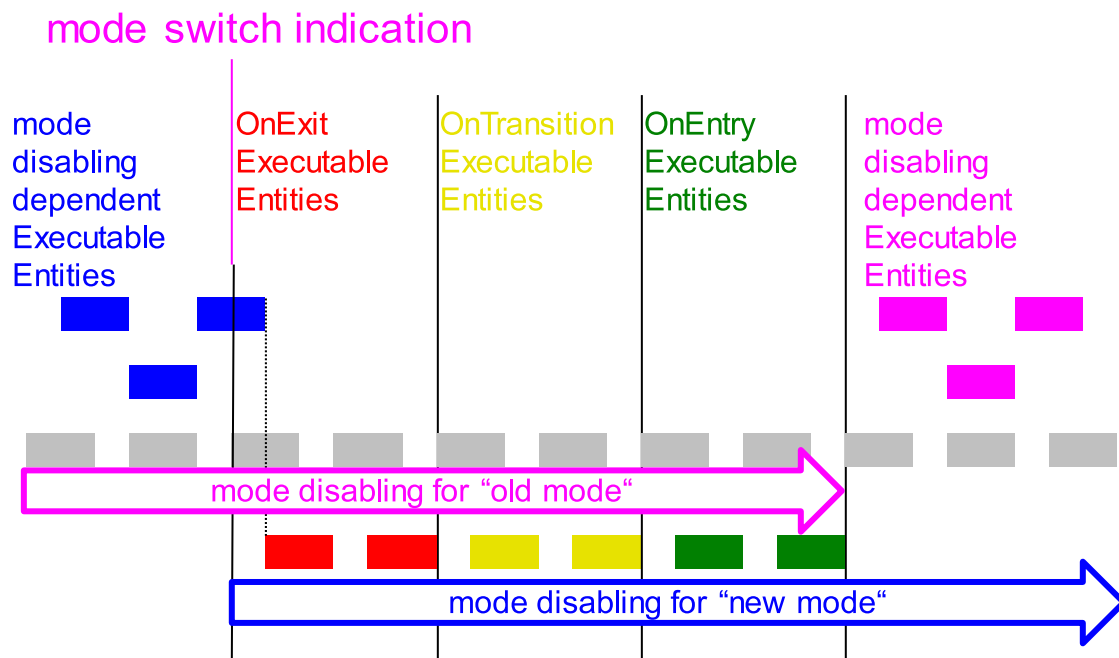


Figure 4.48: This figure shall illustrate what kind of ExecutableEntities will run in what order during a synchronous mode transition. The boxes indicate activated ExecutableEntities. Mode disabling dependant ExecutableEntities are printed in blue (old mode) and pink (new mode). on-exit, on-transition, and on-entry ExecutableEntity are printed in red, yellow, and green.

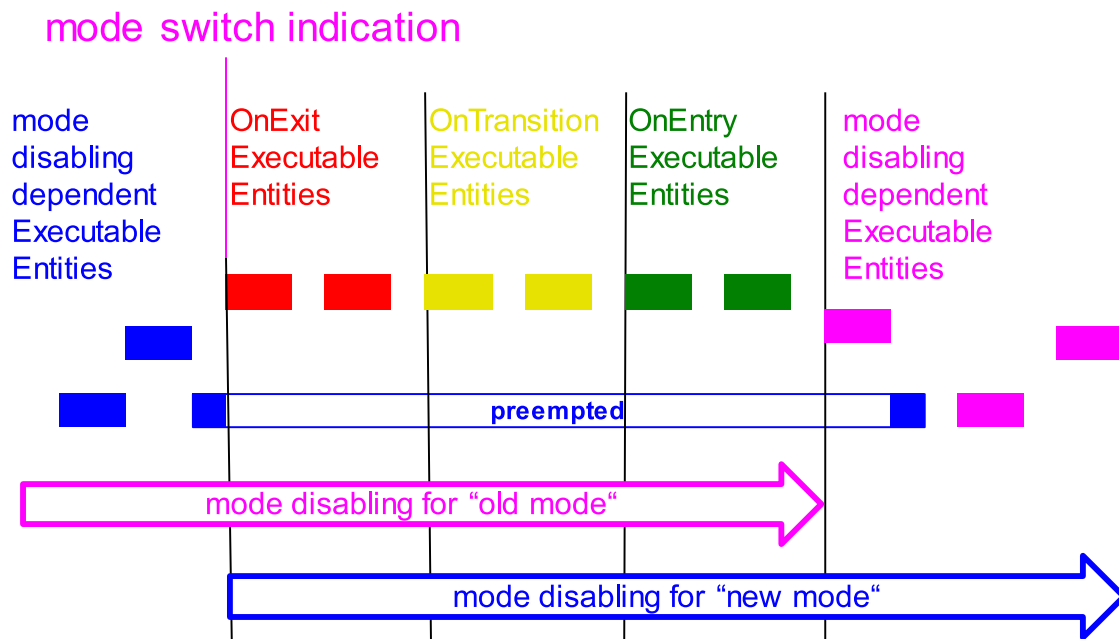


Figure 4.49: This figure shall illustrate what kind of ExecutableEntity will run in what order during an asynchronous mode transition where the ExecutableEntities are triggered on a mode change are mapped to a higher priority task than the Mode Dependent ExecutableEntity. The boxes indicate activated ExecutableEntity. Mode disabling dependant ExecutableEntity are printed in blue (old mode) and pink (new mode). on-exit, on-transition, and on-entry ExecutableEntity are printed in red, yellow, and green.

The remainder of this section lists the requirements that guarantee the behavior described above.

All runnables with dependencies on modes have to be executed or terminated during mode transitions. Restriction [SWS_Rte_02500] requires these runnables to be of category 1 to guarantee finite execution time.

For simplicity of the implementation to guarantee the order of runnable executions, the restriction [SWS_Rte_02662] applies.

A `mode machine instance` implementing an asynchronous mode switch procedure might be fully implemented inside the `Rte_Switch` or `SchM_Switch` API. In this case the `on-entry ExecutableEntities`, `on-transition ExecutableEntities`, `on-exit ExecutableEntities` and `ModeSwitchAck ExecutableEntities` are not mapped to tasks as described in chapter 8.5.1.

[SWS_Rte_07173] [The RTE generator shall support invocation of `on-entry ExecutableEntities`, `on-transition ExecutableEntities`, `on-exit ExecutableEntities` and `ModeSwitchAck ExecutableEntities` via `direct function call`, if all following conditions are fulfilled:

- if the asynchronous mode switch behavior is configured (see [SWS_Rte_07151])

- the `on-entry ExecutableEntities`, `on-transition ExecutableEntities`, `on-exit ExecutableEntities` and `ModeSwitchAck ExecutableEntities` do not define a 'minimum start distance'
- the `mode manager` and `mode user` are in the same Partition
- if the preconditions of [constr_4086] are fulfilled

]([SRS_Rte_00143](#), [SRS_Rte_00213](#))

[SWS_Rte_08905] [The RTE generator shall support invocation of `on-entry ExecutableEntities`, `on-transition ExecutableEntities`, `on-exit ExecutableEntities` and `ModeSwitchAck ExecutableEntities` via `trusted function call`, if all following conditions are fulfilled:

- if the asynchronous mode switch behavior is configured (see [[SWS_Rte_07151](#)])
- the `on-entry ExecutableEntities`, `on-transition ExecutableEntities`, `on-exit ExecutableEntities` and `ModeSwitchAck ExecutableEntities` do not define a 'minimum start distance'
- the `mode manager` and `mode user` are in different Partitions on the same core
- if the preconditions of [constr_4086] are fulfilled

]([SRS_Rte_00143](#), [SRS_Rte_00213](#))

Further on the requirements [[SWS_Rte_05083](#)], [[SWS_Rte_07155](#)] and [[SWS_Rte_07157](#)] has to be considered.

[SWS_Rte_02667] [Within the mode manager's `Rte_Switch` / `SchM_Switch` API call to indicate a mode switch, one of the following shall be done:

1. If the corresponding `mode machine instance` is in a transition, and the queue for `mode switch notifications` is full, `Rte_Switch` / `SchM_Switch` shall return an error immediately.
2. If the corresponding `mode machine instance` is in a transition, and the queue for `mode switch notifications` is not full, the `mode switch notification` shall be queued.
3. If the `mode machine instance` is not in a transition, `Rte_Switch` / `SchM_Switch` shall initiate the transition as described by the sequence in [[SWS_Rte_02665](#)] which in turn activates the `mode disablings` (see [[SWS_Rte_02661](#)]) of the next mode.

]([SRS_Rte_00143](#), [SRS_Rte_00213](#))

The following list holds the requirements for the steps of a mode transition.

- **[SWS_Rte_02661]** [At the beginning of a transition of a *mode machine instance*, the RTE / *Basic Software Scheduler* shall activate the *mode disabling* of the next mode (see also [SWS_Rte_02503]), if any *mode disabling dependencies* for that mode are defined.](SRS_Rte_00143, SRS_Rte_00213)
- **[SWS_Rte_07152]** [If any *mode disabling dependencies* for the next mode are defined (as specified by [SWS_Rte_02661]), the RTE / *Basic Software Scheduler* shall wait until the newly disabled *RunnableEntities* and *Basic Software Schedulable Entities* are terminated, in case of synchronous mode switching procedure.](SRS_Rte_00143, SRS_Rte_00213)

Note: To guarantee in case of synchronous mode switching all activated *mode disabling dependent ExecutableEntities* of this *core local mode user group* have terminated before the start of the *on-exit ExecutableEntities* of the transition, RTE generator can exploit the restriction [SWS_Rte_02663] that *mode disabling dependent ExecutableEntities* run with higher or equal priority than the *on-exit ExecutableEntities* and the *on-entry ExecutableEntities*.

- **[SWS_Rte_02562]** [RTE / *Basic Software Scheduler* shall execute the *on-exit ExecutableEntities* of the previous mode.](SRS_Rte_00143, SRS_Rte_00052, SRS_Rte_00213)
- **[SWS_Rte_07153]** [If any *on-exit ExecutableEntity* is configured the RTE / *Basic Software Scheduler* shall wait after its execution ([SWS_Rte_02562]) until all *on-exit ExecutableEntities* are terminated in case of synchronous mode switching procedure.](SRS_Rte_00143, SRS_Rte_00213)
- **[SWS_Rte_02707]** [RTE / *Basic Software Scheduler* shall execute the *on-transition ExecutableEntities* configured for the transition from previous mode to next mode.](SRS_Rte_00143, SRS_Rte_00052, SRS_Rte_00213)
- **[SWS_Rte_02708]** [If any *on-transition ExecutableEntity* is configured, the RTE / *Basic Software Scheduler* shall wait after its execution ([SWS_Rte_02707]) until all *on-transition ExecutableEntities* are terminated in case of synchronous mode switching procedure.](SRS_Rte_00143, SRS_Rte_00213)
- **[SWS_Rte_02564]** [RTE / *Basic Software Scheduler* shall execute the *on-entry ExecutableEntities* of the next mode.](SRS_Rte_00143, SRS_Rte_00052, SRS_Rte_00213)
- **[SWS_Rte_07154]** [If any *on-entry ExecutableEntity* is configured the RTE shall wait after its execution ([SWS_Rte_02564]) until all *on-entry ExecutableEntities* are terminated in case of synchronous mode switching procedure.](SRS_Rte_00143, SRS_Rte_00213)

- **[SWS_Rte_02563]** [The RTE / *Basic Software Scheduler* shall deactivate the previous `mode disablings` and only keep the `mode disablings` of the next mode.]([SRS_Rte_00143](#), [SRS_Rte_00213](#))

With this, the transition is completed.

- **[SWS_Rte_02587]** [At the end of the transition, RTE / *Basic Software Scheduler* shall trigger the `ModeSwitchedAckEvents` connected to the `mode manager`'s `ModeDeclarationGroupPrototype`.]([SRS_Rte_00143](#), [SRS_Rte_00213](#))

This will result in an acknowledgment on the `mode manager`'s side which allows the `mode manager` to wait for the completion of the mode switch.

The dequeuing of the mode switch notification shall also be done at the end of the transition, see [\[SWS_Rte_02721\]](#).

[SWS_Rte_02665] [During a transition of a `mode machine instance` each applicable of the steps

1. [\[SWS_Rte_02661\]](#) (The transition is entered in parallel with this step),
2. [\[SWS_Rte_07152\]](#),
3. [\[SWS_Rte_02562\]](#),
4. [\[SWS_Rte_07153\]](#),
5. [\[SWS_Rte_02707\]](#),
6. [\[SWS_Rte_02708\]](#),
7. [\[SWS_Rte_02564\]](#),
8. [\[SWS_Rte_07154\]](#),
9. [\[SWS_Rte_02563\]](#) (The transition is completed with this step), and
10. immediately followed by [\[SWS_Rte_02587\]](#)

shall be executed in the order as listed for a core local mode user group. If a step is not applicable, the order of the remaining steps shall be unchanged.

If mode users are belonging to different core local mode user group the steps 1. - 9. may be executed in parallel on the different cores. The step 10. is executed if the step 1. - 9. is finished for the whole mode machine instance.]([SRS_Rte_00143](#), [SRS_Rte_00213](#))

In the case that mode users belonging to the same mode machine instance are mapped to different partitions which in turn are scheduled on different micro controller cores the sequence described in [\[SWS_Rte_02665\]](#) can be parallelized.

[SWS_Rte_02668] [Immediately after the execution of a transition as described in [\[SWS_Rte_02665\]](#), RTE / *Basic Software Scheduler* shall check the queue for pending `mode switch notifications` of this `mode machine instance`. If a `mode switch notification` can be dequeued, the `mode machine instance`

shall enter the corresponding transition directly as described by the sequence in [SWS_Rte_02665].] (SRS_Rte_00143, SRS_Rte_00213)

In the case of a fast sequence of two mode switches, the `Rte_Mode` or `SchM_Mode` API will not indicate an intermediate mode, if a `mode switch notification` to the next mode is indicated before the transition to the intermediate mode is completed.

[SWS_Rte_02630] [In case of synchronous mode switch procedure, the RTE shall execute all steps of a mode switch (see [SWS_Rte_02665]) synchronously for the whole `mode machine instance`.] (SRS_Rte_00143, SRS_Rte_00213)

I.e., the mode transitions will be executed synchronously for all `mode users` that are connected to the same `mode manager's ModeDeclarationGroupPrototype`.

[SWS_Rte_02669] [If the next mode and the previous mode of a transition are the same, the transition shall still be executed.] (SRS_Rte_00143, SRS_Rte_00213)

4.4.5 Assignment of mode machine instances to RTE and Basic Software Scheduler

[SWS_Rte_07533] [A `mode machine instance` shall be assigned to the RTE if the correlating `ModeDeclarationGroupPrototype` is instantiated in a port of a software-component and if the `ModeDeclarationGroupPrototype` is not synchronized (`synchronizedModeGroup` of a `SwcBswMapping`) with a `providedModeGroup ModeDeclarationGroupPrototype` of a Basic Software Module instance.] (SRS_Rte_00143)

[SWS_Rte_07534] [A `mode machine instance` shall be assigned to the *Basic Software Scheduler* if the correlating `ModeDeclarationGroupPrototype` is a `providedModeGroup ModeDeclarationGroupPrototype` of a Basic Software Module instance.] (SRS_Rte_00213)

[SWS_Rte_07535] [The RTE Generator shall create only one `mode machine instance` if a `ModeDeclarationGroupPrototype` instantiated in a port of a software-component is synchronized (`synchronizedModeGroup` of a `SwcBswMapping`) with a `providedModeGroup ModeDeclarationGroupPrototype` of a Basic Software Module instance. The related `common mode machine instance` shall be assigned to the *Basic Software Scheduler*.] (SRS_Rte_00143, SRS_Rte_00213, SRS_Rte_00214)

In case of synchronized `ModeDeclarationGroupPrototypes` the correlating `common mode machine instance` is initialized during the execution of the `SchM_Init`. At this point of time the scheduling of `RunnableEntitys` is not enabled due to the uninitialized RTE. Therefore situation occurs, that the `RunnableEntitys` being `on-entry ExecutableEntitys` are not called if the `mode machine instance` is initialized. Further on the current mode of such `mode machine instance` might be still switched until the RTE gets initialized. Nevertheless the *on-entry Runnables* of the current active mode are executed.

[SWS_Rte_07582] [For *common mode machine instances* the *on-entry Runnable Entities* of the current active mode are executed during the initialization of the RTE if the *common mode machine instance* is not in transition.](*SRS_Rte_00214*)

[SWS_Rte_07583] [A *common mode machine instances* is not allowed to enter transition phase during the RTE initialization if the *common mode machine instances* has *on-entry Runnable Entities*, *on-transition Runnable Entities* or *on-exit Runnable Entities*](*SRS_Rte_00214*)

Note: [SWS_Rte_07582] and [SWS_Rte_07583] shall ensure a deterministic behavior that the software components receiving a Mode Switch Request from a *common mode machine instances* are receiving the current active mode during RTE initialization.

[SWS_Rte_07564] [The RTE generator shall reject configurations where *ModeSwitchPoint(s)* referencing a *ModeDeclarationGroupPrototype* in a *mode switch port* and a *managedModeGroup* association(s) to a *providedModeGroup ModeDeclarationGroupPrototype* are not defined mutual exclusively to one of two synchronized *ModeDeclarationGroupPrototypes*.](*SRS_Rte_00143*, *SRS_Rte_00213*, *SRS_Rte_00214*, *SRS_Rte_00018*)

[SWS_Rte_CONSTR_09014] *ModeSwitchPoint(s)* and *managedModeGroup(s)* are mutually exclusive for synchronized *ModeDeclarationGroupPrototypes* [Only one of two synchronized *ModeDeclarationGroupPrototypes* shall mutual exclusively be referenced by *ModeSwitchPoint(s)* or *managedModeGroup* association(s).]()

Note: [SWS_Rte_CONSTR_09014] shall ensure in the combination with the existence conditions of the *Rte_Switch*, *Rte_Mode*, *Rte_SwitchAck*, *SchM_Switch*, *SchM_Mode* and *SchM_SwitchAck* that either the port based RTE API or the *Basic Software Scheduler* API ([SWS_Rte_07201] and [SWS_Rte_07264]) offered to the implementation of the *mode manager*.

4.4.6 Initialization of mode machine instances

A *mode machine instance* can either be initialized during *Rte_Start* or during *Rte_Init*. The initialization during *Rte_Init* enables a defined order when which *mode machine instance* gets initialized and the belonging *on-entry Runnable Entities* are scheduled.

[SWS_Rte_06766] [RTE shall initiate the transition to the initial modes of each *mode machine instance* belonging to the RTE during *Rte_Start* if the *on-entry Runnable Entities* for the *initialMode* are not mapped to any *RteInitialization-RunnableBatch* container.](*SRS_Rte_00143*, *SRS_Rte_00144*, *SRS_Rte_00116*)

[SWS_Rte_06767] [RTE shall initiate the transition to the initial modes of each *mode machine instance* belonging to the RTE during *Rte_Init* if the *on-entry Runnable Entities* for the *initialMode* are mapped to one or several *RteInitialization-RunnableBatch* container.](*SRS_Rte_00143*, *SRS_Rte_00144*, *SRS_Rte_00116*, *SRS_Rte_00240*)

Please note the restrictions on the mapping to `RteInitializationRunnableBatch` containers [SWS_Rte_CONSTR_09062], [SWS_Rte_CONSTR_09063] and [SWS_Rte_CONSTR_09064].

[SWS_Rte_02544] [During the transition to the initial modes of `mode machine instances` belonging to the RTE, the steps defined in the following requirements have to be omitted as no previous mode is defined:

- [SWS_Rte_02562],
- [SWS_Rte_07153],
- [SWS_Rte_02707],
- [SWS_Rte_02708],
- [SWS_Rte_02563],
- [SWS_Rte_02587]

If applicable, the steps described by the following requirements still have to be executed for entering the initial mode:

- [SWS_Rte_02661],
- [SWS_Rte_02564]

](SRS_Rte_00143, SRS_Rte_00144, SRS_Rte_00116)

[SWS_Rte_07532] [*Basic Software Scheduler* shall initiate the transition to the initial modes of each `mode machine instance` belonging to the *Basic Software Scheduler* during `SchM_Init`. During the transition to the initial modes, the steps defined in the following requirements have to be omitted as no previous mode is defined:

- [SWS_Rte_02562],
- [SWS_Rte_07153],
- [SWS_Rte_02707],
- [SWS_Rte_02708],
- [SWS_Rte_02563],
- [SWS_Rte_02587]

If applicable, the steps described by the following requirements still have to be executed for entering the initial mode:

- [SWS_Rte_02661],
- [SWS_Rte_02564]

](SRS_Rte_00213)

4.4.7 Notification of mode switches

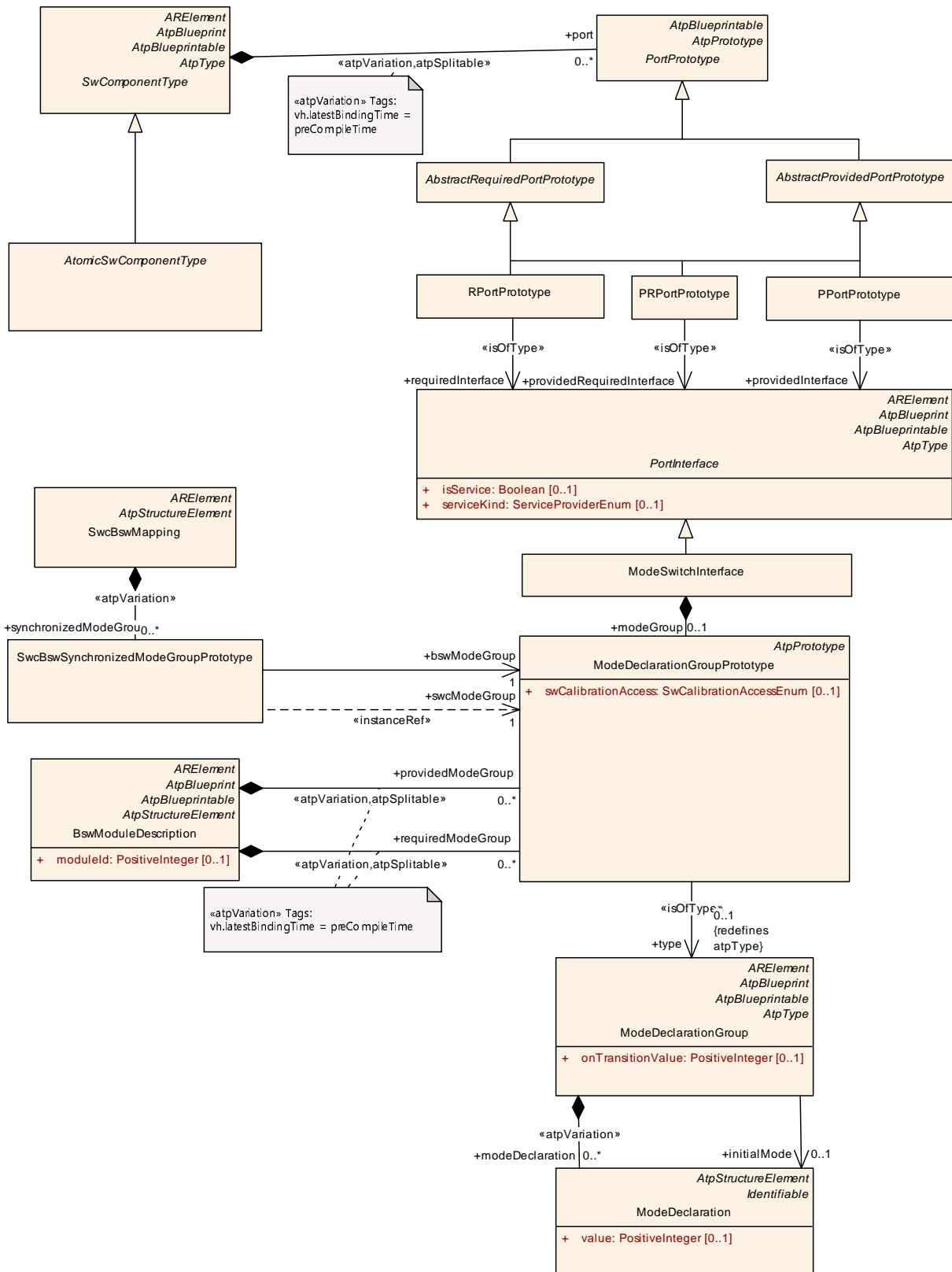


Figure 4.50: Definition of a ModeSwitchInterface.

- **[SWS_Rte_02549]** [Mode switches shall be communicated via RTE by `ModeDeclarationGroupPrototypes` of a `ModeSwitchInterface` as defined in [2], see Fig. 4.50.] (*SRS_Rte_00144*)

The `mode switch ports` of the `mode manager` and the `mode user` are of the type of a `ModeSwitchInterface`.

- **[SWS_Rte_07538]** [Mode switches shall be communicated via *Basic Software Scheduler* via `providedModeGroup` and `requiredModeGroup ModeDeclarationGroupPrototypes` as defined in [9], see Fig. 4.50. Which `ModeDeclarationGroupPrototypes` are connected to each other is defined by the configuration of the *Basic Software Scheduler*.] (*SRS_Rte_00213*)

- RTE / *Basic Software Scheduler* only requires the notification of switches between modes.
- AUTOSAR does not support inter ECU communication of mode switch notifications.

For the distributed mode management mode requests can be distributed via `ServiceProxySwComponentTypes` and the BswM of each target ECU to the `mode users` of the BswMs.

- **[SWS_Rte_02508]** [A mode switch shall be notified asynchronously as indicated by the use of a `ModeSwitchInterface`.] (*SRS_Rte_00144*)

Rationale: This simplifies the communication. Due to [SWS_Rte_08788] the communication is ECU local and no handshake is required to guarantee reliable transmission.

RTE offers the `Rte_Switch` API to the `mode manager` for this notification, see 5.6.6.

Basic Software Scheduler offers the `SchM_Switch` API to the `mode manager` for this notification, see 6.5.7.

- The `mode manager` might still require a feedback to keep its internal state machine synchronized with the RTE / *Basic Software Scheduler* view of active modes.

The RTE generator shall support an `AcknowledgementRequest` from the `mode switch port` / `providedModeGroup ModeDeclarationGroupPrototype` of a `mode manager`, see [SWS_Rte_02587], to notify the `mode manager` of the completion of a mode switch.

- **[SWS_Rte_02566]** [A `ModeSwitchInterface` shall support 1:n communication.] (*SRS_Rte_00144*)

Rationale: This simplifies the configuration and the communication. One mode switch can be notified to all receivers simultaneously.

A `ModeSwitchInterface` does not support n:1 communication, see [SWS_Rte_02670].

- [SWS_Rte_07539] [The connection of `providedModeGroup` and `requiredModeGroup` `ModeDeclarationGroupPrototype` shall support 1:n communication.](SRS_Rte_00213)
- [SWS_Rte_02624] [A mode switch shall be notified with `event semantics`, i.e., the mode switch notifications shall be buffered by RTE or *Basic Software Scheduler* to which the `mode machine instance` is assigned.](SRS_Rte_00144)

The queueing of mode switches (and `SwcModeSwitchEvents`) depends like that of `DataReceivedEvents` on the settings for the receiving port, see section 4.3.1.10.2.

- [SWS_Rte_02567] [A `ModeSwitchInterface` shall only indicate the next mode of the transition.](SRS_Rte_00144)
- [SWS_Rte_07541] [A `providedModeGroup` `ModeDeclarationGroupPrototype` shall only indicate the next mode of the transition.](SRS_Rte_00213)

The API takes a single parameter (plus, optionally, the instance handle) that indicates the requested 'next mode'. For this purpose, RTE and *Basic Software Scheduler* will use identifiers of the modes as defined in [SWS_Rte_02568] and [SWS_Rte_07294].

- [SWS_Rte_02546] [The RTE shall keep track of the active modes of a `mode manager's` `ModeDeclarationGroupPrototypes` (`mode machine instances`) which is assigned to the RTE.](SRS_Rte_00143, SRS_Rte_00144)
- [SWS_Rte_07540] [The *Basic Software Scheduler* shall keep track of the active modes of a `mode manager's` `ModeDeclarationGroupPrototypes` (`mode machine instances`) which is assigned to the *Basic Software Scheduler*.](SRS_Rte_00213, SRS_Rte_00144)

Rationale: This allows the RTE / *Basic Software Scheduler* to guarantee consistency between the timing for firing of `SwcModeSwitchEvents` / `BswModeSwitchEvents` and disabling the start of `ExecutableEntities` by `mode disabling dependency` without adding additional interfaces to a mode manager with fine grained substates on the transitions.

- The RTE offers an `Rte_Mode` API to the SW-C to get information about the active mode, see section 5.6.32.
- The *Basic Software Scheduler* offers an `SchM_Mode` API to the Basic Software Module to get information about the active mode, see section 6.5.8.
- In addition to the `mode switch ports`, the `mode manager` may offer an AUTOSAR interface for requesting and releasing modes as a means to keep modes alive like for ComM and EcuM.

4.4.8 Mode switch acknowledgment

In case of mode switch communication, the `mode manager` may specify a `ModeSwitchedAckEvent` or `BswModeSwitchedAckEvent` to receive a notification from the RTE that the mode transition has been completed, see [SWS_Rte_02679] and [SWS_Rte_07559].

The `ModeSwitchedAckEvent` is triggered by the RTE regardless which runnable entity has requested the mode switch notification, even if the meta model implies a link to a specific `ModeSwitchPoint`.

[SWS_Rte_02679] [If acknowledgment is enabled for a provided `ModeDeclarationGroupPrototype` and a `ModeSwitchedAckEvent` references a `RunnableEntity` as well as the `ModeDeclarationGroupPrototype`, the `RunnableEntity` shall be activated when the mode switch acknowledgment occurs or when the RTE detects that any partition to which the mode users are mapped was stopped or restarted or when a timeout was detected by the RTE.](SRS_Rte_00051, SRS_Rte_00143)

The related *Entry Point Prototype* is defined in [SWS_Rte_02512].

[SWS_Rte_07559] [If acknowledgment is enabled for a provided (`providedModeGroup`) `ModeDeclarationGroupPrototype` and a `BswModeSwitchedAckEvent` references a `BswSchedulableEntity` as well as the `ModeDeclarationGroupPrototype`, the `BswSchedulableEntity` shall be activated when the mode switch acknowledgment occurs or when a timeout was detected by the *Basic Software Scheduler*. [SWS_Rte_02587].](SRS_Rte_00213, SRS_Rte_00143)

The related *Entry Point Prototype* is defined in [SWS_Rte_04542].

Requirement [SWS_Rte_02679] and [SWS_Rte_07559] merely affects when the runnable is activated. The `Rte_SwitchAck` and `SchM_SwitchAck` shall still be created, according to requirement [SWS_Rte_02678] and [SWS_Rte_07558] to actually read the acknowledgment.

[SWS_Rte_02730] [A `ModeSwitchedAckEvent` that references a `RunnableEntity` and is referenced by a `WaitPoint` shall be an invalid configuration which is rejected by the RTE generator.](SRS_Rte_00051, SRS_Rte_00018, SRS_Rte_00143)

The attributes `ModeSwitchedAckRequest` and `BswModeSwitchAckRequest` allow to specify a timeout.

[SWS_Rte_07056] [If `ModeSwitchedAckRequest` or `BswModeSwitchAckRequest` with a timeout greater than zero is specified, the RTE shall ensure that timeout monitoring is performed, regardless of the receive mode of the acknowledgment.](SRS_Rte_00069, SRS_Rte_00143)

[SWS_Rte_07060] [Regardless of an occurred timeout during a mode transition the RTE shall complete the transition of a `mode machine instance` as defined in [SWS_Rte_02665].](SRS_Rte_00069, SRS_Rte_00143)

If a `WaitPoint` is specified to collect the acknowledgment, two timeout values have to be specified, one for the `ModeSwitchedAckRequest` and one for the `WaitPoint`.

[SWS_Rte_07057] [The RTE generator shall reject configuration violating [constr_-4012] in software component template [2].] (*SRS_Rte_00018*, *SRS_Rte_00143*)

[SWS_Rte_07058] [The status information about the success or failure of the mode transition shall be buffered with last-is-best semantics. When a new `mode switch notification` is sent or when the mode switch notification was completed after a timeout, the status information is overwritten.] (*SRS_Rte_00143*)

[SWS_Rte_07058] implies that once the `ModeSwitchedAckEvent` or `BswModeSwitchedAckEvent` has occurred, repeated API calls (`Rte_SwitchAck` or `SchM_SwitchAck` to retrieve the acknowledgment can return different values.

[SWS_Rte_07059] [If the `timeout` value of the `ModeSwitchedAckRequest` or `BswModeSwitchAckRequest` is 0, no timeout monitoring shall be performed.] (*SRS_Rte_00069*, *SRS_Rte_00143*)

4.4.9 Mode switch error handling

Since the mode switch communication may cross partitions basically two error scenarios are possible:

- The partition of the `mode users` gets terminated.
- The partition of the `mode manager` gets terminated.

In both cases additionally the terminated partition may be restarted. For both error scenarios the RTE offers functionality to handle the errors.

4.4.9.1 Mode User gets terminated

When a `mode manager` is getting out of sync with the `mode user(s)` (because the partition of the `mode user` has been terminated) a sequence of error reactions is defined.

This shall support on the one hand to inform the `mode manager` about the fact that the `mode users` are absent. This might be used by the `mode manager` to set internal states. This supports an active error handling by the `mode manager` as well as a synchronization of the `mode manager` to the `mode user's` partition restart.

Furthermore the RTE offers the ability to switch into a default mode automatically. This feature can be used to ensure that either the `mode users` are re-initialized as during ECU start (default mode is initial mode) or that the `mode users` are re-initialized by a dedicated mode (default mode is different from initial mode) which in turn may be used to ensure a secure behavior of the `mode user's`, for instance suppressing the actuator self tests in the running system.

Please note that the application of a default mode during mode user partition restart for modes communicated cross partitions cannot be applied since this would disturb the execution of the fault free partitions. For this scenario the only applicable error reaction is `modeManagerErrorBehavior.errorReactionPolicy` set to `lastMode`. Other configurations are rejected, see [SWS_Rte_08788].

[SWS_Rte_06794] [The RTE Generator shall take the `modeManagerErrorBehavior` from the `ModeDeclarationGroup` typing the `ModeDeclarationGroupPrototype` in the `ModeSwitchInterface` of the `PPortPrototype/PRPortPrototype`.] (*SRS_Rte_00143, SRS_Rte_00144*)

[SWS_Rte_06772] [The RTE shall clear all `mode switch notifications` in the queue when all partitions of the `mode users` are terminated.] (*SRS_Rte_00143, SRS_Rte_00144*)

[SWS_Rte_06773] [The RTE shall activate `RunnableEntity`s triggered by a `Swc-ModeManagerErrorEvent` when all partitions of the `mode users` are terminated.] (*SRS_Rte_00143, SRS_Rte_00144*)

[SWS_Rte_06774] [If `ModeSwitchedAckRequest` or `BswModeSwitchAckRequest` is specified, the RTE shall detect a timeout when mode users partitions are terminated during an ongoing transition.] (*SRS_Rte_00143, SRS_Rte_00144*)

Also see [SWS_Rte_02679], [SWS_Rte_07559], and [SWS_Rte_03853].

The further behavior of the `mode machine instance` depends on the attribute `ModeDeclarationGroup.modeUserErrorBehavior`.

[SWS_Rte_06775] [If the attribute `modeManagerErrorBehavior.errorReactionPolicy` is set to `lastMode` the `mode machine instance` stays in the last mode before the termination of the `mode users`. If the partition of the `mode users` gets terminated during an ongoing transition the last mode is the next mode of the transition.] (*SRS_Rte_00143, SRS_Rte_00144*)

Please note: In case the partition of the `mode users` gets terminated during an ongoing transition logically the transition is still completed even if the mode users didn't "survive" the transition.

[SWS_Rte_06776] [If the attribute `modeManagerErrorBehavior.errorReactionPolicy` is set to `defaultMode` the RTE shall enqueue the mode defined by `modeManagerErrorBehavior.defaultMode` to the `mode switch notification queue`.] (*SRS_Rte_00143, SRS_Rte_00144*)

If the `ModeSwitchInterface` does not define a specific `modeManagerErrorBehavior` the RTE uses the `initialMode` as a default mode.

[SWS_Rte_06777] [If the attribute `modeManagerErrorBehavior` is not defined the RTE shall enqueue the mode defined by `initialMode` to the `mode switch notification queue`.] (*SRS_Rte_00143, SRS_Rte_00144*)

[SWS_Rte_06778] [The RTE shall execute the error reactions in case the partition of the `mode users` gets terminated in following order:

1. [SWS_Rte_06772]
2. [SWS_Rte_06773]
3. [SWS_Rte_06774]
4. [SWS_Rte_06775] or [SWS_Rte_06776] or [SWS_Rte_06777]

](SRS_Rte_00143, SRS_Rte_00144)

If the partition of the `mode users` is capable to restart (`PartitionCanBeRestarted == true`) the `mode manager` shall be able to enqueue new mode switch requests during the restart of the partition. This shall support a dedicated error handling by the `mode manager` depending on other environmental conditions. In this case the `mode manager` may decide which transitions are appropriate to get the `mode users` either back in an operational mode or in a secure default mode. Therefore the `errorReactionPolicy` equals `lastMode` avoids any automatically forced mode transitions by the error handling of the RTE.

[SWS_Rte_06779] [RTE shall support the enqueueing of new mode switch requests during the restart of the `mode user's` partition by the `mode manager` after the call of `Rte_PartitionRestarting`.](SRS_Rte_00143, SRS_Rte_00144)

[SWS_Rte_06780] [When the partition with the mode users is restarted (after call of `Rte_PartitionRestart`), RTE shall dequeue queued `mode switch notifications`.](SRS_Rte_00143, SRS_Rte_00144)

When the first `mode switch notification` after a partition restart is dequeued the previous mode is defined as "last mode" or "on transition" depending on the `modeManagerErrorBehavior.errorReactionPolicy`. See [SWS_Rte_06783] and [SWS_Rte_06784].

Initialization of mode machine instance during mode user's partition restart

Depending on the `modeManagerErrorBehavior` the RTE has to re-initialize the `mode machine instance` during the restart of the `mode user's` partition. In case `modeManagerErrorBehavior.errorReactionPolicy` is set to `default-Mode` the behavior is similar as during the transition to the initial mode (see [SWS_Rte_02544]). During the initialization of the RTE resources for a restarting mode user partition only a subset of the single steps of a mode transition is applicable.

[SWS_Rte_06796] [During the transition to the default mode (next mode is default mode) of `mode machine instances` when the `mode user's` partition restarts, the steps defined in the following requirements have to be omitted as no previous mode is applicable:

- [SWS_Rte_02562],
- [SWS_Rte_07153],

- [SWS_Rte_02707],
- [SWS_Rte_02708],
- [SWS_Rte_02563],
- [SWS_Rte_02587]

If applicable, the steps described by the following requirements still have to be executed for entering the default mode:

- [SWS_Rte_02661],
- [SWS_Rte_02564]

](SRS_Rte_00143, SRS_Rte_00144)

In case `modeManagerErrorBehavior.errorReactionPolicy` is set to `lastMode` the behavior indicates a stable mode during the re-initialization in order to provide the means to the `mode manager` to explicitly decide on the appropriate mode to handle the fault.

[SWS_Rte_06797] [If the attribute `modeManagerErrorBehavior.errorReactionPolicy` is set to `lastMode` the RTE / Basic Software Scheduler shall activate the `mode disabling`s of the last mode during the partition restart, if any `mode disabling dependencies` for that mode are defined.](SRS_Rte_00143, SRS_Rte_00144)

4.4.9.2 Mode Manager gets terminated

When a `mode user` gets out of sync with the `mode manager` (because the partition of the `mode manager` has been terminated) a sequence of error reactions is defined.

Hereby the RTE offers the ability to automatically switch into a default mode. This feature can be used to ensure that the `mode users` are automatically switched into a defined mode which in turn may be used to ensure a secure behavior of the `mode users`, for instance switching off some actuators.

As an alternative the `mode machine instance` can stay in the last mode which can be used to keep the "status quo" until the `mode manager` is restarted.

[SWS_Rte_06795] [The RTE Generator shall take the `modeUserErrorBehavior` from the `ModeDeclarationGroup` typing the `ModeDeclarationGroupPrototype` in the `ModeSwitchInterface` of the `PPortPrototype/PRPortPrototype`.](SRS_Rte_00143, SRS_Rte_00144)

[SWS_Rte_06785] [If the partition of the `mode manager` gets terminated during an ongoing transition, the RTE shall complete the transition.](SRS_Rte_00143, SRS_Rte_00144)

[SWS_Rte_06786] [If the partition of the `mode manager` gets terminated during an ongoing transition, the RTE shall skip the mode switch acknowledgment.] (*SRS_Rte_00143*, *SRS_Rte_00144*) For mode switch acknowledgment see **[SWS_Rte_02587]** and section 4.4.8

[SWS_Rte_06787] [The RTE shall clear all `mode switch notifications` in the queue when the partition of the `mode manager` gets terminated and after an ongoing transition is completed.] (*SRS_Rte_00143*, *SRS_Rte_00144*)

[SWS_Rte_06788] [If the attribute `modeUserErrorBehavior.errorReactionPolicy` is set to `lastMode` the `mode machine instance` stays in the last mode before the termination of the `mode manager`.] (*SRS_Rte_00143*, *SRS_Rte_00144*)

[SWS_Rte_06789] [If the attribute `modeUserErrorBehavior.errorReactionPolicy` is set to `defaultMode` the RTE shall enqueue the mode defined by `modeUserErrorBehavior.defaultMode` to the `mode switch notification` queue.] (*SRS_Rte_00143*, *SRS_Rte_00144*)

[SWS_Rte_06790] [If the attribute `modeUserErrorBehavior` is not defined the RTE shall enqueue the mode defined by `initialMode` to the `mode switch notification` queue.] (*SRS_Rte_00143*, *SRS_Rte_00144*)

[SWS_Rte_06791] [The RTE shall execute the error reactions in case the partition of the `mode manager` gets terminated in the following order:

1. **[SWS_Rte_06785]**, **[SWS_Rte_06786]**
2. **[SWS_Rte_06787]**
3. **[SWS_Rte_06788]** or **[SWS_Rte_06789]** or **[SWS_Rte_06790]**

] (*SRS_Rte_00143*, *SRS_Rte_00144*)

[SWS_Rte_06792] [The RTE shall dequeue queued `mode switch notifications` and execute them regardless whether the partition with the `mode manager` is terminated, restarting or restarted. Thereby the restart of the `mode manager`'s partition shall not abort the ongoing transition of a `mode machine instance`.] (*SRS_Rte_00143*, *SRS_Rte_00144*)

This ensures that the `defaultMode` in the `mode switch notification` queue gets effective.

[SWS_Rte_06793] [The RTE shall activate `RunnableEntity`s triggered by a `Swc-ModeManagerErrorEvent` when the partition of the `mode manager` is restarted.] (*SRS_Rte_00143*, *SRS_Rte_00144*)

4.4.10 Mapping of ModeDeclarations

There exist several use cases (especially if software is reused), where `mode users` are connected to `mode managers` providing `ModeDeclarationGroups` with different `ModeDeclarations` than the user.

Examples:

- A `mode manager` can be able to differentiate more fine grained sub states as it is required by the generic `mode user`. But due to the definition of the mode communication it is not possible to use two p-ports at the `mode manager` because this would lead to two independent and unsynchronized `mode machine instances` in the RTE.
- A generic `mode user` can support additionally modes which are not used by all `mode managers`.

This would normally lead to an error as incompatible ports are connected. To overcome this limitation the Software Component Template [2] provides a mapping between different `ModeDeclarations` so that the RTE can be translated on mode to the other.

[SWS_Rte_08511] [If a `ModeDeclaration` of a `mode user` is mapped to a single `ModeDeclaration` of a `mode manager` the related mode of the `mode user` is entered or exit when the mapped mode of the `mode manager` is entered or exit.] (*SRS_Rte_00236*)

[SWS_Rte_08512] [If one `ModeDeclaration` of a `mode user` is mapped to several `ModeDeclarations` of a `mode manager` the related mode of the `mode user` is entered when any of the mapped modes of the `mode manager` mapped by one `modeDeclarationMapping` is entered. The related mode of the `mode user` is exit when any of the mapped modes of the `mode manager` mapped by one `modeDeclarationMapping` is exit and if the new mode is not mapped by the same `modeDeclarationMapping` to related mode of the `mode user`.] (*SRS_Rte_00236*)

Note: If one `ModeDeclaration` of a `mode user` is mapped to several `ModeDeclarations` of a `mode manager` by the means of several `modeDeclarationMappings` the semantics is defined in a way that the individual mode transitions of the `mode manager` are getting visible as “exit” and “enter” events for the mode user. Further on the transition phase gets visible by the `RTE_TRANSITION` return value in the case that `Rte_Mode-API` is called during such a transition phase.

If one `ModeDeclaration` of a `mode user` is mapped to several `ModeDeclarations` of a `mode manager` by the means of a single `modeDeclarationMapping` the semantics is defined in a way that the individual mode transitions of the `mode manager` are **not** visible for the `mode user`.

Example:

The `mode manager` and the `mode user` have different `ModeDeclarationGroups` which are mapped by several `modeDeclarationMappings`. The `ModeDeclarationGroup` of the `mode manager` is more fine grained, so more than one

of its `ModeDeclarations` has to be mapped onto the same `ModeDeclaration` of the `mode user`. The `modeDeclarationMappings` can be seen in table 4.19. The complete example is listed as ARXML in Appendix F.1.

<code>modeDeclarationMapping</code>	<code>ModeDeclarations</code> of the <code>mode manager</code>	Mapped <code>ModeDeclarations</code> of the <code>mode user</code>
StartUp_2_STARTUP	StartUp	STARTUP
Run_2_RUN	Run	RUN
PostRunX_2_POST_RUN	PostRun1 PostRun2	POST_RUN
ShutDown_2_SHUTDOWN	ShutDown	SHUTDOWN
Sleep_Hibernate_2_SHUTDOWN	Sleep Hibernate	SHUTDOWN

Table 4.19: Example of a `modeDeclarationMapping` which maps `ModeDeclarations` from `mode manager` to `ModeDeclarations` of the `mode user`

Table 4.20 shows a possible scenario how mode transitions of a `mode manager` will be seen from the point of view of a `mode user` when the `modeDeclarationMapping` maps more than one `ModeDeclaration` of the `mode manager`'s `ModeDeclarationGroup` onto the same `ModeDeclaration` of the `mode user`'s `ModeDeclarationGroup`.

<code>Mode transitions</code> of the <code>mode manager</code>	<code>Mode transitions</code> of the <code>mode user</code> resulting out of the mapping
Undefined → StartUp	Undefined → STARTUP
StartUp → Run	STARTUP → RUN
Run → PostRun1	RUN → POST_RUN
PostRun1 → PostRun2	— (no transition)
PostRun2 → ShutDown	POST_RUN → SHUTDOWN
ShutDown → Sleep	SHUTDOWN → SHUTDOWN
Sleep → Hibernate	— (no transition)

Table 4.20: Possible scenario of mode transitions by the `mode manager` and the resulting transitions from the point of view of the `mode user`

A configuration that maps several `ModeDeclarations` of a `mode user` to a single `ModeDeclaration` representing a mode of a `mode manager` shall be rejected (see also [constr_1209]). This is not valid as it violates the principle that modes are mutually exclusive.

[SWS_Rte_08513] [The RTE-Generator shall reject configurations violating [constr_1209].] (*SRS_Rte_00236*)

If a `modeDeclarationMapping` exists that references a `ModeDeclaration` representing a mode of the `mode manager` then `ModeDeclarationMappings` shall exist that map all `ModeDeclarations` of the `mode manager` to `ModeDeclarations` of the `mode user` (see also [constr_1210]).

[SWS_Rte_08514] [The RTE-Generator shall reject configurations violating [constr_1210].] (*SRS_Rte_00236*)

Note: It is only supported that modes of the `mode user` might not be mapped.

4.4.11 Distributed Shared Mode Queues

In case different mode state machines are switched via synchronous mode switches, the order of their execution is basically undefined. Limited possibilities exist by using separate tasks for the different mode state machines. But these would globally give switches of one `mode machine instance` a higher priority than switches of another `mode machine instance`. In some cases it is required to keep the strict order of the mode switches, independent to which mode state machine they belong. One example, could be the key state (ON, OFF) and the engine state (RUNNING, STOPPED) which are technically independent `mode machine instances`, but have a functional connection. If the mode switch from key ON to OFF occurs first, followed by the switch from engine RUNNING to STOPPED, it was obviously the user's intention to stop the engine. If the two transitions are executed in the reverse order, the system will see a switch from engine RUNNING to STOPPED while the key state is still ON which indicates a stalled engine which a start stop system might try to restart. This example shows how important it is for the application software to see the execution of the mode switches in the order they have been requested. As a result, it is required to have a mechanism to define a FIFO order for the mode switches of at least a subset of the mode machine machines in the ECU.

A similar issue occurs in multi core systems in which user components on multiple cores have to react directly or indirectly on a mode switch. On one side it is already clear that in case mode disabling dependencies exist on multiple cores, to fulfill the requirements about the synchronous switching of these disabling dependencies, it is necessary to have one mode switch task per partition having mode disabling dependencies. But also in case there are `SwcModeSwitchEvents` in components of different partitions which react on switches of the same `mode machine instance` there have to be multiple tasks performing these switches as it is not legal to execute `RunnableEntitys` of a software component assigned to one partition in tasks belonging to another partition. To avoid that one partition is already in the new state while the other one didn't even start the transition, it is also necessary to synchronize the mode switch tasks of multiple partitions, especially if they reside on different cores. This is important for the same reason as above. A component might expect a certain behavior of the system in a certain state. If now one partitions is still in the old state while another one is already in the new state, the expectation does not match reality with the consequence of functional misbehavior.

A `distributed shared mode queue` is characterized by a set of `mode machine instances` and a set of `OsTasks` in which the mode switches of the participating mode state machines will be executed.

[SWS_Rte_06832] [The RTE Generator shall retrieve the set of `mode machine instances` belonging to one `distributed shared mode queue` from the set of `RteDSMQModeMachineInstanceRef`.] (*SRS_Rte_00143*, *SRS_Rte_00310*)

[SWS_Rte_06833] [The RTE Generator shall retrieve the set of DSMQ transition *OsTasks* belonging to one *distributed shared mode queue* from the set of *RteDSMQOsTaskRefs*.] (*SRS_Rte_00143*, *SRS_Rte_00310*)

The *OsTasks* participating in a single *distributed shared mode queue* may or may not belong to a separate partition. If such *OsTasks* are belonging to *OsApplications* executed on the same micro controller core such DSMQ transition *OsTasks* have to be chained via the EcuC configuration. But not necessarily each partition will have an *OsTask* participating in a distributed shared mode queue.

The *OsTasks* participating in a single *distributed shared mode queue* will only contain *ExecutableEntitys* mapped to this *OsTasks* via *SwcModeSwitchEvents*, *BswModeSwitchEvents*, *ModeSwitchedAckEvents* or *BswModeSwitchedAckEvents* referencing one of the *mode machine instance* participating in this *distributed shared mode queue*.

[SWS_Rte_CONSTR_09102] Exclusive usage of *OsTasks* used for *distributed shared mode queue* [An *OsTask* belonging to a *distributed shared mode queue* shall have only mapped *on-entry ExecutableEntitys*, *on-transition ExecutableEntitys*, *on-exit ExecutableEntitys*, and *ModeSwitchAck ExecutableEntitys* to it which are triggered by *mode machine instances* belonging to the identical *distributed shared mode queue*.] ()

Thereby **[SWS_Rte_06839]** constraints the order of the event to task mappings.

Similar to the behavior defined in **[SWS_Rte_02665]** the execution of the mode switch may be triggered for each partition in parallel. If the partitions are executed on the same micro controller core the order depends on the priorities of the *OsTasks* or on a configured task chaining. In case partitions are executed on different micro controller cores, execution of the *on-entry ExecutableEntitys*, *on-transition ExecutableEntitys*, and *on-exit ExecutableEntitys* may run concurrently.

[SWS_Rte_06834] [The RTE shall trigger all *OsTasks* belonging to a *distributed shared mode queue* simultaneously, except the ones which are chained after another *OsTask* belonging to this *distributed shared mode queue*.] (*SRS_Rte_00143*, *SRS_Rte_00310*)

[SWS_Rte_06835] [The RTE shall execute the mode switches of the *mode machine instances* participating in a *distributed shared mode queue* in the order of the calls of the related *Rte_Switch* or *SchM_Switch* APIs.] (*SRS_Rte_00143*, *SRS_Rte_00310*)

Thereby the queued mode switches of the *mode machine instances* of the same *distributed shared mode queue* are processed one after the other according the FIFO principle.

[SWS_Rte_06838] [The RTE shall switch at most one *mode machine instance* of the set of *mode machine instances* participating in a *distributed shared mode queue* at the same time into transition.] (*SRS_Rte_00143*, *SRS_Rte_00310*)

The implementation of the behavior defined in [SWS_Rte_06835] requires a single mode queue which handles the queuing of the mode switches for all *mode machine instances*. In opposite to the *mode machine instance* local queues such a shared queue has to memorize which transition in which *mode machine instance* was notified.

[SWS_Rte_06836] [The size of the mode queue of the *distributed shared mode queue* shall be the sum of the individual queue lengths of all mode machine instances participating in this *distributed shared mode queue*.] (*SRS_Rte_00143*, *SRS_Rte_00310*)

Nevertheless the RTE has still to check the individual queue sizes of each *mode machine instances*. This ensures, that each *mode manager* can always enqueue the maximum number of *mode switch notifications* reserved for this *mode machine instances*.

[SWS_Rte_06840] [If a new *mode switch notification* is received the RTE shall check if not more *mode switch notifications* of a particular *mode machine instance* are queued than the queue size of this particular *mode machine instance* supports. If the queue size would be exceeded, the RTE shall discard the received notification.] (*SRS_Rte_00143*, *SRS_Rte_00310*)

In this case, *Rte_Switch* will return an error, see [SWS_Rte_02675].

The behavior described in [SWS_Rte_02665] has the consequence, that RTE / Basic Software Scheduler deactivates the previous mode disablings asynchronous on each core. But one major use case of *distributed shared mode queues* is the synchronization of activities across partitions. Therefore previous mode disablings deactivated by RTE after all *on-exit ExecutableEntitys* are executed.

[SWS_Rte_06837] [During a transition of a *mode machine instance* belonging to one *distributed shared mode queue* following steps are applicable:

1. [SWS_Rte_02661],
2. [SWS_Rte_07152]
3. [SWS_Rte_02562],
4. [SWS_Rte_07153],
5. [SWS_Rte_02707],
6. [SWS_Rte_02708],
7. [SWS_Rte_02564],
8. [SWS_Rte_07154]
9. [SWS_Rte_02563] (The transition is completed with this step), and
10. immediately followed by [SWS_Rte_02587]

If a step is not applicable, the order of the remaining steps shall be unchanged.

Thereby:

- Step 1. - 2 shall be executed synchronously in each partition for the whole mode machine instance.
- Step 3. - 8. may be executed in parallel on the different cores and therefore are triggered in parallel for each partition.
- Step 9. shall be executed synchronously in each partition for the whole mode machine instance.

The step 10. is executed if the step 1. - 9. is finished for the whole mode machine instance.]([SRS_Rte_00143](#), [SRS_Rte_00310](#))

4.5 External and Internal Trigger

4.5.1 External Trigger Event Communication

4.5.1.1 Introduction

With the mechanism of the trigger event communication a software component or a *Basic Software Module* acting as a [trigger source](#) is able to request the activation of *Runnable Entities* respectively *Basic Software Schedulable Entities* of connected [trigger sinks](#). Typically but not necessarily these *Runnable Entities* and *Basic Software Schedulable Entities* are executed in a sequential order.

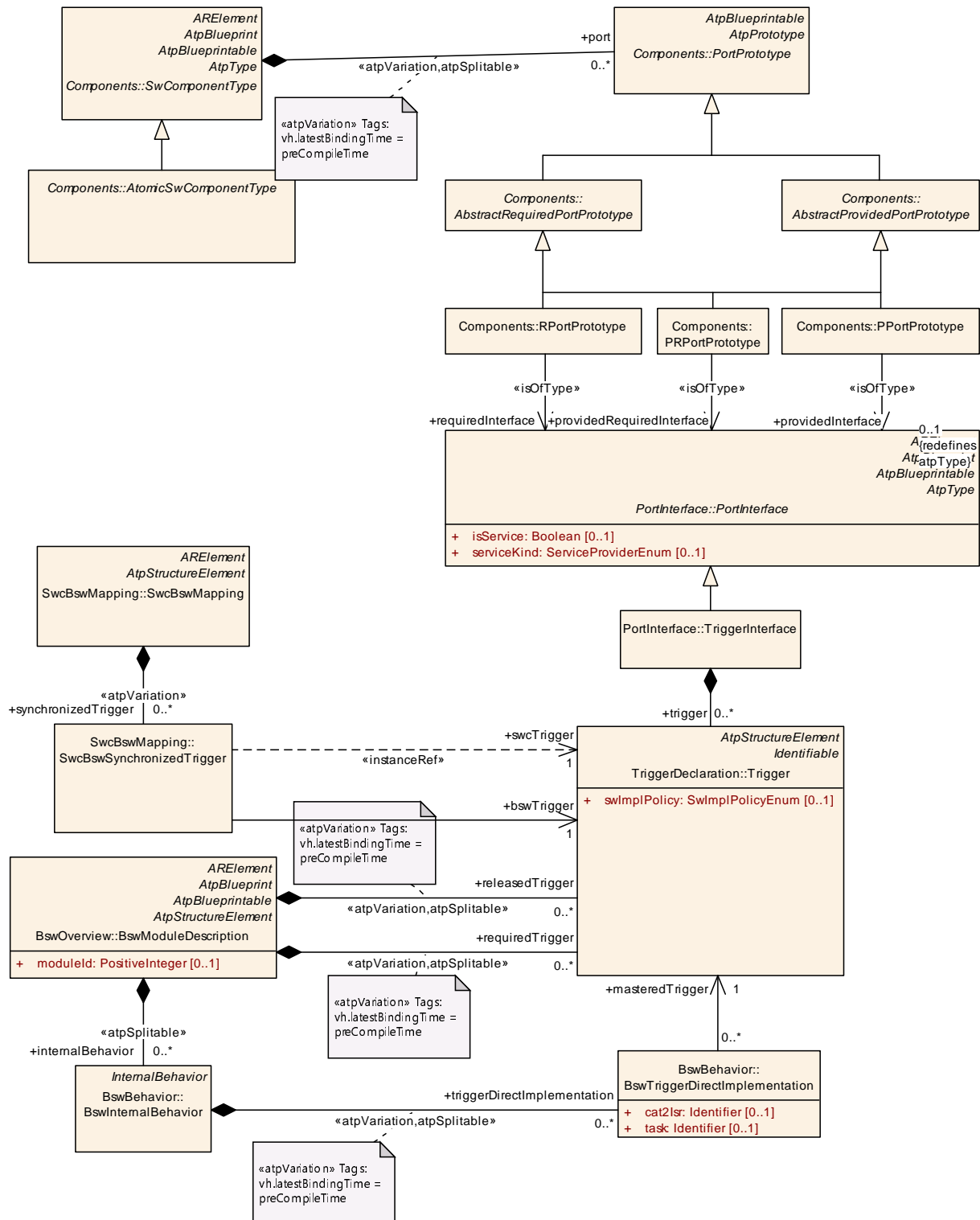


Figure 4.51: Summary of the use of Trigger by an AUTOSAR software-components and Basic Software Modules as defined in the *Software Component Template Specification*[2] and *Specification of BSW Module Description Template*[9].

[SWS_Rte_07212] [The RTE shall support *External Trigger Event Communication*.]
(SRS_Rte_00162)

[SWS_Rte_07542] [The *Basic Software Scheduler* shall support the activation of *Basic Software Schedulable Entities* occurrence of External Trigger Events.] ([SRS_Rte_00216](#))

4.5.1.2 Trigger Sink

A AUTOSAR software-component `trigger sink` has a dedicated require `trigger port`. The `trigger port` is typed by an *TriggerInterface* declaring one or more *Trigger*. See figure 4.51. The *Runnable Entities* of the software component are activated at the occurrence of the external event by the means of an `ExternalTriggerOccurredEvent`.

An *Basic Software Module* `trigger sink` has to define a *requiredTrigger Trigger*. The *Basic Software Schedulable Entities* of the *Basic Software Module* are activated at the occurrence of the external event by the means of a `BswExternalTriggerOccurredEvent`. See figure 4.51.

Basically there are two approaches to implement the activation of `triggered ExecutableEntity`s. In one case the `triggered ExecutableEntity`s of the `trigger sinks` triggered by one *Trigger* of the `trigger source` are mapped in one or more tasks/ISR2s. In this case the event communication can be implemented by the means of activating an Operating System Task. Please note that the tasks/ISR2s may belong to different partitions.

[SWS_Rte_07213] [The RTE generator shall support invocation of `triggered ExecutableEntity`s via OS Task/ISR2s.] ([SRS_Rte_00162](#), [SRS_Rte_00216](#))

In the other case the Event Communication is mapped to a function call which means that the `triggered ExecutableEntity`s of the `trigger sinks` are executed in the `Rte_Trigger` API respectively `SchM_Trigger` API used to raise the trigger event in the `trigger sinks`.

[SWS_Rte_07214] [The RTE generator shall support invocation of `triggered ExecutableEntity`s via *direct function calls*, if all of the following conditions are fulfilled:

- the `triggered ExecutableEntity`s do not define a ‘minimum start distance’
- the `trigger sink` and `trigger source` are in the same Partition
- if no *BswTriggerDirectImplementation* is defined.
- if the preconditions of [constr_4086] are fulfilled

] ([SRS_Rte_00162](#), [SRS_Rte_00216](#))

[SWS_Rte_08906] [The RTE generator shall support invocation of `triggered ExecutableEntity`s via *trusted function calls*, if all of the following conditions are fulfilled:

- the `triggered ExecutableEntitys` do not define a ‘minimum start distance’
- the `trigger sink` and `trigger source` are in different Partitions on the same core
- if no *BswTriggerDirectImplementation* is defined.
- if the preconditions of [constr_4086] are fulfilled

]([SRS_Rte_00162](#), [SRS_Rte_00216](#))

4.5.1.3 Trigger Source

An AUTOSAR software-component `trigger source` has a dedicated provide `trigger port`. The `trigger port` is typed by an *TriggerInterface* declaring one or more *Trigger*. See figure 4.51. To be able to connect a provide `trigger port` and a require `trigger port`, both ports must be categorized by the same or by compatible *TriggerInterface(s)*.

An *Basic Software Module* `trigger source` has to define a *releasedTrigger Trigger*. See figure 4.51. The connection of *releasedTrigger* and *requiredTrigger Trigger* is defined by the ECU configuration of the *Basic Software Scheduler*.

To inform the RTE about an occurrence of the external trigger event the RTE provides the `Rte_Trigger` to an AUTOSAR software-component `trigger source`.

[SWS_Rte_07543] [The call of the `Rte_Trigger` API shall activate all *Runnable Entities* that are activated by *ExternalTriggerOccurredEvents* associated to a connected *Trigger* of the `trigger source` if the trigger queue is empty.]([SRS_Rte_00162](#))

For Basic Software Module `trigger source` are two options defined to interfaces with *Basic Software Scheduler*.

The first option is that the *Basic Software Module* `trigger source` inform the *Basic Software Scheduler* about an occurrence of the external trigger event by the call of the `SchM_Trigger` API.

[SWS_Rte_07544] [The call of the `SchM_Trigger` API shall activate all *ExecutableEntitys* that are activated by *ExternalTriggerOccurredEvents* associated to a connected *Trigger* of the `trigger source` if the trigger queue is empty.]([SRS_Rte_00216](#))

The second option is that the *Basic Software Module* `trigger source` directly takes care about the activation of the particular OS task to which the *ExternalTriggerOccurredEvents* of the `triggered ExecutableEntitys` are mapped. In this case the `trigger source` has to define a *BswTriggerDirectImplementation*. The name of the used OS tasks is annotated by the *task* attribute. If an *BswTriggerDirectImplementation* is defined no `SchM_Trigger` API is generated by the RTE generator. see [\[SWS_Rte_07548\]](#) and [\[SWS_Rte_07264\]](#).

[SWS_Rte_07545] [The RTE generator shall reject configurations where a *BswTriggerDirectImplementation* is specified and an *ExecutableEntity* that is activated by an *ExternalTriggerOccurredEvent* associated to a connected *Trigger* of the *trigger source* is mapped to an OS task different from the one defined by the task attribute of the *BswTriggerDirectImplementation*.] (*SRS_Rte_00216*, *SRS_Rte_00018*)

[SWS_Rte_07548] [The RTE generator shall reject configurations where a *issuedTrigger* association and a *BswTriggerDirectImplementation* is defined for the same *releasedTrigger Trigger*.] (*SRS_Rte_00216*, *SRS_Rte_00018*)

[SWS_Rte_CONSTR_09007] *issuedTrigger* and *BswTriggerDirectImplementation* are mutually exclusive [A *releasedTrigger Trigger* shall not be referenced by both a *issuedTrigger* and a *BswTriggerDirectImplementation*.] ()

Note: This shall ensure in the combination with the existence conditions ([SWS_Rte_07264]) of the *SchM_Trigger* that either the *Trigger* API or the direct task activation is offered to the implementation of the *trigger source*.

Note also that several OS tasks might be used to implement a *Trigger* (several *BswTriggerDirectImplementation* can be defined for a *releasedTrigger*).

If the *BswTriggerDirectImplementation* is defined for a *releasedTrigger* which *swImplPolicy* attribute is set to *queued* it is part of the *trigger source* to implement the queue or to use the means of the OS (*OsTaskActivation* > 1) to queue the number of raised triggers. (*OsTaskActivation* > 1). Further details about queuing of triggers is described in 4.5.5.

4.5.1.4 Multiplicity

4.5.1.4.1 Multiple Trigger

A trigger interface contains one or more *Trigger*. A port of an AUTOSAR software-component that provides an AUTOSAR trigger interface to the component can independently raise events related to each *Trigger* defined in the interface .

[SWS_Rte_07215] [The RTE API shall support independent event raising for each *Trigger* in a trigger interface.] (*SRS_Rte_00162*)

Further on a *Basic Software Module trigger source* can define several *releasedTrigger Trigger* which can be independently raised.

[SWS_Rte_07546] [The *Basic Software Scheduler* API shall support independent event raising for each *releasedTrigger Trigger*.] (*SRS_Rte_00216*)

4.5.1.4.2 Multiple Trigger Sinks Single Trigger Source

The concept of external event communication supports, that a `trigger source` activates one or more `triggered ExecutableEntities` in one or more `trigger sinks`.

[SWS_Rte_07216] [The RTE generator shall support `triggered ExecutableEntities` triggered by the same `Trigger` of a `trigger source` ('1 : n ' communication where $n \geq 1$).] ([SRS_Rte_00162](#), [SRS_Rte_00216](#))

The execution order of the `triggered ExecutableEntities` in the trigger sinks depends from the `RteEventToTaskMapping` described in chapter 8.5.1 and the configured priorities of the operating system.

4.5.1.4.3 Multiple Trigger Sources Single Trigger Sink

The RTE generator does not support multiple `trigger sources` communicating events to the same `Trigger` in a `trigger sink` (' n : 1' communication where $n > 1$).

[SWS_Rte_07039] [The RTE generator shall reject configurations where multiple `trigger sources` communicating events to the same `Trigger` in a `trigger sink` (' n : 1' communication where $n > 1$).] ([SRS_Rte_00018](#))

[SWS_Rte_CONSTR_09008] **The same `Trigger` in a `trigger sink` must not be connected to multiple `trigger sources`** [The same `Trigger` in a `trigger sink` must not be connected to multiple `trigger sources`.] ()

4.5.1.5 Synchronized Trigger

If two `Triggers` are synchronized by the definition of a `SwcBswSynchronizedTrigger` then the `Trigger` in the referenced provide `trigger port` and the referenced `releasedTrigger Trigger` are treated as one common `Trigger`. This means that all `ExecutableEntities` activated by an `ExternalTriggerOccurredEvent` associated to one of the connected `Triggers` are activated together.

[SWS_Rte_07218] [The RTE and *Basic Software Scheduler* shall activate together all `ExecutableEntities` that are activated by `ExternalTriggerOccurredEvents` associated to a synchronized connected `Trigger`.] ([SRS_Rte_00162](#), [SRS_Rte_00216](#), [SRS_Rte_00217](#))

[SWS_Rte_07549] [The RTE generator shall reject configurations where a synchronized `Trigger` is referenced by more than one type of access method, where the type is one of the following:

1. `ExternalTriggeringPoint`
2. `issuedTrigger`

3. BswTriggerDirectImplementation

](SRS_Rte_00216, SRS_Rte_00217, SRS_Rte_00018)

[SWS_Rte_CONSTR_09009] Synchronized `Trigger` shall not be referenced by more than one type of access method [A synchronized `Trigger` shall only be referenced by either `ExternalTriggeringPoints`, `issuedTriggers` or `BswTriggerDirectImplementations`.]()

Note: This shall ensure in the combination with the existence conditions of the `Rte_Trigger` and `SchM_Trigger` that only one kind of Trigger API ([SWS_Rte_07201] and [SWS_Rte_07264]) or the direct task activation is offered to the implementation of the `trigger source`.

4.5.2 Inter Runnable Triggering

With the mechanism of *Inter Runnable Triggering* one *Runnable Entity* is able to request the activation of *Runnable Entities* of the same software-component instance.

[SWS_Rte_07220] [The RTE shall support Inter Runnable Triggering.](SRS_Rte_00163)

Similar to External Trigger Event Communication (described in chapter 4.5.1) the activation of triggered runnables can be implemented by means of activating an Operating System Task or by direct or trusted function call.

[SWS_Rte_07555] [The call of the `Rte_IrTrigger` API shall activate all `triggered runnables` which *InternalTriggerOccurredEvents* are associated with the related *InternalTriggeringPoint* of the same software-component instance if the trigger queue is empty.](SRS_Rte_00163)

[SWS_Rte_07221] [The RTE shall support for Inter Runnable Triggering that `triggered runnables` entities are invoked via OS Task activation.](SRS_Rte_00163)

[SWS_Rte_07224] [The RTE shall support for *Inter Runnable Triggering* that `triggered runnables` are invoked via direct function call if all of the following conditions are fulfilled:

- none of the `triggered BswSchedulableEntitys` activated by this *InternalTriggeringPoint* define a 'minimum start distance'

](SRS_Rte_00163)

4.5.2.1 Multiplicity

An `InternalTriggeringPoint` might be referenced by more than one `InternalTriggerOccurredEvent`. Therefore one `RunnableEntity` is able to request the

activation of several `RunnableEntity`'s with the mechanism of Inter Runnable Triggering contemporaneously.

[SWS_Rte_07223] [The RTE shall support multiple `RunnableEntity`'s triggered by the same `InternalTriggeringPoint` ('1 : n' Inter Runnable Triggering where $n \geq 1$).] ([SRS_Rte_00163](#))

The execution order of the runnable entities in the trigger sinks depends from the Runnable Entity to task mapping described in chapter 8.5.1 and the configured priorities of the operating system.

4.5.3 Inter Basic Software Module Entity Triggering

The *Inter Basic Software Module Entity Triggering* is similar to the mechanism of *Inter Runnable Triggering* (see chapter 4.5.2) with the exception that it is used inside a Basic Software Module. It can be used to request the activation of a `BswSchedulableEntity` by a *Basic Software Entity* of the same a *Basic Software Module* instance.

[SWS_Rte_07551] [The *Basic Software Scheduler* shall support *Inter Basic Software Module Entity Triggering*.] ([SRS_Rte_00230](#))

Similar to External Trigger Event Communication (described in chapter 4.5.1) the activation of triggered `BswSchedulableEntity` can be implemented by means of activating an Operating System Task or by direct or trusted function call.

[SWS_Rte_07552] [The call of the `SchM_ActMainFunction` API shall activate all `triggered BswSchedulableEntitys` which `BswInternalTriggerOccurredEvents` are associated by the related *activationPoint* of the same a *Basic Software Module* instance if the trigger queue is empty.] ([SRS_Rte_00230](#))

[SWS_Rte_07553] [The *Basic Software Scheduler* shall support for *Inter Basic Software Module Entity Triggering* that `triggered BswSchedulableEntitys` are invoked via OS Task activation.] ([SRS_Rte_00230](#))

[SWS_Rte_07554] [The *Basic Software Scheduler* shall support for *Inter Basic Software Module Entity Triggering* that `triggered BswSchedulableEntitys` are invoked via direct or trusted function call if

- the `triggered BswSchedulableEntitys` do not define a 'minimum start distance'
- if the preconditions of constraint [constr_4086] are fulfilled

] ([SRS_Rte_00230](#))

Note: Typically the feature of *Inter Basic Software Module Entity Triggering* is used to decouple the execution context of *Basic Software Entities*. But if this decoupling is really required depends from the particular scheduling concept and microcontroller performance.

4.5.4 Inter ECU Trigger Communication

The trigger communication is also possible in case of [inter-ECU](#) communication. In this case, a software component on an ECU can act as a [trigger source](#) for a software component on another ECU, so requesting the activation of software components on the other ECU.

[SWS_Rte_08409] [The RTE shall support [inter-ECU Trigger](#) Communication.]()

[SWS_Rte_08410] [The RTE shall support the activation of [RunnableEntity](#)s occurrence of [Trigger](#) Events coming from another ECU.]()

[SWS_Rte_08411] [In case of an issued [Trigger](#) the RTE shall send the [ISignal](#) associated with that [Trigger](#) to the Com stack.]()

In case no data transformation is used, the API call argument of `Com_SendSignal` has no meaning. In case of data transformation, the first transformer is executed without input data.

[SWS_Rte_08412] [In case of a received [Trigger](#) without data transformation the RTE shall only care about the COM Notification which indicates a reception of the zero size signal. The value of such signal shall not be read (`Com_ReceiveSignal` shall not be called).]()

In case of a received [Trigger](#) with data transformation the RTE executes the inverse data transformation on the received data from Com Stack. (See [\[SWS_Rte_08597\]](#)). This is necessary to recognize transformation errors.

[SWS_Rte_08072] [The RTE generator shall reject configurations violating the [\[constr_3065\]](#).] ([SRS_Rte_00018](#))

4.5.5 Queuing of Triggers

Conceptually triggers are always queued. The queuing of triggers ensures that the number of executions of [triggered ExecutableEntity](#)s is equal to the number of released triggers. Further on it ensures that the number of activations of [triggered ExecutableEntity](#)s is equal for all associated [triggered ExecutableEntity](#)s of a [trigger emitter](#) if the associated [triggered ExecutableEntity](#)s are not activated by other [RTEEvents](#).

Note: The conceptional queue can be implemented in various ways, depending on the SWC or BSWM integration and RTE vendor's choice. In some cases the trigger queue can be implemented by simple counter. While in other cases the queue is not even implemented in the RTE at all. For example, in case of using the OS task queue as the trigger queue (see further down in this chapter), the trigger enqueue operation boils down to calling `ActivateTask` and the dequeue operation to the termination of the activated task(s). In case of trigger events not being mapped to an [OsTask](#) the enqueue and dequeue operations are even both reduced to the same moment when the execution of the related [RunnableEntity](#)s in the Trigger API starts.

[SWS_Rte_07087] [The RTE shall support the queuing of triggers for

- *External Trigger Event Communication*
- *Inter Runnable Triggering*
- *Inter Basic Software Module Entity Triggering*

regardless of the value of the attribute `swImplPolicy` of the trigger entity or the existence or value of `RteTriggerSourceQueueLength` / `RteBswTriggerSourceQueueLength`.] ([SRS_Rte_00235](#))

[SWS_Rte_07088] [The RTE shall enqueue a trigger when the RTE gets informed about the occurrence of a trigger by the call of the related API (`Rte_IrTrigger`, `Rte_Trigger`, `SchM_Trigger`, `SchM_ActMainFunction`) if the maximum queue length (`RteTriggerSourceQueueLength` / `RteBswTriggerSourceQueueLength`) is not exceeded.] ([SRS_Rte_00235](#))

[SWS_Rte_07089] [The RTE shall dequeue a trigger when the RTE is informed about the end of execution of all `triggered ExecutableEntitys` which are triggered by this `trigger emitter`. In the case of `triggered ExecutableEntitys` whose execution is disabled by a mode disabling dependency then the trigger is dequeued as if the entities ran. This behaviour prevents the dequeue operation from being blocked indefinitely.] ([SRS_Rte_00235](#))

[SWS_Rte_07090] [The RTE shall activate all `triggered ExecutableEntitys` associated to a `trigger emitter` when it has successfully dequeued a trigger from the trigger queue of the `trigger emitter` except for the last dequeued trigger.] ([SRS_Rte_00235](#))

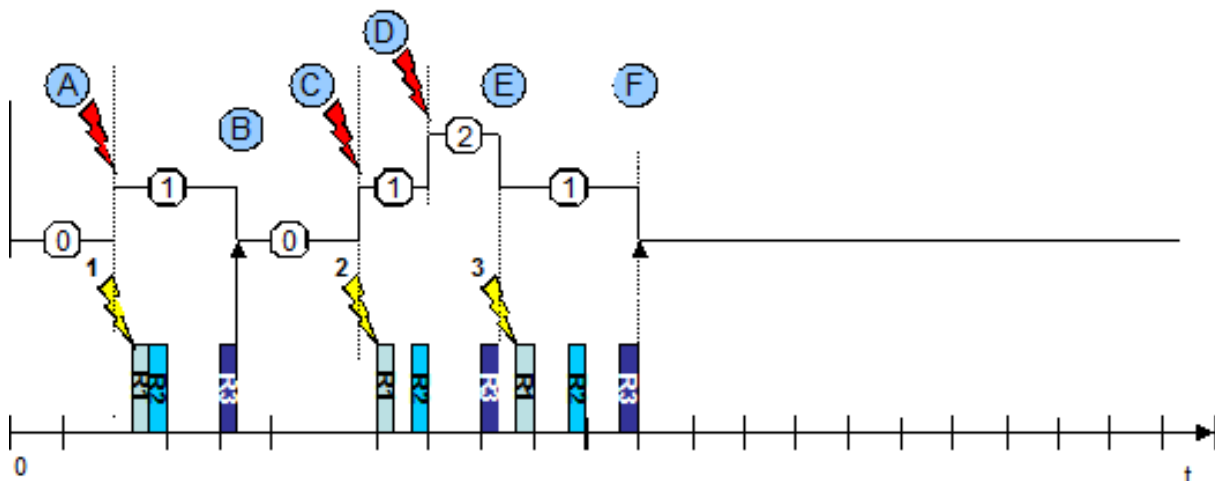


Figure 4.52: Queued activation of `ExecutableEntitys`

The figure 4.52 illustrates the basic behavior of a trigger queue.

- At "A" the RTE gets informed by the call of the API about the occurrence of a Trigger. Since no trigger is in the queue all associated `triggered`

`ExecutableEntities` are activated ([SWS_Rte_07544], [SWS_Rte_07555], [SWS_Rte_07552]) and the trigger is enqueued ([SWS_Rte_07088]).

- At "B" all `triggered ExecutableEntities` which are triggered by this `trigger emitter` have terminated. The RTE dequeues the trigger but since it is the last dequeued trigger the associated `triggered ExecutableEntities` are not activated again.
- At "C" the RTE gets informed by the call of the API about the occurrence of a Trigger. Enqueuing of triggers and activating of `triggered ExecutableEntities` is done as in "A"
- At "D" the RTE gets informed again by occurrence of a trigger. Since a trigger is already in the queue the associated `triggered ExecutableEntities` are not activated ([SWS_Rte_07544], [SWS_Rte_07555], [SWS_Rte_07552]). Nevertheless the trigger is enqueued ([SWS_Rte_07088]).
- At "E" all `triggered ExecutableEntities` which are triggered by this `trigger emitter` have terminated. The RTE dequeues the trigger ([SWS_Rte_07089]) and activates all associated `triggered ExecutableEntities` ([SWS_Rte_07090]).
- At "E" all `triggered ExecutableEntities` which are triggered by this `trigger emitter` have terminated. Dequeuing of triggers is done as in "B"

Implementation hint:

One possible solution to implement the queue for the number of released triggers is to use the means of the operation systems which already can queue the activation requests for a OS task (`OsTaskActivation > 1`). This for sure is only possible if all `ExternalTriggerOccurredEvents`, `InternalTriggerOccurredEvents`, `BswExternalTriggerOccurredEvent` and `BswInternalTriggerOccurredEvent` connected to the same `trigger emitter` are mapped exclusively to one OS task.

4.5.6 Activation of triggered ExecutableEntities

The activation of `triggered ExecutableEntities` is done like described in chapter 4.2.3. See also Fig. 4.18.

If the `triggered ExecutableEntities` are activated synchronous or asynchronous depends how the `RTEEvents` and `BswEvents` are mapped to OS tasks.

If all `ExternalTriggerOccurredEvents` of the `trigger sinks` which are associated to connected `Trigger` of the `trigger source`

- either are mapped to OS task(s) with higher priority as the OS task where the `Executable Entity` calling the `Rte_Trigger` respectively the `SchM_Trigger` API is mapped

- or are activated by direct or trusted function call

the triggering behaves synchronous. This means that all "triggered" *Executable Entities* of the `trigger sinks` are executed before the `Rte_Trigger` or `SchM_Trigger` API returns.

If any *ExternalTriggerOccurredEvent* of the `trigger sinks` which are associated to connected *Trigger* of the `trigger source`

are mapped to an OS task with lower priority as the OS task where the *Executable Entity* calling the `Rte_Trigger` respectively the `SchM_Trigger` API is mapped the triggering behaves asynchronous. This means that **not** all *triggered ExecutableEntities* of the `trigger sinks` are executed before the `Rte_Trigger` or `SchM_Trigger` API returns.

4.6 Initialization and Finalization

4.6.1 Initialization and Finalization of the RTE

RTE and *Basic Software Scheduler* have a nested life cycle. It is only permitted to initialize the RTE if the *Basic Software Scheduler* is initialized ([SWS_Rte_CONSTR_09036]). Further on it is only supported to finalize the *Basic Software Scheduler* after the RTE is finalized ([SWS_Rte_CONSTR_09056]).

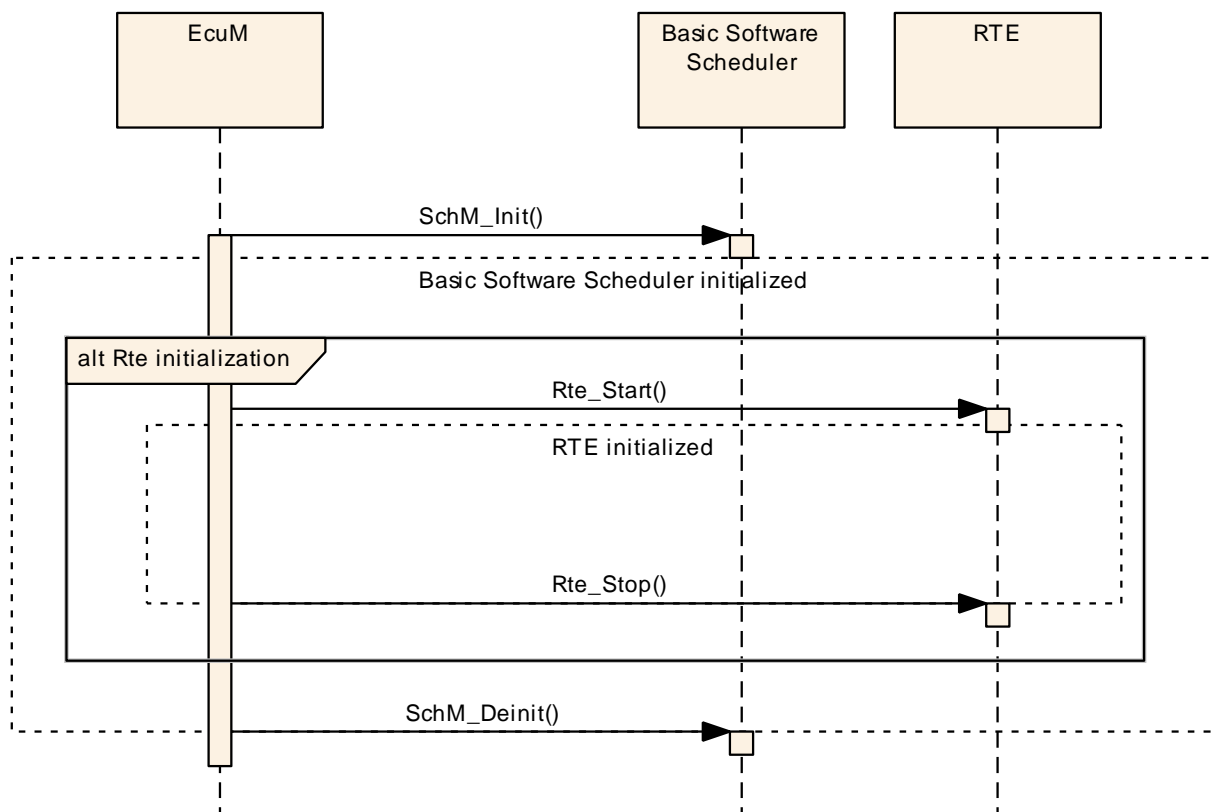


Figure 4.53: Nested life cycle of RTE and *Basic Software Scheduler*

4.6.1.1 Initialization of the Basic Software Scheduler

Before the *Basic Software Scheduler* is initialized only the API calls `SchM_Enter` and `SchM_Exit` are available ([SWS_Rte_07578]).

The ECU state manager calls the startup routine `SchM_Init` of the *Basic Software Scheduler* before any *Basic Software Module* needs to be scheduled.

The initialization routine of the *Basic Software Scheduler* will return within finite execution time (see [SWS_Rte_07273]).

The *Basic Software Scheduler* will initialize the `mode machine instances` ([SWS_Rte_02544]) assigned to the *Basic Software Scheduler*. This will activate the `mode disablings` of all initial modes during `SchM_Init` and trigger the execution of the `on-entry ExecutableEntities` of the initial modes. After initialization of the *Basic Software Scheduler* internal data structure and `mode machine instances` the activation of *Basic Software Schedulable Entities* triggered by `BswTimingEvents` starts.

[SWS_Rte_07574] [The call of `SchM_StartTiming` shall start the activation of `BswSchedulableEntities` triggered by `BswTimingEvents`.] (SRS_Rte_00211)

[SWS_Rte_07584] [The call of `SchM_Init` shall start the activation of `BswSchedulableEntities` triggered by `BswBackgroundEvents`.] (SRS_Rte_00211)

Note: In case of OS task where `BswEvents` and `RTEEvents` are mapped to the RTE Generator has to ensure, that `RunnableEntities` are not activated before the RTE is initialized or after the RTE is finalized. See [SWS_Rte_07580] and [SWS_Rte_02538].

[SWS_Rte_07580] [The *Basic Software Scheduler* has to prevent the activation of `RunnableEntities` before the RTE is initialized.] (SRS_Rte_00220)

4.6.1.2 Initialization of the RTE

The ECU state manager calls the startup routine `Rte_Start` of the RTE at the end of startup phase II when the OS is available and all basic software modules are initialized.

The initialization routine of the RTE will return within finite execution time (see [SWS_Rte_02585]).

Before the RTE is initialized completely, there is only a limited capability of RTE to handle incoming data from COM:

The RTE will initialize the `mode machine instances` ([SWS_Rte_02544]) assigned to the RTE. This will activate the `mode disablings` of all initial modes during `Rte_Start` and trigger the execution of the `on-entry ExecutableEntities` of the initial modes. Further on for `common mode machine instances` the `on-entry Runnable Entities` of the current active mode are executed during the initialization of the RTE ([SWS_Rte_07582]). `common mode machine instances` can not enter the transition phase during RTE initialization ([SWS_Rte_07583]).

[SWS_Rte_07575] [The call of `Rte_Start` shall start the activation of `RunnableEntities` triggered by `TimingEvents` if the `Rte_StartTiming` API does not exist.] (*SRS_Rte_00072*)

[SWS_Rte_07178] [The call of `Rte_Start` shall start the activation of `RunnableEntities` triggered by `BackgroundEvents` if the `Rte_StartTiming` API does not exist.] (*SRS_Rte_00072*)

[SWS_Rte_06759] [The call of `Rte_StartTiming` shall start the activation of `RunnableEntities` triggered by `TimingEvents` if the `Rte_StartTiming` API does exist.] (*SRS_Rte_00072*, *SRS_Rte_00240*)

[SWS_Rte_06760] [The call of `Rte_StartTiming` shall start the activation of `RunnableEntities` triggered by `BackgroundEvents` if the `Rte_StartTiming` API does exist.] (*SRS_Rte_00072*, *SRS_Rte_00240*)

[SWS_Rte_07615] [The call of `Rte_Start` shall be executed on every core independently.] ()

[SWS_Rte_07616] [The `Rte_Start` includes the partition specific startup activities of RTE for all partitions that are mapped to the core, from which the `Rte_Start` is called.] ()

4.6.1.3 Stop and restart of the RTE

Partitions of the ECU can be stopped and restarted. In a stopped or restarting partition, the OS has killed all running tasks. RTE has to react to stopping and restarting partitions.

The RTE does not execute `ExecutableEntities` of a terminated or restarting partition.

[SWS_Rte_07604] [The RTE shall not activate, start or release `ExecutableEntity execution-instances` of a terminated or restarting partition.] (*SRS_Rte_00195*)

The RTE is notified of the termination (respectively, the beginning of restart) of a partition by the `Rte_PartitionTerminated` (respectively, `Rte_PartitionRestarting`) API. At this point in time, the tasks containing the runnables of this partition are already killed by the OS. In case of restart, RTE is notified by the `Rte_RestartPartition` API when the communication can be re-initialized and re-enabled.

[SWS_Rte_07604] also applies to `ExecutableEntities` whose execution started before the notification to the RTE. RTE can rely on the OS functionality to stop or restart an OS application and all related OS objects.

When a partition is restarted, the RTE will restore an initial environment for its SW-Cs.

[SWS_Rte_02735] [When the `Rte_RestartPartition` API for a partition is called, the RTE shall restore an initial environment for its SW-Cs on this partition.] ()

The SW-Cs themselves are responsible to restore their internal initial environment and should not rely on any initialization performed by the compiler. This should be done in initialization runnables.

[SWS_Rte_07610] [The RTE Generator shall reject configurations where the `handleTerminationAndRestart` attribute of a SW-C is not set to `canBeTerminatedAndRestarted` and this SW-C is mapped on a Partition with the `PartitionCanBeRestarted` parameter set to TRUE.]([SRS_Rte_00018](#), [SRS_Rte_00196](#))

When a partition is terminated or is being restarted, it is important that the runnable entities of this partition are not activated before the partition returns to the ACTIVE state.

In case of partition restart or termination, event sent to this partition or activation of tasks of this partition are discarded. The RTE can use these mechanism to ensure that `ExecutableEntitys` are not activated.

4.6.1.4 Finalization of the RTE

The finalization routine `Rte_Stop` of the RTE is called by the ECU state manager at the beginning of shutdown phase I when the OS is still available. (For details of the ECU state manager, see [7]. For details of `Rte_Start` and `Rte_Stop` see section 5.8.)

[SWS_Rte_02538] [The RTE shall not activate, start or release `RunnableEntitys` on a core after `Rte_Stop` has been called on this core.]([SRS_Rte_00116](#), [SRS_Rte_00220](#))

Note: RTE does not kill the tasks during the ‘running’ state of the runnables.

[SWS_Rte_02535] [RTE shall ignore incoming client server communication requests, before RTE is initialized completely and when it is stopped.]([SRS_Rte_00116](#))

[SWS_Rte_02536] [Incoming data and events from sender receiver communication shall be ignored, before RTE is initialized completely and when it is stopped.]([SRS_Rte_00116](#))

4.6.1.5 Finalization of the *Basic Software Scheduler*

The ECU state manager calls the finalization routine `SchM_Deinit` of the *Basic Software Scheduler* if the scheduling of *Basic Software Modules* has to be stopped.

[SWS_Rte_07586] [The BSW Scheduler shall neither activate nor start `BswScheduleableEntitys` on a core after `SchM_Deinit` has been called on this core.]([SRS_Rte_00116](#))

Note: The BSW Scheduler does not kill the tasks during the ‘running’ state of the [BswSchedulableEntity](#)s.

[SWS_Rte_04552] [The basic software scheduler shall ignore incoming client server communication requests, before the basic software scheduler is initialized completely or after it is stopped.]([SRS_Rte_00116](#))

4.6.2 Initialization and Finalization of AUTOSAR Software-Components

For the initialization and finalization of AUTOSAR software components, RTE provides the mechanism of mode switches. A [SwcModeSwitchEvent](#) of an appropriate [ModeDeclaration](#) can be used to trigger a corresponding initialization or finalization runnable (see [\[SWS_Rte_02562\]](#)). Runnables that shall not run during initialization or finalization can be disabled in the corresponding modes with a `mode disabling` dependency (see [\[SWS_Rte_02503\]](#)).

Since category 2 runnables have no predictable execution time and can not be terminated using `ModeDisablingDependencies`, it is the responsibility of the implementer to set meaningful termination criteria for the cat 2 runnables. These criteria could include mode information. At latest, all runnables will be terminated by RTE during the shutdown of RTE, see [\[SWS_Rte_02538\]](#).

It is appropriate to use user defined modes that will be handled in a proprietary [application mode manager](#).

All runnables that are triggered by entering an initial mode, are activated immediately after the initialization of RTE. They can be used for initialization. In many cases it might be preferable to have a multi step initialization supported by a sequence of different initialization modes.

In addition to the mode-based approach [RunnableEntity](#)s to be used for initialization purposes can be activated by [InitEvents](#) as well. More information is provided in section [4.2.2.11](#).

4.7 Variant Handling Support

4.7.1 Overview

The *AUTOSAR Templates* support the creation of *Variants* in a subset of its model elements. The *Variant Handling* support in the *AUTOSAR Templates* is driven by the purpose to describe variability in a *AUTOSAR System* on several aspects, e.g.

- Virtual Functional Bus
- Component [SwcInternalBehavior](#) and [SwcImplementation](#)
- Deployment of the software components to ECUs
- Communication Matrix
- Basic Software Modules

This approach requires that the RTE Generator is able to process the described Variability in input configurations and partially to implement described variability in the generated RTE and Basic Software Scheduler code.

In the meta-model all locations that may exhibit variability are marked with the stereotype `<<atpVariation>>`. This allows the definition of possible variation points. Tagged Values are used to specify additional information.

There are four types of locations in the meta-model which may exhibit variability:

- Aggregations
- Associations
- Attribute Values
- Classes providing property sets

More details about the AUTOSAR Variant Handling Concept can be found in the AUTOSAR Generic Structure Template [10].

[SWS_Rte_06543] [The RTE generator shall support the [VariationPoints](#) defined in the *AUTOSAR Meta Model*] ([SRS_Rte_00201](#), [SRS_Rte_00202](#), [SRS_Rte_00229](#), [SRS_Rte_00191](#))

The list of [VariationPoints](#) shall provide an overview about the most prominent ones which impacting the generated RTE code. Further on tables will show which implementation of variability is standardized due to the relevance for contract phase. (see tables [4.23](#), [4.25](#), [4.26](#), [4.27](#), [4.28](#), [4.29](#), [4.33](#), [4.34](#), [4.36](#) and [4.37](#). But please note that these tables are not listing all possible variation of the input configuration. For that the related Template Specifications are relevant.

4.7.2 Choosing a Variant and Binding Variability

To understand the later definition it is required to clarify the difference between *Choosing a Variant* and *Resolving Variability*.

A particular *PreBuild Variant* in a variant rich input configuration is chosen by assigning particular values to the `SwSystemconsts` with the means of `PredefinedVariants` and associated `SwSystemconstantValueSets`. With this information `SwSystem-constDependentFormulas` can be evaluated which determines PreBuild conditions of `VariationPoints` and attribute values. Nevertheless the input configuration contains still the information of all potential variants.

A particular *PostBuild Variant* in a variant rich input configuration is chosen by assigning particular values to the `PostBuildVariantCriterion` with the means of `PredefinedVariants` and associated `PostBuildVariantCriterionValueSets`. With this information `PostBuildVariantConditions` can be evaluated for instance to check the consistency of chosen *PostBuild Variant*. Nevertheless the input configuration contains still the information of all potential variants.

From an RTE perspective this information is mainly used to generate the *RTE Post Build Variant Sets* which are used to bind the `post-build variability` during initialization of the RTE (call of `SchM_Init`).

The variability of an input configuration is bound if information related to other variants is removed and only the information of the bound variant is kept. Binding respectively resolving variability in the scope of this specification means that the generated code only implements the particular variant which results out of the chosen variant of the input configuration.

If the variability can not be resolved in a particular phase of the *RTE Generation Process* (see chapter 3) the generated RTE files have to be able to support the potential variants by implementing all potential variants.

If the variability is relevant for the software components contract the RTE Generator uses standardized *Condition Value Macros* to implement the `pre-build variability`. These *Condition Value Macros* are set in the *RTE PreBuild Data Set Contract Phase* and *RTE PreBuild Data Set Generation Phase* to the resulting value of the evaluated `ConditionByFormula` of the related `VariationPoint`.

For further definition see sections 4.7.2.3, 4.7.2.4, 4.7.2.5, 4.7.2.6 and 4.7.2.7.

4.7.2.1 General impact of Binding Times on RTE generation

In the AUTOSAR meta-model, each `VariationPoint` is associated with a tag named `vh.latestBindingTime`. The value of the tag yields the applicable latest binding time for the given `VariationPoint`.

Each `VariationPoint` with a `swSyscond` has an attribute `bindingTime` in its `ConditionByFormula`, which defines when the pre-build condition may be evaluated earliest for this `VariationPoint`. This controls the capability of the software implementation to bind the variant earliest at a certain point of time.

Even if the variability is chosen earlier (for instance by assigning `SwSystemconst-Values` to the `SwSystemconsts` used by the `VariationPoint`'s condition) the RTE generator has to respect potential later binding of the `VariationPoints`.

Please note that variability with the `bindingTime` `PreCompileTime` and `post-BuildVariantConditions` has a particular semantic for the RTE generation and impacts the generated output.

For instance a conditional existence RTE API which is bound at `PreCompileTime` requires that the RTE generator inserts specific pre processor statements.

RTE Phase	System Design Time	Code Generation Time	Pre Compile Time	Link Time	Post Build
RTE Contract Phase	R	R	I	n/a	n/a
Basic Software Scheduler Contract Phase	R	R	I	n/a	n/a
RTE PreBuild Data Set Contract Phase	n/a	n/a	RV	n/a	n/a
Basic Software Scheduler Generation Phase	R	R	I	n/a	I
RTE Generation Phase	R	R	I	n/a	I
RTE PreBuild Data Set Generation Phase	n/a	n/a	RV	n/a	n/a
RTE PostBuild Data Set Generation Phase	n/a	n/a	n/a	n/a	RV

Table 4.21: Overview impact of Binding Times on RTE generation

R	resolve variability, a particular variant is the output
I	implement variability, all possible variants in the output
RV	provide values to resolve implemented variability <i>PreBuild</i> or <i>PostBuild</i>
n/a	not applicable

Table 4.22: Key to table 4.21

4.7.2.2 Choosing a particular variant

A particular variant of the variant rich input configuration is chosen via the ECU configuration. For that purpose a set of `PredefinedVariants` is configured to chosen

a variant in the input configuration and to later on bind the variability in subsequent phases of the *RTE Generation Process* 3. For further information see document [10].

[SWS_Rte_06500] [For each *pre-build variability* in the input configuration the RTE Generator shall choose a particular variant according to the *Predefined-Variants* selected by the parameter *EcucVariationResolver*.] (*SRS_Rte_00201*, *SRS_Rte_00202*, *SRS_Rte_00229*, *SRS_Rte_00191*)

[SWS_Rte_06546] [For each *post-build variability* in the input configuration the RTE Generator shall choose a particular variant according to the *PredefinedVariants* selected by the parameter *RtePostBuildVariantConfiguration*.] (*SRS_Rte_00201*, *SRS_Rte_00202*, *SRS_Rte_00229*, *SRS_Rte_00191*)

Having variants chosen the RTE generator can apply further consistency checks on the particular variants.

4.7.2.3 SystemDesignTime

Variability with latest binding time *SystemDesignTime* (called *SystemDesignTime variability*) has to be bound before the *RTE Contract Phase* respectively *Basic Software Scheduler Contract Phase*. Such variability is resolved by RTE generator in all generation phases. Due to that such kind of variability results always in a particular variant and needs no special code generation rules for RTE generator.

[SWS_Rte_06501] [The RTE generator shall bind *SystemDesignTime variability* in the *RTE Contract Phase*, *Basic Software Scheduler Contract Phase*, *RTE Generation Phase* and *Basic Software Scheduler Generation Phase* (3).] (*SRS_Rte_00191*)

[SWS_Rte_06502] [The RTE Generator shall reject input configurations during the *RTE Contract Phase* where not a particular variant is chosen for each *SystemDesignTime variability* affecting the software components contract.] (*SRS_Rte_00201*, *SRS_Rte_00018*)

[SWS_Rte_06503] [The RTE Generator shall reject input configurations during the *Basic Software Scheduler Contract Phase* where not a particular variant is chosen for each *SystemDesignTime variability* affecting the *Basic Software Scheduler* contract.] (*SRS_Rte_00229*, *SRS_Rte_00018*)

[SWS_Rte_06504] [The RTE Generator shall reject input configurations during the *Basic Software Scheduler Generation Phase* where not a particular variant is chosen for each *SystemDesignTime variability* affecting the *Basic Software Scheduler* generation.] (*SRS_Rte_00229*, *SRS_Rte_00018*)

[SWS_Rte_06505] [The RTE Generator shall reject input configurations during the *RTE Generation Phase* where not a particular variant is chosen for each *SystemDesignTime variability* affecting the *RTE* generation.] (*SRS_Rte_00201*, *SRS_Rte_00202*, *SRS_Rte_00018*)

4.7.2.4 CodeGenerationTime

During *RTE Contract Phase*, *RTE Generation Phase* and *Basic Software Scheduler Generation Phase* the variability with latest binding time *CodeGenerationTime* (called *CodeGenerationTime variability*) has to be bound and the RTE generator resolves the variability. This denotes that the code is generated for a particular variant. To do this it is required that a particular variant for each *CodeGenerationTime variability* has to be chosen.

[SWS_Rte_06507] [The RTE generator shall bind *CodeGenerationTime variability* in the *RTE Contract Phase*, *Basic Software Scheduler Contract Phase*, *RTE Generation Phase* and *Basic Software Scheduler Generation Phase* (see sections 3.1.1, 3.1.2, 3.4.1 and 3.4.2).] (*SRS_Rte_00229*, *SRS_Rte_00191*)

[SWS_Rte_06547] [The RTE Generator shall reject input configurations during the *RTE Contract Phase* where not a particular variant is chosen for each *CodeGenerationTime variability* affecting the software components contract.] (*SRS_Rte_00191*, *SRS_Rte_00018*)

[SWS_Rte_06548] [The RTE Generator shall reject input configurations during the *Basic Software Scheduler Contract Phase* where not a particular variant is chosen for each *CodeGenerationTime variability* affecting the *Basic Software Scheduler* contract.] (*SRS_Rte_00229*, *SRS_Rte_00018*)

[SWS_Rte_06508] [The RTE Generator shall reject input configurations during the *Basic Software Scheduler Generation Phase* where not a particular variant is chosen for each *CodeGenerationTime variability* affecting the *Basic Software Scheduler* generation.] (*SRS_Rte_00229*, *SRS_Rte_00018*)

[SWS_Rte_06509] [The RTE Generator shall reject input configurations during the *RTE Generation Phase* where not a particular variant is chosen for each *CodeGenerationTime variability* affecting the *RTE* generation.] (*SRS_Rte_00191*, *SRS_Rte_00018*)

4.7.2.5 PreCompileTime

Variability with latest binding time *PreCompileTime* (called *PreCompileTime variability*) is relevant for the *RTE Contract Phase* and *Basic Software Scheduler Contract Phase* as well as for the *RTE Generation Phase* and *Basic Software Scheduler Generation Phase*. The *Application Header File*, *Application Types Header File*, *Module Interlink Header* and *Module Interlink Types Header* and the generated *RTE / Basic Software Scheduler* has to support the potential variability of the software components and *Basic Software Modules*. The variability is resolved during the execution of the pre processor of the C-Compiler.

[SWS_Rte_06510] [The RTE generator shall implement *PreCompileTime variability* in the *RTE Contract Phase*, *Basic Software Scheduler Contract Phase*, *RTE Generation Phase*, *Basic Software Scheduler Generation Phase* via pre processor

statements in the generated RTE code (see sections 3.1.1, 3.1.2, 3.4.1 and 3.4.2).] ([SRS_Rte_00191](#))

[SWS_Rte_06553] [The RTE Generator shall use the defined *Attribute Value Macro* instead of immediate values if the value depends on an *AttributeValueVariationPoint* where the *bindingTime* is set to *preCompileTime*.] ([SRS_Rte_00191](#))

4.7.2.6 LinkTime

The latest Binding Time *LinkTime* will not be supported for *VariationPoints* relevant for the RTE Generator.

[SWS_Rte_06511] [The RTE generator shall reject configuration which defines RTE or *Basic Software Scheduler* relevant *LinkTime variability*.] ([SRS_Rte_00018](#))

4.7.2.7 PostBuild

Variability with latest binding time *PostBuild* (called *post-build variability*) might be bound / rebound after the generated RTE is compiled and has been linked to the executable. The generated RTE binary code has to contain all variants. Which variant is executed during ECU runtime is decided by variant selectors.

[SWS_Rte_06512] [The RTE generator shall implement *post-build variability* in the *RTE Generation Phase* and *Basic Software Scheduler Generation Phase* via C statements in the generated RTE code (see 3.4.1 and 3.4.2).] ([SRS_Rte_00191](#))

Combining PreBuild and post-build variability

According document [10] it is supported that a *VariationPoint* defines a *pre-build variability* in conjunction with *post-build variability*. If the *PreBuild condition* is false, it is not expected that the element which is subject to variability including the code evaluating the *PostBuild condition* gets implemented at all.

[SWS_Rte_06549] [In cases where a *VariationPoint* defines a *SystemDesignTime variability* or *CodeGenerationTime variability* in conjunction with *post-build variability* the *post-build variability* shall only be implemented by the RTE Generator in the generated RTE code if the condition of the *pre-build variability* evaluates to true.] ([SRS_Rte_00191](#))

[SWS_Rte_06550] [In cases where a *VariationPoint* defines a *PreCompileTime variability* in conjunction with *post-build variability* the *post-build variability* shall only be effective in the RTE executable if the condition of the *PreCompileTime variability* evaluates to true.] ([SRS_Rte_00191](#))

In this case the *post-build variability* implemented according **[SWS_Rte_06512]** depends from the *PreCompileTime variability* implemented according **[SWS_Rte_06510]**.

4.7.3 Variability affecting the RTE generation

4.7.3.1 Software Composition

This section describes the affects of the existence of variation points with regards to compositions. Though the application software compositions have been flattened and effectively eliminated after allocation to an ECU there is still one composition to consider for the RTE (i.e. the [RootSwCompositionPrototype](#)). The [RootSwCompositionPrototype](#) contains the atomic software components allocated to the respective ECU, its assembly connections, its delegation connections and the connections of the delegation ports to system signals. Once the variability is resolved for a variation point it must adhere to the constraints and limitations that apply to a model that does not have any variations. For example dangling connectors are not allowed and as such their existence will lead to undefined behavior if such configurations still exist after resolving post-build variation points.

Also within this specification section the wording "a variant is enabled or disabled" refers to the variation point's *SwSystemConstDependentFormula* and/or *PostBuildVariantCondition* evaluating to "true or false" respectively.

4.7.3.1.1 Variant existence of [SwComponentPrototypes](#)

[SWS_Rte_06601] [If a variant is disabled for the aggregation of a [SwComponentPrototype](#) in a [CompositionSwComponentType](#) then all [RTEEvents](#) destined for [Runnables](#) in the respective [SwComponentPrototype](#) shall be blocked; No [RTEEvent](#) is allowed to reach any [Runnable](#) that is contained in a "disabled" [SwComponentPrototype](#).] ([SRS_Rte_00206](#), [SRS_Rte_00207](#), [SRS_Rte_00204](#))

Potential misconfigurations of connectors connecting to ports of "disabled" SWC's will result in undefined behavior; It is the responsibility of the person considering the variability of the [SwComponentPrototype](#) to make the connections also variable and valid when a variant selection results in the elimination of a [SwComponentPrototype](#) from a composition. It is recommended to use predefined variants to ensure proper configurations are established.

4.7.3.1.2 Variant existence of [SwConnectors](#)

[SWS_Rte_06602] [If a variant is disabled for a [SwConnector](#) (i.e. [AssemblySwConnector](#) or [DelegationSwConnector](#)) aggregated in a [CompositionSwComponentType](#) then the [PortPrototypes](#) at each end of the connector shall behave as an unconnected port (see section 5.2.7 for the defined RTE behavior) if no other variant enables a [SwConnector](#) between these ports.] ([SRS_Rte_00206](#), [SRS_Rte_00207](#))

4.7.3.1.3 COM related Variant existence

This section describes the impact on the RTE interaction with the COM layer as a result of variability of DataMappings (i.e. [SenderReceiverToSignalMapping](#) and [SenderReceiverToSignalGroupMapping](#) in the [SystemMapping](#)) as well as the existence of variants for [ISignals](#). The Meta Model allows for mapping the same data to different [SystemSignals](#) as well as associating a [SystemSignal](#) with 1 or more [ISignals](#).

[SWS_Rte_06603] [If a variant is enabled for a [SystemMapping](#) aggregating a [DataMapping](#) then the RTE shall call the appropriate API's for the applicable mapping type.]([SRS_Rte_00206](#), [SRS_Rte_00207](#))

[SWS_Rte_06604] [The appropriate API shall be determined based on the existence of variants of [ISignals](#) to which a [SystemSignal](#) is associated to. For each enabled [ISignal](#) the RTE shall call the proper COM API to send and receive data [System-Signals](#)]([SRS_Rte_00206](#), [SRS_Rte_00207](#))

For example for an instance mapping from a [VariableDataPrototype](#) to a [SystemSignal](#) the RTE shall call the corresponding [Com_SendSignal](#) with the proper [SignalId](#) and [SignalDataPtr](#) based on the selected variant [DataMapping](#).

The existence of variants of [ISignals](#) is determined by the System element (see also [constr_3028]).

[SWS_Rte_06605] [Delegation ports on a [RootSwCompositionPrototype](#) for which no [DataMapping](#) exists (i.e. no variant [DataMapping](#) is enabled) shall be considered unconnected because no path exists to a designated [SystemSignal](#). Since this is a delegation port all enabled delegation connectors linking SWC R-ports to the respective delegation port must be considered unconnected (see section 5.2.7). P-Ports shall behave as documented in section 4.7.3.1.2.]([SRS_Rte_00206](#), [SRS_Rte_00207](#))

4.7.3.1.4 Variant existence of *PortPrototypes*

[SWS_Rte_06606] [If no variant is enabled for a delegation port on a [RootSwCompositionPrototype](#) then all connected R-Ports using a [DelegationSwConnector](#) to this delegation port shall be considered unconnected (see section 5.2.7). The behavior of the P-ports shall be as defined in section 4.7.3.1.2.]([SRS_Rte_00206](#), [SRS_Rte_00207](#))

Note on variant disabling criteria: In a proper variant configuration the following should be followed: when a [PortPrototype](#) is eliminated from any [SwComponentType](#) then any associated [SwConnector](#) should also have a variation point removing the connection since the connection is illegal.

4.7.3.2 Atomic Software Component and its Internal Behavior

4.7.3.2.1 RTE API which is subject to variability

Following [VariationPoints](#) in the Meta Model do control the variant existence of RTE API for a software component. If a RTE API is variant existent, the API mapping and the related entries in the component data structure are 'variant' as well. This means, if a RTE API does not exist the API mapping does not exist as well. A part of the component data structure entries are related to the existences of the port. In these cases the *component data structure entry* depends from the existence of the [PortPrototype](#).

Variation Point	RTE API which is subject to variability	form	kind infix
Condition Value Macro			
ExclusiveArea [SWS_Rte_06518]	Rte_Enter , Rte_Exit	component internal	ExAr
VariableDataPrototype in the role arTyped-PerInstanceMemory [SWS_Rte_06518]	Rte_Pim	component internal	PIM
PerInstanceMemory [SWS_Rte_06518]	Rte_Pim	component internal	PIM
ParameterDataPrototype in the role perInstanceParameter [SWS_Rte_06518]	Rte_CData	component internal	Prm
ParameterDataPrototype in the role shared-Parameter [SWS_Rte_06518]	Rte_CData	component internal	Prm
ServerCallPoint [SWS_Rte_06515]	Rte_Call	component port	
AsynchronousServerCallResultPoint [SWS_Rte_06515]	Rte_Result	component port	
InternalTriggeringPoint [SWS_Rte_06519]	Rte_IrTrigger	entity internal	IRT
ExternalTriggeringPoint [SWS_Rte_06515]	Rte_Trigger	component port	
ModeSwitchPoint [SWS_Rte_06515]	Rte_Switch , Rte_SwitchAck	component port	
ModeAccessPoint [SWS_Rte_06515]	Rte_Mode	component port	
VariableAccess in the role dataReadAccess [SWS_Rte_06515]	Rte_IRead , Rte_IStatus , Rte_IsUpdated	entity port	

VariableAccess in the role dataWriteAccess [SWS_Rte_06515]	Rte_IWrite, Rte_IWriteRef, Rte_IInval- idate, Rte_ IFeedback	entity port	
VariableAccess in the role dataSendPoint [SWS_Rte_06515]	Rte_Write, Rte_Invalidate, Rte_Feedback	component port	
VariableAccess in the role dataReceive- PointByArgument [SWS_Rte_06515]	Rte_Read	component port	
VariableAccess in the role dataReceive- PointByValue [SWS_Rte_06515]	Rte_DRead	component port	
VariableAccess in the role readLocalVari- able referring an explicitInterRunnable- Variable [SWS_Rte_06518]	Rte_IrvRead	component internal	IRV
VariableAccess in the role writtenLo- calVariable referring an explicitInter- RunnableVariable [SWS_Rte_06518]	Rte_IrvWrite	component internal	IRV
VariableAccess in the role readLocalVari- able referring an implicitInterRunnable- Variable [SWS_Rte_06519]	Rte_IrvIRead	entity internal	IRV
VariableAccess in the role writtenLo- calVariable referring an implicitInter- RunnableVariable [SWS_Rte_06519]	Rte_IrvIWrite Rte_IrvI- WriteRef	entity internal	IRV
PortPrototype referring a ParameterInter- face [SWS_Rte_06515]	Rte_Prm	component port	
PortAPIOption with attribute indirectAPI [SWS_Rte_06520]	Rte_Port		

Table 4.23: variant existence of RTE API

column	description
kind infix	The column kind infix defines infix strings to differentiate condition value macros belonging to variation points of different API sets
form	The column form specifies which names for the macro of the condition value are concatenated to ensure a unique name space of the macro.
form	description
component port	The related API is provide for the whole software component and belongs to a software components port
entity port	The related API is provide for a particular RunnableEntity and belongs to a software components port
component internal	The related API is provide for the whole software component and belongs to a software component internal functionality

entity internal	The related API is provide per RunnableEntity and belongs to a software component internal functionality
-----------------	--

Table 4.24: Key to table 4.23

[SWS_Rte_06517] [The RTE generator shall treat RTE API as variant RTE API only if all elements (e.g. [VariableAccess](#)) in the input configuration controlling the existence of the same RTE API are subject to variability.] ([SRS_Rte_00203](#))

4.7.3.2.2 Conditional API options

Following variation points in the Meta Model do control the variant properties of RTE API or allocated Memory.

Variation Point Condition Value Macro	Subject to variability
PortAPIOption with attribute portArgValue not standardized	PortDefinedArgument-Value is passed to a RunnableEntity
PortAPIOption with attribute indirectAPI not standardized	Number of Ports which are supporting indirect API, see Rte_NPorts and Rte_Ports

Table 4.25: Conditional API options

4.7.3.2.3 Runnable Entity's and RTEEvents

Following variation points in the Meta Model do control the variant existence and activation of [RunnableEntity](#)s.

Variation Point Condition Value Macro	Subject to variability
RunnableEntity [SWS_Rte_06530]	Existence of the RunnableEntity prototype
RTEEvent not standardized	Activation of the RunnableEntity

Table 4.26: variation on Runnable Entity's and RTEEvents

4.7.3.2.4 Conditional Memory Allocation

Following variation points in the Meta Model do control the variant existence of RTE memory allocation for the software component instance.

Variation Point Condition Value Macro	Subject to variability
<code>implicitInterRunnableVariable</code> not standardized	variable definition implementing the <code>implicitInterRunnableVariable</code>
<code>explicitInterRunnableVariable</code> not standardized	variable definition implementing the <code>explicitInterRunnableVariable</code>
<code>arTypedPerInstanceMemory</code> not standardized	variable definition implementing the <code>arTypedPerInstanceMemory</code>
<code>PerInstanceMemory</code> not standardized	variable definition implementing the <code>PerInstanceMemory</code>
<code>perInstanceParameter</code> not standardized	constant definition implementing the <code>perInstanceParameter</code>
<code>sharedParameter</code> not standardized	variable definition implementing the <code>sharedParameter</code>
<code>InstantiationDataDefProps</code> , <code>SwDataDefProps</code> not standardized	Allocation of the memory objects described via <code>swAddrMethod</code> , accessibility for MCD systems described via <code>swCalibrationAccess</code> , <code>displayFormat</code> , <code>mcFunction</code>

Table 4.27: Conditional Memory Allocation

4.7.3.3 NvBlockComponent and its Internal Behavior

Variation Point Condition Value Macro	Subject to variability
<code>PortPrototype</code> of a <code>NvBlockSwComponentType</code> typed by <code>NvDataInterface</code> not standardized	Existence of the ability to access the memory objects of the <code>ramBlock</code>
<code>NvBlockDataMapping</code> of a <code>NvBlockDescriptor</code> not standardized	Existence of the ability to access the memory objects of the <code>ramBlock</code>

provide <code>PortPrototype</code> of a <code>NvBlockSwComponentType</code> typed by <code>ClientServerInterface</code> , <code>RunnableEntity</code> and referring <code>OperationInvokedEvent</code> not standardized	Existence of the <i>Block Management</i> port and the ability to access the <i>Block Management</i> API of the <i>NvRAM Manager</i>
require <code>PortPrototype</code> of a <code>NvBlockSwComponentType</code> typed by <code>ClientServerInterface</code> , <code>RoleBasedPortAssignment</code> and referring the <code>PortPrototype</code> not standardized	Existence of the <i>callback notification</i> port
<code>NumericalValueSpecification</code> or <code>TextValueSpecification</code> of the <code>ramBlock</code> or <code>romBlocks</code> <code>initValue</code> <code>ValueSpecification</code> (aggregated or referred one) not standardized	initialization values of the memory objects implementing the <code>ramBlock</code> or <code>romBlock</code>
<code>InstantiationDataDefProps</code> not standardized	Allocation of the memory objects implementing the <code>ramBlock</code> or <code>romBlock</code> described via <code>swAddrMethod</code> , accessibility for MCD systems described via <code>swCalibrationAccess</code> , <code>displayFormat</code> , <code>mcFunction</code>

Table 4.28: variation in `NvBlockSwComponentTypes`

4.7.3.4 Parameter Component

Variation Point Condition Value Macro	Subject to variability
<code>PortPrototype</code> of a <code>ParameterSwComponentType</code> not standardized	Existence of the memory objects / definitions related to the <code>ParameterDataPrototypes</code> in the <code>PortInterface</code> referred by the <code>PortPrototype</code>
<code>NumericalValueSpecification</code> or <code>TextValueSpecification</code> of the <code>ParameterProvideComSpecs</code> <code>initValue</code> <code>ValueSpecification</code> (aggregated or referred one) not standardized	initialization values of the memory objects / definitions related to the <code>ParameterDataPrototypes</code>

Table 4.29: variation in `ParameterSwComponentTypes`

4.7.3.5 Data Type

Following variation points in the Meta Model do control the variant generation of data types.

Variation Point Condition Value Macro	Subject to variability
<code>ImplementationDataTypeElement</code> [SWS_Rte_06542]	Existence of the structure or union element

<code>arraySize</code> [SWS_Rte_06541]	Number of elements in the array
<code>CompuMethod upperLimit</code>	Upper limit of the <code>ImplementationDataType</code>
<code>CompuMethod lowerLimit</code>	Lower limit of the <code>ImplementationDataType</code>
<code>CompuMethod v</code> attributes	Coefficients of nominator and denominator

Table 4.30: variation in `ImplementationDataTypes`

Variation Point Condition Value Macro	Subject to variability
<code>DataConstr upperLimit</code> [SWS_Rte_06551]	Upper limit of the <code>Application-PrimitiveDataType</code>
<code>DataConstr lowerLimit</code> [SWS_Rte_06552]	Lower limit of the <code>Application-PrimitiveDataType</code>
<code>CompuMethod upperLimit</code>	Upper limit of the <code>Application-PrimitiveDataType</code>
<code>CompuMethod lowerLimit</code>	Lower limit of the <code>Application-PrimitiveDataType</code>
<code>CompuMethod v</code> attributes	Coefficients of nominator and denominator

Table 4.31: variation in `ApplicationDataTypes` and related meta classes

4.7.3.6 Constants

Variation Point Condition Value Macro	Subject to variability
<code>NumericalValueSpecification value</code>	numerical value
<code>ApplicationValueSpecification v</code> (swArraysize)	size of compound primitives
<code>ApplicationValueSpecification v</code> (value) attributes	physical value

Table 4.32: variation in `ValueSpecifications`

4.7.3.7 Basic Software Modules and its Internal Behavior

4.7.3.7.1 Basic Software Interfaces

Variation Point Condition Value Macro	Subject to variability
providedEntry not standardized	Existence of the provided BswModuleEntry
outgoingCallback not standardized	Existence of the expected BswModuleEntry
ModeDeclarationGroupPrototype in role provided-ModeGroup not standardized	Existence of the provided ModeDeclarationGroupPrototype
ModeDeclarationGroupPrototype in role required-ModeGroup not standardized	Existence of the required ModeDeclarationGroupPrototype
Trigger in role releasedTrigger not standardized	Existence of the released Trigger
Trigger in role requiredTrigger not standardized	Existence of the required Trigger

Table 4.33: variability affecting *Basic Software Interfaces*

4.7.3.8 Flat Instance descriptor

It is possible to instruct the RTE Generator to provide various instances for a ParameterDataPrototype in the component description. Therefore one FlatInstanceDescriptor per expected parameter instance has to point to the ParameterDataPrototype. Thereby the FlatInstanceDescriptors needs to define post build variation points to resolve the access to the various parameter instances.

Further details are described in section 4.2.9.3.7.

4.7.4 Variability affecting the Basic Software Scheduler generation

4.7.4.1 Basic Software Scheduler API which is subject to variability

The VariationPoints listed in table 4.34 in the input configuration are controlling the variant existence of *Basic Software Scheduler* API.

Variation Point Condition Value Macro	Subject to variability	form	kind infix
ExclusiveArea [SWS_Rte_06535]	SchM_Enter, SchM_Exit	module internal	ExAr
managedModeGroup association to providedModeGroup ModeDeclarationGroupPrototype	SchM_Switch, SchM_SwitchAck	module external	MMod

[SWS_Rte_06536]			
accessedModeGroup association to providedModeGroup or requiredModeGroup ModeDeclarationGroupPrototype [SWS_Rte_06536]	SchM_Mode	module external	AMod
issuedTrigger association to releasedTrigger Trigger [SWS_Rte_06536]	SchM_Trigger	module external	Tr
BswModuleCallPoint [SWS_Rte_06536]	SchM_Call	module external	SrvCall
BswAsynchronousServerCallResult-Point [SWS_Rte_06536]	SchM_Result	module external	SrvRes
dataSendPoint association to provided-Data [SWS_Rte_06536]	SchM_Send	module external	DSP
dataReceivePoint association to requiredData [SWS_Rte_06536]	SchM_Receive	module external	DRP
BswInternalTriggeringPoint [SWS_Rte_06536]	SchM_ActMainFunction	entity internal	ITr
perInstanceParameter Parameter-DataPrototype [SWS_Rte_06535]	SchM_CData	module internal	PIP

Table 4.34: variant existence of Basic Software Scheduler API

column	description
kind infix	The column kind infix defines infix strings to differentiate condition value macros belonging to variation points of different API sets
form	The column form specifies which names for the macro of the condition value are concatenated to ensure a unique name space of the macro.
form	description
module external	The related API is provide for the whole module and belongs to a module interface
module internal	The related API is provide for the whole module and belongs to a module internal functionality
entity internal	The related API is provide per ExecutableEntity and belongs to a module internal functionality

Table 4.35: Key to table 4.34

[SWS_Rte_06537] [The RTE generator shall treat the existence of *Basic Software Scheduler* API as subject to variability only if all elements (e.g. [managedModeGroup](#) association) in the input configuration controlling the existence of the same *Basic Software Scheduler* API are subject to variability.]([SRS_Rte_00229](#))

4.7.4.2 Basic Software Entities

The [VariationPoints](#) listed in table 4.36 in the input configuration are controlling the variant existence of [BswModuleEntity](#)s and the variant activation of [BswSchedulableEntity](#)s.

Variation Point Condition Value Macro	Subject to variability
BswSchedulableEntity [SWS_Rte_06532]	Existence of the BswSchedulableEntity prototype
BswEvent not standardized	Activation of the BswSchedulableEntity

Table 4.36: variability affecting [BswSchedulableEntity](#)s

4.7.4.3 API behavior

The [VariationPoints](#) listed in table 4.37 in the input configuration are controlling the variant behavior of *Basic Software Scheduler* API.

Variation Point Condition Value Macro	Subject to variability
BswModeSenderPolicy not standardized	Queue length in the mode machine instance dependent from the attribute
BswModeReceiverPolicy not standardized	attribute supportsAsynchronousModeSwitch has to be considered according the bound variant

Table 4.37: variant existence of [BswSchedulableEntity](#)

4.7.5 Variability affecting SWC implementation

In this section some examples will be given in order to describe the affects of variability with regard to SWC implementation. The implemented variability in SWCs is described through [VariationPointProxys](#) and can be resolved by pre-build evaluation, by post-build evaluation or by the combination of them. Furthermore for each [VariationPointProxy](#) AUTOSAR defines the [category](#)s VALUE and CONDITION (see Software Component Template [2]). In the following code examples one scenario for each [category](#) will be described. The first scenario addresses the post-build case and the second one the case of combination of pre-build and post-build.

Scenario for category VALUE

VariationPointProxy FRIDA

postBuildValueAccess Rte_PBCon_FRIDA = 3

might result for example in something like:

```

1  /* Generated RTE-Code */
2
3  const Rte_PBCon_FRIDA 3

1  /* SWC-Code */
2
3  if (Rte_PBCon_FRIDA == 3) {
4      /* code depending on proxy FRIDA */
5  }
6  else {
7      /* functional alternative, if FRIDA is not selected */
8  }

```

Scenario for category CONDITION

SystemConstant FRANZ = 10

VariationPointProxy HUGO

conditionAccess Rte_SysCon_HUGO = (FRANZ == 10)

postBuildVariantCondition A = 3, postBuildVariantCondition B = 5

might result for example in something like:

```

1  /* Generated RTE-Code */
2
3  #define Rte_SysCon_HUGO 1
4
5  #define Rte_PBCon_HUGO (
6      Rte_SysCon_HUGO  &&
7      RteInternal_EvalPostBuildVariantCondition_HUGO_A &&
8      RteInternal_EvalPostBuildVariantCondition_HUGO_B
9  )

1 /*SWC-Code*/
2
3 /* ensure that no code for HUGO remains in
4    the binary, if HUGO is not selected */
5 #if Rte_SysCon_HUGO
6
7 /* check during run time, if HUGO is
8    active due to post-build conditions */
9 if (Rte_PBCon_HUGO) {
10     /* code depending on proxy HUGO */
11 }
12 else {
13     /* functional alternative, if HUGO is not selected */
14 }
15
16 #else
17 /* functional alternative is always
18    active since HUGO is not selected */
19 #endif

```

Since the post-build data structure is not standardized the algorithm for the evaluation of the expressions `RteInternal_EvalPostBuildVariantCondition_HUGO_A` and `RteInternal_EvalPostBuildVariantCondition_HUGO_B` is up to the implementer.

In contrast to `Rte_SysCon` the `Rte_PBCon` API has no guarantee, that it can be resolved in the pre-processor. It is subject to the optimization of the compiler to reduce code size. If one wants to be absolutely sure, that no superfluous code exists even with non optimizing compilers, he needs to implement a pre-processor directive in addition (see example).

4.8 Development error

Errors which can occur at runtime in the RTE are classified as development errors. The RTE uses a BSW module report these types of errors to the DET [25] (Default Error Tracer).

4.8.1 DET Report Identifiers

[SWS_Rte_06631] [The RTE shall use the OS Application Identifier as the Instance Id to enable the developer to identify in which runtime section of the RTE the error occurs. This Instance ID is even unique across multi cores and so implicitly allows the development error to be traced to a specific core.] ([SRS_BSW_00337](#))

[SWS_Rte_06632] [The RTE shall use the Service Id as identified in the table 4.39. Each RTE API template, RTE callback template and RTE API will have an Identifier. This ID Service ID must be used when running code in the context of the respective RTE call.] ([SRS_BSW_00337](#))

4.8.2 DET Error Identifiers

Only a limited set of development identifiers are currently recognized. Each of these need to be detected either at runtime or during initialization of the RTE. To report these errors extra development code must be generated by the RTE generator.

[SWS_Rte_06633] [An `RTE_E_DET_ILLEGAL_SIGNAL_ID` (0x01) shall be reported at runtime by the RTE when it receives a COM callback for a signal name (e.g. `Rte_COMCbK_<sn>`, `Rte_COMCbKTack_<sn>`) which was not expected within the context of the currently-selected postBuild variant. See section 5.9.2.1 for the list of possible COM callback template API.] ([SRS_BSW_00337](#))

[SWS_Rte_06634] [An `RTE_E_DET_ILLEGAL_VARIANT_CRITERION_VALUE` (0x02) shall be reported by the RTE when it determines that a value is assigned to a

variant criterion which is not in the list of possible values for that criterion. This error shall be detected during the RTE initialization phase.]([SRS_BSW_00337](#))

[SWS_Rte_07684] [An RTE_E_DET_ILLEGAL_VARIANT_CRITERION_VALUE (0x02) shall be reported by the *Basic Software Scheduler* when the [SchM_Init](#) API is called with a `NULL` parameter.]([SRS_BSW_00337](#))

[SWS_Rte_06635] [An RTE_E_DET_ILLEGAL_INVOCATION (0x03) shall be reported by the RTE when it determines that an RTE API is called by a Runnable which should not call that RTE API. The RTE can identify the active Runnable when it dispatches the RTE Event and if it subsequently receives a call from that Runnable to an API that is not part of its contract then this particular error ID must be logged.]([SRS_BSW_00337](#))

[SWS_Rte_06637] [An RTE_E_DET_WAIT_IN_EXCLUSIVE_AREA (0x04) shall be reported by the RTE when an application has called an [Rte_Enter](#) API and subsequently asks the RTE to enter a wait state. This is illegal because it would lock the ECU.]([SRS_BSW_00337](#))

[SWS_Rte_07675] [An RTE_E_DET_ILLEGAL_NESTED_EXCLUSIVE_AREA (0x05) shall be reported by the RTE when an application violates [\[SWS_Rte_CONSTR_09029\]](#).]([SRS_BSW_00337](#))

[SWS_Rte_07685] [An RTE_E_DET_SEG_FAULT (0x06) shall be reported by the RTE when the parameters of an RTE API call contain a direct or indirect reference to memory that is not accessible from the callers partition as defined in [\[SWS_Rte_02752\]](#) and [\[SWS_Rte_02753\]](#).]([SRS_BSW_00337](#))

[SWS_Rte_07682] [If [RteDevErrorDetectUninit](#) is enabled, an RTE_E_UNINIT (0x07) shall be reported by the RTE when one of the APIs :

- Specified in [5.6](#).
- [Rte_NvMNotifyInitBlock](#).
- [Rte_PartitionTerminated](#).
- [Rte_PartitionRestarting](#).
- [Rte_RestartPartition](#).

is called before [Rte_Start](#), after [Rte_Stop](#) or After the partition to which the API belongs is terminated.]([SRS_BSW_00337](#))

Note:

- In production mode, No checks are performed.
- In development mode, if an error is detected the API behaviour is undefined and it is left to the Rte implementer.

Rational: The introduction of this developpement check should not introduce big changes to production mode configuration.

[SWS_Rte_07683] [If [RteDevErrorDetectUninit](#) is enabled, an RTE_E_UNINIT (0x07) shall be reported by the *Basic Software Scheduler* / RTE when one of the APIs [SchM_Switch](#), [SchM_Mode](#), [SchM_SwitchAck](#), [SchM_Trigger](#), [SchM_Send](#), [SchM_Receive](#), [SchM_Call](#), [SchM_Result](#), [SchM_ActMainFunction](#), [SchM_Start](#), [SchM_StartTiming](#), or [Rte_Start](#) is called before [SchM_Init](#).] ([SRS-BSW_00337](#))

4.8.3 DET Error Classification

The following abbreviations are used to identify the DET error in table 4.39.

Abbreviation	RTE DET Error
ISI	RTE_E_DET_ILLEGAL_SIGNAL_ID
IVCV	RTE_E_DET_ILLEGAL_VARIANT_CRITERION_VALUE
II	RTE_E_DET_ILLEGAL_INVOCATION
INEA	RTE_E_DET_ILLEGAL_NESTED_EXCLUSIVE_AREA
WIEA	RTE_E_DET_WAIT_IN_EXCLUSIVE_AREA
UNINIT	RTE_E_UNINIT

Table 4.38: Abbreviations of RTE DET Errors to APIs

The following table 4.39 indicates which DET errors are relevant for the various RTE APIs, and the service ID associated with the RTE APIs (see [\[SWS_Rte_06632\]](#)):

API name	Service ID	ISI	IVCV	II	INEA	WIEA	UNINIT
Rte_Ports APIs	0x10						X
Rte_NPorts APIs	0x11						X
Rte_Port APIs	0x12						X
Rte_Send APIs	0x13						X
Rte_Write APIs	0x14						X
Rte_Switch APIs	0x15						X
Rte_Invalidate APIs	0x16						X
Rte_Feedback APIs	0x17					X	X
Rte_SwitchAck APIs	0x18					X	X
Rte_Read APIs	0x19						X
Rte_DRead APIs	0x1A						X
Rte_Receive APIs	0x1B					X	X
Rte_Call APIs	0x1C					X	X
Rte_Result APIs	0x1D					X	X
Rte_Pim APIs	0x1E						X
Rte_CData APIs	0x1F						X
Rte_Prm APIs	0x20						X
Rte_IRead APIs	0x21						X
Rte_IWrite APIs	0x22						X
Rte_IWriteRef APIs	0x23						X
Rte_IInvalidate APIs	0x24						X
Rte_IStatus APIs	0x25						X
Rte_IrvIRead APIs	0x26						X

Rte_IrvIWrite APIs	0x27						X
Rte_IrvIWriteRef APIs	0x31						X
Rte_IrvRead APIs	0x28						X
Rte_IrvWrite APIs	0x29						X
Rte_Enter APIs	0x2A						X
Rte_Exit APIs	0x2B				X		X
Rte_Mode APIs	0x2C						
Rte_Trigger APIs	0x2D						X
Rte_IrTrigger APIs	0x2E						X
Rte_IFeedback APIs	0x2F						X
Rte_IsUpdated APIs	0x30						X
trigger by TimingEvent	0x50			X			
trigger by BackgroundEvent	0x51			X			
trigger by SwcModeSwitchEvent	0x52			X			
trigger by AsynchronousServerCallReturnsEvent	0x53			X			
trigger by DataReceiveErrorEvent	0x54			X			
trigger by OperationInvokedEvent	0x55			X			
trigger by DataReceivedEvent	0x56			X			
trigger by DataSendCompletedEvent	0x57			X			
trigger by ExternalTriggerOccurredEvent	0x58			X			
trigger by InternalTriggerOccurredEvent	0x59			X			
trigger by DataWriteCompletedEvent	0x5A			X			
trigger by OsTaskExecutionEvent	0x5B			X			
Rte_Start API	0x70						X
Rte_Stop API	0x71						
Rte_PartitionTerminated APIs	0x72						
Rte_PartitionRestarting APIs	0x73						
Rte_RestartPartition APIs	0x74						
Rte_Init API	0x75						
Rte_StartTiming API	0x76						
Rte_COMCbKTack_<sn> callbacks	0x90	X					
Rte_COMCbKTErr_<sn> callbacks	0x91	X					
Rte_COMCbKInv_<sn> callbacks	0x92	X					
Rte_COMCbKRxTOut_<sn> callbacks	0x93	X					
Rte_COMCbKTxTOut_<sn> callbacks	0x94	X					
Rte_COMCbK_<sg> callbacks	0x95	X					
Rte_COMCbKTack_<sg> callbacks	0x96	X					
Rte_COMCbKTErr_<sg> callbacks	0x97	X					
Rte_COMCbKInv_<sg> callbacks	0x98	X					
Rte_COMCbKRxTOut_<sg> callbacks	0x99	X					
Rte_COMCbKTxTOut_<sg> callbacks	0x9A	X					
Rte_COMCbK_<sn> callbacks	0x9F	X					
Rte_COMCbKTxPrep_<mn> callbacks	0xA8	X					X
Rte_LdComCbKRxIndication_<sn> callbacks	0xA0	X					X
Rte_LdComCbKStartOfReception_<sn> callbacks	0xA1	X					X
Rte_LdComCbKCopyRxData_<sn> callbacks	0xA2	X					X
Rte_LdComCbKTpRxIndication_<sn> callbacks	0xA3	X					X
Rte_LdComCbKCopyTxData_<sn> callbacks	0xA4	X					X
Rte_LdComCbKTpTxConfirmation_<sn> callbacks	0xA5	X					X
Rte_LdComCbKTriggerTransmit_<sn> callbacks	0xA6	X					X
Rte_LdComCbKTxConfirmation_<sn> callbacks	0xA7	X					X
Rte_SetMirror callbacks	0x9B						
Rte_GetMirror callbacks	0x9C						

Rte_NvMNotifyJobFinished callbacks	0x9D						
Rte_NvMNotifyInitBlock callbacks	0x9E						X
SchM_Init API	0x00		X				
SchM_Deinit API	0x01						
SchM_GetVersionInfo API	0x02						
SchM_Enter APIs	0x03						
SchM_Exit APIs	0x04				X		
SchM_ActMainFunction APIs	0x05						X
SchM_Switch APIs	0x06						X
SchM_Mode APIs	0x07						X
SchM_SwitchAck APIs	0x08						X
SchM_Trigger APIs	0x09						X
SchM_Send APIs	0x0A						X
SchM_Receive APIs	0x0B						X
SchM_Call APIs	0x0C						X
SchM_Result APIs	0x0D						X

Table 4.39: Applicability of RTE DET Errors to APIs

4.9 Bypass Support

Rapid prototyping can be used during electronic control unit development to evaluate and test new software control algorithms for various functions.

With Fullpass technology the original ECU is totally replaced by a Rapid Prototyping Unit (RPU).

With Bypass technology the original ECU and software stays in the control loop to supports the majority of the control algorithms and interface with sensors, actuators and communication buses: only the specific control algorithm that shall be prototyped is deported into the RPU (external bypass) or even directly executed in the original ECU (internal bypass). Bypass mainly consists in replacing at run time inputs and/or outputs of the original software algorithms by value computed by the prototype algorithm under test.

The RTE does not directly implement bypass but the RTE provides supports for the integration of such implementation by CDD and/or integration code.

4.9.1 Bypass description

In order to describe a rapid prototyping system as an Autosar Software Component a System Description with the category `RPT_SYSTEM` is used. This System Description is not relevant for the RTE itself but is only a support for the ECU integrator to setup the rapid prototyping solution.

[SWS_Rte_07833] [RTE shall ignore definitions in System Description of category `RPT_SYSTEM`.] ([SRS_Rte_00244](#))

4.9.2 Component wrapper method

The component wrapper method consists in wrapping the original software component implementation with a CDD that implements the bypass. With this method the CDD is able to take the control of the AUTOSAR interfaces of the software component because there is no more direct call between RTE and the SWC but everything go through the CDD.

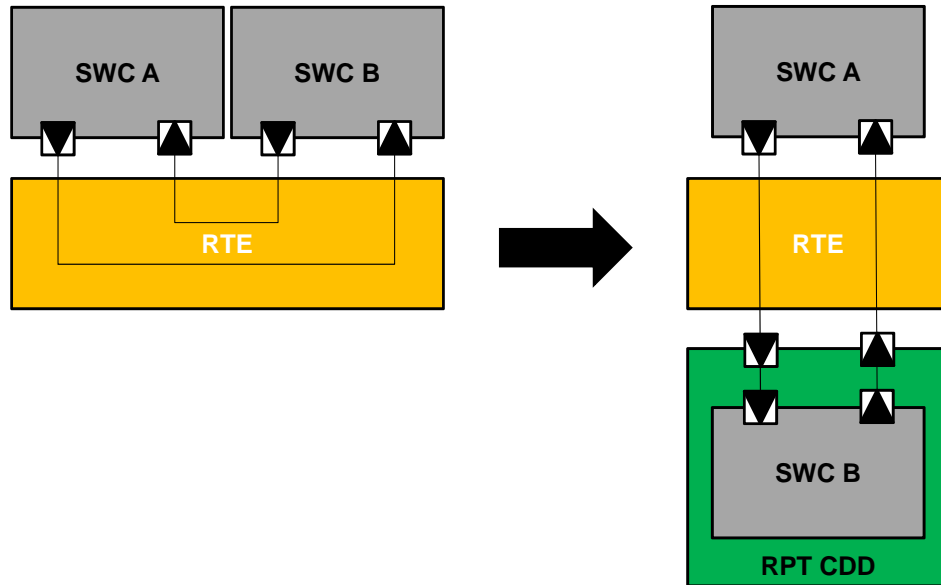


Figure 4.54: Component wrapper method

The RTE supports the component wrapper method by generating the SWC interfaces with a c-namespace including an additional [Byps_] infix for the bypassed SWC (i.e. SWC B in Figure 4.54). This includes:

- naming of Application Header File
- naming of the Application Type Header File
- naming of the RTE APIs (excepted life cycle APIs)
- naming of the runnables
- naming of the instance handle
- naming of the Component Data Structure type
- naming of the memory sections

The component wrapper method for bypass support is enabled per software component type.

[SWS_Rte_07840] [The component wrapper method for bypass support is enabled for a software component type if the general switch [RteBypassSupport](#) is set to `COMPONENT_WRAPPER` and the individual switch for this software component type [RteBypassSupportEnabled](#) is set to true.]([SRS_Rte_00244](#))

[SWS_Rte_07841] [The component wrapper method for bypass support is disabled for a software component type if the general switch `RteBypassSupport` is set to value different from `COMPONENT_WRAPPER` or if the individual switch for this software component type `RteBypassSupportEnabled` is not configured or is set to false.] ([SRS_Rte_00244](#))

[SWS_Rte_07834] [If the component wrapper method for bypass support is enabled for a software component type, the RTE generator shall include the optional infix `[Byps_]` to the name of all the elements generated for this software component type that are defined in this specification with the optional infix `[Byps_]`.] ([SRS_Rte_00244](#))

[SWS_Rte_07835] [If the component wrapper method for bypass support is disabled for a software component type, the RTE generator shall remove the optional infix `[Byps_]` to the name of all the elements generated for this software component type that are defined in this specification with the optional infix `[Byps_]`.] ([SRS_Rte_00244](#))

4.9.3 Direct buffer access method

The direct buffer access method provides runtime direct read and write access to the RTE buffers that implement the ECU communication infrastructure.

The RTE supports the direct buffer access method by generating the `McSupportData` for these buffers. This is already supported by the RTE measurement and calibration support but for the rapid prototyping purpose additional elements shall be generated.

The component wrapper method for bypass support is enabled per software component type.

The component wrapper method for bypass support is enabled for a software component type if the individual switch for this software component type `RteBypassSupportEnabled` is set to true.

[SWS_Rte_07836] [If the direct buffer access method for bypass support is enabled for a software component type, the RTE generator shall generate `McSupportData` with `mcDataAccessDetails` for each preemption area specific buffer that implements the implicit communication for this software component type.] ([SRS_Rte_00244](#))

4.9.4 Extended buffer access method

The extended buffer access method enhances the support for rapid prototyping (RP) to support the bypass use case where the RTE cannot be regenerated by the bypass user. The goal is to ensure that all `VariableDataPrototypes` that are communicated via RTE APIs are written to and read back from a `RP global buffer` that can be modified by rapid prototyping tools (RPT). The method applies to all RTE APIs and not just those for implicit access and hence is termed the *extended* buffer access method.

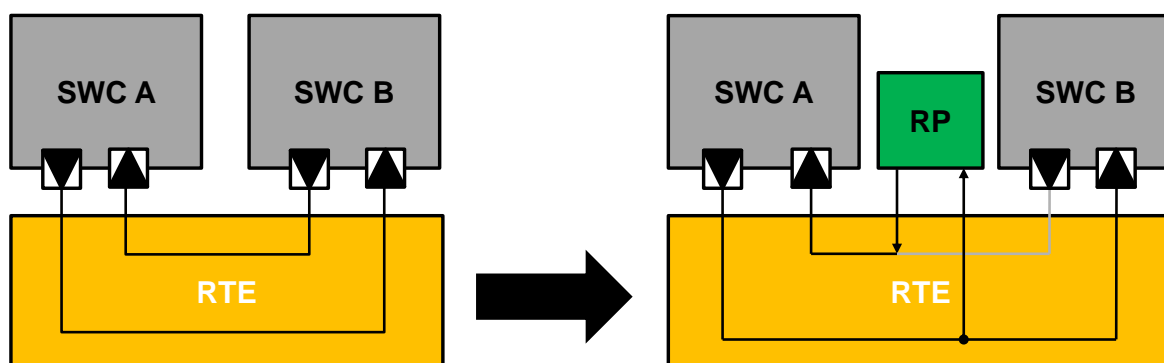


Figure 4.55: Extended Buffer Access method

Within the Extended buffer access method a [VariableDataPrototype](#), an [RTE-Event](#) or a complete [SwComponentPrototype](#) can be flagged for rapid prototyping at one of three levels depending on whether or not post-build hooking is used. [rptLevel1](#) is intended for use by post-build hooking tools and [rptLevel2](#) and [rptLevel3](#) by non post-build hooking. The mapping from RTE API class to supported level is defined by Table 4.40.

API Class	rptLevel1	rptLevel2	rptLevel3
Explicit S/R	Yes	Yes	Yes
Implicit S/R	Yes	Yes	Yes
C/S	Yes	Yes	Yes
Mode	Yes	Yes	Yes
Trigger	No	No	No
Explicit IRV	Yes	Yes	Yes
Implicit IRV	Yes	Yes	Yes

Table 4.40: Table of API classes and supported RPT level

4.9.4.1 Global Enable

[SWS_Rte_06086] [The Extended Buffer Access method is enabled if the general switch [RteBypassSupport](#) is set to `EXTENDED_BUFFER_ACCESS`] ([SRS_Rte_00244](#))

When [RteBypassSupport](#) is set to a value other than `EXTENDED_BUFFER_ACCESS` then no bypass support, i.e. no use of RP memory interface, no [RP service point](#), etc., is generated.

When [RteBypassSupport](#) is set to `EXTENDED_BUFFER_ACCESS` then the [RteBypassSupportEnabled](#) and/or [RteServicePointSupportEnabled](#) must also be set to `true` for Extended Buffer Access bypass support to be generated for a software component.

The configuration options are summarized in Table 4.41.

RteBypassSupport (global)	RteBypass-SupportEnabled (per-SWC)	RteServicePoint-SupportEnabled (per-SWC)	Effect
NONE or COMPONENT_WRAPPER	Any	Any	No bypass support generated by RTE. No RP export generated by RTE
EXTENDED_BUFFER_ACCESS	FALSE	FALSE	No bypass support for SWC type generated by RTE in code (i.e. No service points and no use of RP memory interface). RP export describes service points for SWC Internal service points only.
EXTENDED_BUFFER_ACCESS	FALSE	TRUE	Service points generated for SWC. No use of RP memory interface. RP export describes resulting SWC Internal and RTE assigned service points.
EXTENDED_BUFFER_ACCESS	TRUE	FALSE	Service points not generated for SWC. RP memory interface generated for RTE APIs. RP export describes SWC Internal service points and also the resulting RP buffers and enabler flags.
EXTENDED_BUFFER_ACCESS	TRUE	TRUE	Service points generated for SWC. RP memory interface generated for RTE APIs. RP export describes resulting SWC Internal and RTE assigned service points, RP buffers and enabler flags.

Table 4.41: Summary of enable/disable options for Extended Buffer Access method

4.9.4.2 RPT Preparation

The `RptImplPolicy.rptPreparationLevel` supports three preparation levels:

- **Level 1** – When `RptImplPolicy.rptPreparationLevel` is set to `rptLevel1` then the generated RTE uses a specific memory access pattern (a write-read cycle within accessing code created by the RTE generator) suitable for access by post-build hooking tools patch writes to buffers.
- **Level 2** – When `RptImplPolicy.rptPreparationLevel` is set to `rptLevel2` then in addition to the use of an RP global buffer (as for `rptLevel1`)

the generated code also includes an RP enabler flag that is used to make update of the RP global buffer conditional.

The RP enabler flag can be in either (calibratable) ROM or RAM based on `RptContainer.rptEnablerImplType`.

- **Level 3** – When `RptImplPolicy.rptPreparationLevel` is set to `rptLevel3` then in addition to the requirements of `rptLevel2`, the generated code also records the original ECU-generated value as well as the RP replacement value.

When `rptImplPolicy` of a `RptContainer` is used the `RptContainer` can reference:

- `VariableDataPrototype` – the preparation level applies to a single data item (and hence, for example, related Sender-Receiver APIs).
- `ArgumentDataPrototype` – the preparation level applies to a single `operation` argument (and hence related Client-Server APIs).
- `ModeDeclarationGroupPrototype` – the preparation level applies to a single `ModeDeclaration` argument (and hence related Mode APIs).
- `operation` – the preparation level applies to all `ClientServerOperation`'s `ArgumentDataPrototypes` (and hence related Client-Server APIs).
- `RunnableEntity` – the preparation level applies to all data items / arguments accessed by the `RunnableEntity`.
- `SwComponentPrototype` – the preparation level applies to all `RunnableEntities` (and hence all accessed data items and arguments) in the software component.

4.9.4.3 Level 1 - Post-Build Hooking

This level is intended to be used by post-build hooking tools that patch writes to buffers such that a bypass value is written into a buffer rather than the value calculated by the ECU.

Logically this means that a C statement like:

```
1 buffer = ecu_value;
```

is patched to be:

```
1 buffer = f(ecu_value);
```

where `f()` is a function calculated by the RP system, e.g. on external RP hardware. Note that the function call in the example may be, in reality, a simple access to a value calculated by the RP system rather than an actual function call.

4.9.4.3.1 Explicit Sender-Receiver and IRV APIs

As an example of the changes to generated RTE code when `rptLevel1` of the Extended Buffer Access method is enabled, consider an `Rte_Write` API that sends `VariableDataPrototype` `D` via port `P` using explicit semantics. A “typical” implementation might look something like Example 4.13:

Example 4.13

```
1 Std_ReturnType Rte_Write_P_D(<type> data)
2 {
3     <send> data;
4     return <result of send>;
5 }
```

Where `<type>` is the implementation data type of the `VariableDataPrototype`, `<send>` represents the transmission process, e.g. via COM or direct access, and `<result of send>` represents the return value of the RTE API.

To support RP the implementation, Example 4.13 is modified as follows:

Example 4.14

```
1 /* RP global buffer */
2 volatile <type> SWCA_Bypass_P_D;
3
4 Std_ReturnType Rte_Write_P_D(<type> data)
5 {
6     SWCA_Bypass_P_D = data;
7     <send> SWCA_Bypass_P_D;
8     return <result of send>;
9 }
```

The changes as a result of `rptLevel1` support revolve around the reads/writes of the `RP global buffer`. These changes are summarized by the following two requirements:

[SWS_Rte_06033] [When `rptLevel1` support is enabled for a `VariableDataPrototype` accessed using explicit semantics the RTE generator shall write each associated `IN` or `INOUT` API parameter to a `RP global buffer`.] ([SRS_Rte_00244](#))

Subsequent accesses to the actual parameter within the generated function are replaced by use of the `RP global buffer` instead.

[SWS_Rte_06034] [When `rptLevel1` support is enabled for a `VariableDataPrototype` accessed using explicit semantics then within RTE APIs the RTE generator shall read the value of the associated `IN` and `INOUT` parameters from the `RP global buffer` rather than use the formal parameter.] ([SRS_Rte_00244](#))

These modifications ensure that if an RP tool patches the write to the `RP global buffer` `SWCA_Bypass_P_D` then the value that is written by the RP tool to `SWCA_Bypass_P_D` will be sent instead of the actual function parameter `data`.

The requirements inherently cause the `RP global buffer` to exist thus there is no explicit requirement to create the global buffer. However the characteristics of this buffer are constrained as follows.

[SWS_Rte_06035] [An `RP global buffer` used for `rptLevel1` data shall be marked as `volatile`.] (*SRS_Rte_00244*)

The `volatile` keyword is essential to ensure that compiler optimization does not elide the read of `SWCA_Bypass_P_D` in `<send> SWCA_Bypass_P_D`.

[SWS_Rte_06036] [The `RP global buffer` contents shall be valid for at least the lifetime of the accessing RTE function (i.e. the lifetime of the runnable that calls the RTE function) and any related measurement and stimulation services.] (*SRS_Rte_00244*)

[SWS_Rte_06037] [The same `RP global buffer` shall always be used for the same SWCI/API-type/port/variable-data-prototype.] (*SRS_Rte_00244*)

Requirement **[SWS_Rte_06037]** ensures stability for post-build hooking tools, e.g. if we have `Rte_Write_P_D` for `SWCA` then the same `RP global buffer` is used irrespective of when or how `SWCA` calls `Rte_Write_P_D`. Since the RTE API is created per-SWC instance then different instances will use different `RP global buffers`.

Note that requirement **[SWS_Rte_06036]** indicates the minimum lifetime required; in an implementation the actual lifetime may be longer.

The above requirements are not intended to indicate that a dedicated `RP global buffer` must be created. In particular, if the generated RTE already contains a buffer whose characteristics satisfy those of an `RP global buffer` then an implementation is free to reuse the existing buffer.

As an additional example, consider an `Rte_Read` API that receives `VariableDataPrototype` `D` via port `P`. A “typical” implementation might look something like Example 4.15:

Example 4.15

```

1 Std_ReturnType Rte_Read_P_D(<type>* const data)
2 {
3     *data = <receive>;
4     <notifications>;
5     return <result of receive>;
6 }
```

Where `<type>` is the implementation data type of the `VariableDataPrototype`, `<receive>` represents the reception process, e.g. from COM or direct access, `<notifications>` the steps required (if any) to notify that the reception has occurred and `<result of receive>` represents the return value of the RTE API.

When using the Extended buffer access method and the `rptPreparationLevel` is `rptLevel1`, the `RptContainer` references `D` and `rptReadAccess` is `rptReadAccess` the generated RTE API from Example 4.15 is modified to become Example 4.16:

Example 4.16

```

1 volatile <type> SWCB_Bypass_P_D; /* RP global buffer */
2 Std_ReturnType Rte_Read_P_D(<type>* const data)
3 {
4     SWCB_Bypass_P_D = <receive>;
5     *data = SWCB_Bypass_P_D;
6     <notifications>;
7     return <result of receive>;
8 }

```

[SWS_Rte_06038] [When `rptLevel1` support is enabled for a `VariableDataPrototype` accessed by explicit semantics the RTE generator shall substitute the write of received data to an associated `OUT` or `INOUT` API parameter with a write to an `RP global buffer`.] (*SRS_Rte_00244*)

[SWS_Rte_06039] [When `rptLevel1` support is enabled for a `VariableDataPrototype` accessed by explicit semantics the RTE generator shall copy from the `RP global buffer` to `OUT` or `INOUT` API parameters before performing any AUTOSAR data reception notifications (and thus before the API returns if there are no notifications).] (*SRS_Rte_00244*)

As with the explicit write, these requirements ensure that if an RP tool patches the write to `SWCB_Bypass_P_D` then the value that the tool writes will be returned to the API caller rather than the originally received value.

The characteristics of the `RP global buffer` are defined for the `<send>` process above. In particular the `volatile` keyword is essential to ensure that compiler optimization does not elide the read of the `RP global buffer` in `*data = SWCB_Bypass_P_D`.

Additional `volatile RP global buffers` are also used for IRV arguments in a similar way to the sender-receiver `Rte_Read` and `Rte_Write` APIs.

4.9.4.3.2 Interaction With Data Conversion

[SWS_Rte_06088] [Where a `VariableDataPrototype` is subject to data conversion before being transmitted the conversion shall occur before the write to the `RP global buffer`.] (*SRS_Rte_00244*)

Assuming the data conversion is represented by the function $f(x)$ then the example `Rte_Write` API would become Example 4.17:

Example 4.17

```

1  /* RP global buffer */
2  volatile <type2> SWCA_Bypass_P_D;
3
4  Std_ReturnType Rte_Write_P_D(<type> data)
5  {
6      SWCA_Bypass_P_D = f(data);
7      <send> SWCA_Bypass_P_D;
8      return <result of send>;
9  }

```

Where <type2> is the data type after conversion.

4.9.4.3.3 Implicit Sender-Receiver and IRV

For implicit Sender-Receiver and IRV communication, RP global buffers are used when the context-local implicit communication buffers are initialized and written back. Consider an `Rte_IWrite` API that sends `VariableDataPrototype` D via port P and an `Rte_IRead` API that reads `VariableDataPrototype` E via port Q. A “typical” implementation might look like:

```

1  local_P_D = global_P_D;
2  local_Q_E = global_Q_E;
3  Runnable();
4  global_P_D = local_P_D;

```

Where `Runnable()` uses `Rte_IWrite_P_D()` and `Rte_IRead_Q_E()` which in turn access the context-local buffers `local_P_D` and `local_Q_E` to provide the required semantics.

When `rptPreparationLevel` is `rptLevel1` and the container references the implicitly accessed `VariableDataPrototype` this is modified as follows:

```

1  volatile <type> Bypass_P_D; /* RP global buffer */
2  volatile <type> Bypass_Q_E; /* RP global buffer */

```

And inside the generated task body:

```

1  TASK(...)
2  {
3      volatile <type> local_P_D;
4      volatile <type> local_Q_E;
5
6      /* ... */
7
8      local_P_D = global_P_D; /* Not changed */
9      Bypass_Q_E = global_Q_E; /* Setup via RP global buffer */
10     local_Q_E = Bypass_Q_E;
11     Runnable();
12     Bypass_P_D = local_P_D; /* Write-back via RP global buffer */
13     global_P_D = Bypass_P_D;
14 }

```


To enable the RP tool to intercept the update of the context-local buffer used by the implicit APIs the Extended Buffer Access method uses an `RP global buffer` in a similar fashion to the explicit APIs.

[SWS_Rte_06040] [When `rptLevel1` support is enabled for a `VariableDataPrototype` accessed by implicit semantics the RTE generator shall first update the `RP global buffer` from the RTE global variable / COM signal and then update the preemption area specific buffer from the `RP global buffer` before runnable invocation] (*SRS_Rte_00244*)

[SWS_Rte_06087] [When `rptLevel1` support is enabled for a `VariableDataPrototype` accessed by implicit semantics the RTE generator shall, after runnable termination, perform any write-back by first writing the preemption area specific buffer to the `RP global buffer` and then updating the RTE global variable / COM signal from the `RP global buffer`.] (*SRS_Rte_00244*)

The `Runnable()` sequence can comprise of one or more calls to different runnables. Each runnable has a unique implicit API and therefore can, potentially, access different context-local buffers.

Finally, the write to the preemption area specific buffer and subsequent use could be used as the write-read cycle required for post-build hooking. A distinct `RP global buffer` may therefore be optimized away in some circumstances and the preemption area specific buffer used to enforce the requirement memory access pattern.

[SWS_Rte_06091] [When `rptLevel1` support is enabled the RTE generator should avoid dedicated `RP global buffer` variables for implicit communication by implementing the preemption area specific buffers according to the (implementation) requirements on a `RP global buffer` ([SWS_Rte_06035],[SWS_Rte_06036]).] (*SRS_Rte_00244*)

For instance in this case the preemption area specific buffers needs to be declared as `volatile`.

4.9.4.3.4 Mode APIs

Mode APIs are handled in a similar manner to explicit Sender-receiver APIs with the actual function parameters being written to an associated `RP global buffer` before use.

[SWS_Rte_06107] [When `rptLevel1` support is enabled for a `ModeDeclarationGroupPrototype` the RTE generator shall write the API parameter to a `RP global buffer`.] (*SRS_Rte_00244*)

Subsequent accesses to the actual parameter within the generated function are replaced by use of the `RP global buffer` instead.

[SWS_Rte_06108] [When `rptLevel1` support is enabled for a `ModeDeclarationGroupPrototype` then within RTE APIs the RTE generator shall read the value

of the associated parameter from the `RP global buffer` rather than use the formal parameter. (SRS_Rte_00244)

These modifications ensure that if an RP tool patches the write to the `RP global buffer` then the value that is written by the RP tool will be used as the new mode instead of the actual function parameter.

As an additional example, consider the typical implementation for an `Rte_Switch` API shown in Example 4.18 (error handling omitted for clarity):

Example 4.18

```

1 Std_ReturnType Rte_Switch_P_M( <type> newMode )
2 {
3     if ( ! <in_transition> )
4     {
5         mode = newMode;
6         <notifications>
7     }
8     else
9     {
10        <enqueue>( newMode );
11    }
12    return E_OK;
13 }
```

When using the Extended buffer access method and the `rptPreparationLevel` is `rptLevel1` the generated RTE API from Example 4.18 is modified to become Example 4.19:

Example 4.19

```

1 /* RP global buffer */
2 volatile <type> SWCA_Bypass_P_M;
3
4 Std_ReturnType Rte_Switch_P_M( <type> newMode )
5 {
6     SWCA_Bypass_P_M = newMode;
7
8     if ( ! <in_transition> )
9     {
10        mode = SWCA_Bypass_P_M;
11        <notifications>
12    }
13    else
14    {
15        <enqueue>( SWCA_Bypass_P_M );
16    }
17    return E_OK;
18 }
```

4.9.4.3.5 Client-Server APIs

`rptLevel1` support can be enabled for individual parameters within an `operation`. The generated support differs based on the parameter `direction`.

4.9.4.3.5.1 IN Parameters

Client-Server parameters with `direction` of `IN` are copied to a dedicated `RP global buffer` variable before use to ensure the required write-read cycle. For `IN` parameters passed by reference a deep-copy is used.

[SWS_Rte_06092] [When `rptLevel1` support is enabled for an `ArgumentDataPrototype` with `direction` of `IN` the generated RTE API shall write the parameter to a `RP global buffer`.] (*SRS_Rte_00244*)

Subsequent accesses to the actual parameter within the generated RTE function are replaced by use of the `RP global buffer` instead.

[SWS_Rte_06093] [When `rptLevel1` support is enabled for an `ArgumentDataPrototype` with `direction` of `IN` the RTE generator shall read the value of the associated parameter from the `RP global buffer` rather than use the formal parameter.] (*SRS_Rte_00244*)

These modifications ensure that if an RP tool patches the write to the `RP global buffer` `SWCA_Bypass_P_OP_a` then the value that is written by the RP tool to `SWCA_Bypass_P_OP_a` will be seen by the server instead of the actual function parameter `a`.

As an example of the changes to generated RTE code when `rptLevel1` of the Extended Buffer Access method is enabled, consider an `Rte_Call` API that invokes `ClientServerOperation` `OP` via port `P`. A “typical” implementation might look something like Example 4.20:

Example 4.20

```

1 Std_ReturnType Rte_Call_P_OP([IN] <type> a)
2 {
3     Server( a );
4     return E_OK;
5 }
```

[SWS_Rte_06092] and **[SWS_Rte_06093]** modify Example 4.20 as follows:

Example 4.21

```

1 /* RP global buffer */
2 volatile <type> SWCA_Bypass_P_OP_a;
3
4 Std_ReturnType Rte_Call_P_OP([IN] <type> a)
5 {
```

```

6  /* Copy to RP global buffer */
7  SWCA_Bypass_P_OP_a = a;
8  Server( SWCA_Bypass_P_OP_a );
9  return E_OK;
10 }

```

The `RP global buffer` is volatile according to [SWS_Rte_06035].

4.9.4.3.5.2 OUT Parameters

When `rptLevel1` support is enabled for Client-Server parameters with `direction` of `OUT` the server generated value can be replaced with a value generated by the RPT. In the generated code the value generated by the server is captured into a dedicated `RP global buffer` and then, after the server has completed, returned to the client via a copy that permits the RPT to affect the returned value.

[SWS_Rte_06094] [When `rptLevel1` support is enabled for an `ArgumentDataPrototype` with `direction` of `OUT` the generated RTE API shall invoke the server with the `OUT` parameter replaced by a reference to an `RP global buffer`.] (*SRS_Rte_00244*)

After the server call the generated RTE API must return either the RPT generated result or the server generated result returned to the client.

[SWS_Rte_06095] [When `rptLevel1` support is enabled for an `ArgumentDataPrototype` with `direction` of `OUT` the RTE generator shall copy the value of the associated parameter from the `RP global buffer`.] (*SRS_Rte_00244*)

These modifications ensure that if an RP tool patches the write to the `RP global buffer` `SWCA_Bypass_P_OP_a` then the value that is written by the RP tool to `SWCA_Bypass_P_OP_a` will be seen by the server instead of the actual function parameter `a`.

As an example of the changes to generated RTE code when `rptLevel1` of the Extended Buffer Access method is enabled, consider an `Rte_Call` API that invokes `ClientServerOperation` `OP` via port `P`. A “typical” implementation might look something like Example 4.22:

Example 4.22

```

1  Std_ReturnType Rte_Call_P_OP([OUT] <type> a)
2  {
3      Server( a );
4      return E_OK;
5  }

```

[SWS_Rte_06094] and [SWS_Rte_06095] modify Example 4.22 as follows:

Example 4.23

```

1  /* RP global buffer */
2  volatile <type> SWCA_Bypass_P_OP_a;
3
4  Std_ReturnType Rte_Call_P_OP([OUT] <type> a)
5  {
6      /* Pass reference to RP global buffer to server */
7      Server( &SWCA_Bypass_P_OP_a );
8
9      /* Copy server value (possible modified by RPT) to client */
10     <deep-copy>( a, &SWCA_Bypass_P_OP_a );
11     return E_OK;
12 }
```

4.9.4.3.5.3 IN-OUT Parameters

When `rptLevel1` support is enabled for Client-Server parameters with direction of IN-OUT the server generated value can be replaced with a value generated by the RPT as well as the value seen by the server being modified by RPT. Therefore in addition to the support for OUT parameters an initial copy before the server invocation is necessary.

[SWS_Rte_06096] [When `rptLevel1` support is enabled for an `ArgumentDataPrototype` with direction of IN-OUT the generated RTE API shall initialize the RP global buffer with the actual parameter before server invocation.] (*SRS_Rte_00244*)

After the server call the generated RTE API must return either the RPT generated result or the server generated result returned to the client.

[SWS_Rte_06097] [When `rptLevel1` support is enabled for an `ArgumentDataPrototype` with direction of IN-OUT the RTE generator shall copy the value of the associated parameter from the RP global buffer.] (*SRS_Rte_00244*)

As an example of the changes to generated RTE code when `rptLevel1` of the Extended Buffer Access method is enabled, consider an `Rte_Call` API that invokes `ClientServerOperation` OP via port P. A “typical” implementation might look something like Example 4.24:

Example 4.24

```

1  Std_ReturnType Rte_Call_P_OP([IN-OUT] <type> a)
2  {
3      Server( a );
4      return E_OK;
5  }
```

[SWS_Rte_06094] and [SWS_Rte_06095] modify Example 4.22 as follows:

Example 4.25

```

1  /* RP global buffer */
2  volatile <type> SWCA_Bypass_P_OP_a;
3
4  Std_ReturnType Rte_Call_P_OP([IN-OUT] <type> a)
5  {
6      /* Copy in value (possible modified by RPT) to RP global buffer */
7      <deep-copy>( &SWCA_Bypass_P_OP_a, a );
8
9      /* Pass reference to RP global buffer to server */
10     Server( &SWCA_Bypass_P_OP_a );
11
12     /* Copy server value (possible modified by RPT) to client */
13     <deep-copy>( a, &SWCA_Bypass_P_OP_a );
14     return E_OK;
15 }

```

4.9.4.4 Level 2 - Non Post-Build Hooking

This level is used for bypass scenarios where the binary code remains unchanged after RTE generation – in particular any code level requirements for bypass are inserted when the RTE is generated. For example, RP global buffers may be inserted as for `rptLevel1` however run-time RP enabler flags are also added to allow control of how the buffers are used.

The typical `Rte_Write` Example 4.13 becomes Example 4.26:

Example 4.26

```

1  /* RP global buffer */
2  volatile <type> SWCA_Bypass_P_D;
3
4  /* RP enabler flag */
5  volatile <flag> SWCA_Bypass_P_D_Enable = FALSE;
6
7  Std_ReturnType Rte_Write_P_D(<type> data)
8  {
9      if ( FALSE == SWCA_Bypass_P_D_Enable )
10     {
11         SWCA_Bypass_P_D = data;
12     }
13     <send> SWCA_Bypass_P_D;
14     <notifications>;
15     return <result of send>;
16 }

```

Where `<type>`, `<send>`, `<notifications>` and `<result of send>` are as before.

`rptLevel2` is conceptually similar to `rptLevel1` but with the additional constraint that the `RP global buffer` is only updated within the generated RTE function when the `RP enabler flag` is **disabled**¹¹. Thus when the `RP enabler flag` is disabled, `rptLevel2` has the same semantics as `rptLevel1`.

[SWS_Rte_06041] [When `rptLevel2` support is enabled for a `ModeDeclarationGroupPrototype` or a `VariableDataPrototype` accessed using explicit semantics and the `RP enabler flag` is **disabled** the RTE generator shall write each associated `IN` or `INOUT` API parameter to a `RP global buffer` before the actual parameter is otherwise used within the generated function.]([SRS_Rte_00244](#))

Subsequent accesses to the actual parameter within the generated function are replaced by use of the `RP global buffer` instead.

[SWS_Rte_06042] [When `rptLevel2` support is enabled for a `ModeDeclarationGroupPrototype` or a `VariableDataPrototype` accessed using explicit semantics then within RTE APIs the RTE generator shall read the value of the associated `IN` and `INOUT` parameters from the `RP global buffer` rather than use the formal parameter.]([SRS_Rte_00244](#))

The typical `Rte_Read` Example 4.15 becomes Example 4.27:

Example 4.27

```

1  /* RP global buffer */
2  volatile <type> SWCB_Bypass_P_D;
3
4  /* RP enabler flag */
5  volatile <flag> SWCB_Bypass_P_D_Enable = FALSE;
6
7  Std_ReturnType Rte_Read_P_D(<type>* const data)
8  {
9      <type> temp = <receive>;
10     if ( FALSE == SWCB_Bypass_P_D_Enable )
11     {
12         SWCB_Bypass_P_D = temp;
13     }
14     *data = SWCB_Bypass_P_D;
15     <notifications>;
16     return <result of receive>;
17 }
```

¹¹The *RP enabler flags* are described using inverted logic to reflect the requirements of bypass enable/disable. When `rptLevel2/rptLevel3` bypass is **disabled** we want the API to use the value from the API's "data" argument whereas when `rptLevel2/rptLevel3` bypass is **enabled** we do not want the API to use the value from the "data" argument because the *RP service point* will have written the bypass value into the *RP global buffer* before the runnable containing the API runs.

[SWS_Rte_06043] [When `rptLevel2` support is enabled for a `ModeDeclarationGroupPrototype` or a `VariableDataPrototype` accessed using explicit semantics and the `RP enabler flag` is **disabled** the RTE generator shall write the value destined for each `OUT` or `INOUT` API parameter to an associated `RP global buffer` after the value is received within the generated function.] (*SRS_Rte_00244*)

[SWS_Rte_06044] [When `rptLevel2` support is enabled for a `VariableDataPrototype` accessed using explicit semantics then within RTE APIs the RTE generator shall read the value of the associated `OUT` and `INOUT` parameters from the `RP global buffers` rather than directly using the values received in the generated function.] (*SRS_Rte_00244*)

`rptLevel2` support can be enabled for individual parameters within an `operation`. The generated `RP enabler flags` control the copies of the parameter before and/or after the server invocation within the generated RTE API.

For `IN` and `IN-OUT` parameters the generated code conditionally overwrites the value in the associated `RP global buffer` before server invocation. The overwrite occurs when the `RP enabler flag` is **disabled** and hence bypass – use of the `RP` generated value – is enabled.

[SWS_Rte_06098] [When `rptLevel2` support is enabled for a `ArgumentDataPrototype` with direction `IN` or `IN-OUT` and the `RP enabler flag` is **disabled** the RTE generator shall write the actual parameter value destined for each `IN` or `IN-OUT` API parameter to an associated `RP global buffer` after the value is received within the generated function.] (*SRS_Rte_00244*)

To enable replacement of the server generated value with one generated by the RPT a selection can be made based on the `RP enabler flag`.

[SWS_Rte_06099] [When `rptLevel2` support is enabled for a `ArgumentDataPrototype` with direction `IN-OUT` or `OUT` and the `RP enabler flag` is **disabled** the RTE generator shall copy the server-generated value to the `RP global buffer` before copying the `RP global buffer` to the client's `IN-OUT` or `OUT` parameter .] (*SRS_Rte_00244*)

[SWS_Rte_06100] [When `rptLevel2` support is enabled for a `ArgumentDataPrototype` with direction `IN-OUT` or `OUT` and the `RP enabler flag` is **enabled** the RTE generator shall copy the `RP global buffer` to the client's `IN-OUT` or `OUT` parameter after the server invocation is complete. Note that in this case the server-generated value is ignored.] (*SRS_Rte_00244*)

Requirements [\[SWS_Rte_06099\]](#) and [\[SWS_Rte_06100\]](#) require that the output comes from two different places; the server generated value when bypass is disabled and the RPT generate value when enabled. This implies the use of a temporary data store passed to the server to avoid overwriting the RPT value held in the `RP global buffer`.

[SWS_Rte_06101] [When `rptLevel2` support is enabled for a `ArgumentDataPrototype` with direction IN-OUT the generated code shall use separate RP enabler flags for input-side and output-side bypass.]([SRS_Rte_00244](#))

The `Rte_Call` Example 4.24 is then modified as follows:

Example 4.28

```

1  /* Input-side bypass */
2  volatile <type> SWCA_BypassIN_P_OP_a;
3  volatile <flag> SWCA_BypassIN_P_OP_Enable = FALSE;
4
5  /* Output-side bypass */
6  volatile <type> SWCA_BypassOUT_P_OP_a;
7  volatile <flag> SWCA_BypassOUT_P_OP_Enable = FALSE;
8
9  Std_ReturnType Rte_Call_P_OP([IN-OUT] <type> a)
10 {
11     if ( FALSE == SWCA_BypassIN_P_OP_Enable )
12     {
13         /* RP disabled... use IN value */
14         <deep-copy>( &SWCA_BypassIN_P_OP_a, a );
15     }
16
17     /* Pass reference to RP global buffer to server */
18     Server( &SWCA_BypassIN_P_OP_a );
19
20     if ( FALSE == SWCA_BypassOUT_P_OP_Enable )
21     {
22         /* Output-side bypass disabled: use server value */
23         <deep-copy>( a, &SWCA_BypassIN_P_OP_a );
24     }
25     else
26     {
27         /* Copy RPT-initialized value to client */
28         <deep-copy>( a, &SWCA_BypassOUT_P_OP_a );
29     }
30
31     return E_OK;
32 }

```

Note: The update of `SWCA_BypassOUT_P_OP_a` occurs in the background and is not shown in Example 4.28. The exact point that this occurs is not defined but will be before it is used in the generated function.

For IN and OUT parameters the generated code is similar to Example 4.28 but with either the input-side or output-side bypass omitted as appropriate.

4.9.4.4.1 RP Enabler Flag

The `RP enabler flags` control how the generated APIs interact with the `RP global buffers` (e.g. as updated by a post build hooking tool) depending on the flag state:

Disabled – When the `RP enabler flag` for a `VariableDataPrototype` is **disabled** the values received by the APIs are written to the `RP global buffers` and the APIs behave as normal.

Enabled – When the `RP enabler flag` for a `VariableDataPrototype` is **enabled** the write defined by [SWS_Rte_06043] does not occur and thus the API ignores data generated by runnables and uses bypass values written into the `RP global buffers`.

[SWS_Rte_06075] [When `rptLevel2` support is enabled for a `ModeDeclarationGroupPrototype` or a `VariableDataPrototype` accessed using explicit semantics then within RTE APIs the RTE generator shall support `RP enabler flags` to permit the write to the `RP global buffer` to be disabled.](SRS_Rte_00244)

The `RP enabler flags` can be variables in RAM (as in the example), calibration characteristics or both - as specified in the input configuration. The `<type>` used for `RP enabler flag` is implementation dependent, e.g. an AUTOSAR `Boolean` or a bit-packed type, but is described in the generated RP description to enable access by RPT.

[SWS_Rte_06073] [The RTE generator shall create `RP enabler flags` in RAM when `rptEnablerImplType` is `rptEnablerRam` or `rptEnablerRamAndRom`.](SRS_Rte_00244)

[SWS_Rte_06074] [The RTE generator shall create `RP enabler flags` as calibration characteristics when a `rptEnablerImplType` is `rptEnablerRom`.](SRS_Rte_00244)

To enable the bypass to take effect the generated API must use the `RP global buffers` (as updated according to [SWS_Rte_06043], [SWS_Rte_06073] and [SWS_Rte_06074]) within the generated code rather than the values on input to the API.

[SWS_Rte_06079] [When the `rptEnablerImplType` is `rptEnablerRamAndRom` the two `RP enabler flags` are logically AND'd.](SRS_Rte_00244)

When both RAM and calibration characteristics are used the formulation would be something like:

Example 4.29

```
1  /* RP enabler flag (in RAM) */
2  volatile <flag> SWCA_Bypass_P_D_Enable = FALSE;
3
4  /* RP enabler flag (as a characteristic) */
5  volatile const <flag> SWCA_Bypass_P_D_Enable_Char = FALSE;
```

```

6
7 if ( ( FALSE == SWCA_Bypass_P_D_Enable ) &&
8       ( FALSE == SWCA_Bypass_P_D_Enable_Char ) )
9 {
10     SWCA_Bypass_P_D = data;
11 }

```

In the above examples <flag> represents the [RP enabler flag](#) data type. Implementations are at liberty to provide optimized implementations of the enablers, e.g. packing multiple enabler flags into a single variable, depending on known hardware characteristics.

4.9.4.5 Level 3 - Extended Non Post-Build Hooking

[rptLevel3](#) is an extension of [rptLevel2](#) but also records the value the ECU calculated. For example:

Example 4.30

```

1  /* RP global buffer */
2  volatile <type> SWCA_Bypass_P_D;
3
4  /* RP global measurement buffer */
5  volatile <type> SWCA_Bypass_P_D_Original;
6
7  /* RP enabler flag */
8  volatile <flag> SWCA_Bypass_P_D_Enable = FALSE;
9
10 Std_ReturnType Rte_Write_P_D(<type> data)
11 {
12     SWCA_Bypass_P_D_Original = data;
13     if ( FALSE == SWCA_Bypass_P_D_Enable )
14     {
15         SWCA_Bypass_P_D = data;
16     }
17     <send> SWCA_Bypass_P_D
18     return <result of send>
19 }

```

[SWS_Rte_06045] [When [rptLevel3](#) support is enabled for a [ModeDeclarationGroupPrototype](#) or a [VariableDataPrototype](#) accessed using explicit semantics the RTE generator shall write the associated IN or INOUT API parameter to a [RP global measurement buffer](#) on entry to the generated function.] ([SRS_Rte_00244](#))

[SWS_Rte_06046] [When [rptLevel3](#) support is enabled for a [ModeDeclarationGroupPrototype](#) or a [VariableDataPrototype](#) accessed using explicit semantics and the [RP enabler flag](#) is **disabled** the RTE generator shall write each associated IN or INOUT API parameter to a [RP global buffer](#) after the [RP](#)

`global measurement buffer` is updated and before the `RP global buffer` is otherwise used within the generated function.]([SRS_Rte_00244](#))

[SWS_Rte_06102] [When `rptLevel3` support is enabled for a `ArgumentDataPrototype` the RTE generator shall write the associated `IN` or `INOUT` API parameter to a `RP global measurement buffer` on entry to the generated function.]([SRS_Rte_00244](#))

[SWS_Rte_06103] [When `rptLevel3` support is enabled for a `ArgumentDataPrototype` and the `RP enabler flag` is **disabled** the RTE generator shall write each associated `IN` or `INOUT` API parameter to a `RP global buffer` after the `RP global measurement buffer` is updated and before the `RP global buffer` is otherwise used within the generated function.]([SRS_Rte_00244](#))

Subsequent accesses to the actual parameter within the generated function are replaced by use of the `RP global buffer` instead.

[SWS_Rte_06047] [When `rptLevel3` support is enabled for a `ModeDeclarationGroupPrototype` or a `VariableDataPrototype` accessed using explicit semantics then within RTE APIs the RTE generator shall read the value of the associated `IN` and `INOUT` parameters from the `RP global buffer` rather than use the formal parameter.]([SRS_Rte_00244](#))

[SWS_Rte_06104] [When `rptLevel3` support is enabled for a `ArgumentDataPrototype` then within RTE APIs the RTE generator shall read the value of the associated `IN` and `INOUT` parameters from the `RP global buffer` rather than use the formal parameter.]([SRS_Rte_00244](#))

And likewise for the `Rte_Read` API:

Example 4.31

```

1  /* RP global buffer */
2  volatile <type> SWCB_Bypass_P_D;
3
4  /* RP global measurement buffer */
5  volatile <type> SWCB_Bypass_P_D_Original;
6
7  /* RP enabler flag */
8  volatile <flag> SWCB_Bypass_P_D_Enable = FALSE;
9
10 Std_ReturnType Rte_Read_P_D(<type>* const data)
11 {
12     <type> temp = <receive>;
13     SWCB_Bypass_P_D_Original = temp;
14     if ( FALSE == SWCB_Bypass_P_D_Enable )
15     {
16         SWCB_Bypass_P_D = temp;
17     }
18     *data = SWCB_Bypass_P_D;
19     return <result of receive>;
20 }
```

[SWS_Rte_06048] [When `rptLevel3` support is enabled for a `ModeDeclarationGroupPrototype` or a `VariableDataPrototype` accessed using explicit semantics the RTE generator shall write the value destined for each OUT or INOUT API parameter to an associated RP global measurement buffer after the value is received within the generated function.](SRS_Rte_00244)

[SWS_Rte_06105] [When `rptLevel3` support is enabled for a `ArgumentDataPrototype` the RTE generator shall write the value destined for each OUT or INOUT API parameter to an associated RP global measurement buffer after the value is returned by the server within the generated function.](SRS_Rte_00244)

[SWS_Rte_06049] [When `rptLevel3` support is enabled for a `ModeDeclarationGroupPrototype` or a `VariableDataPrototype` accessed using explicit semantics and the RP enabler flag is **disabled** the RTE generator shall write the value destined for each OUT or INOUT API parameter to an associated RP global buffer after the RP global measurement buffer is updated.](SRS_Rte_00244)

[SWS_Rte_06106] [When `rptLevel3` support is enabled for a `ArgumentDataPrototype` and the RP enabler flag is **disabled** the RTE generator shall write the value destined for each OUT or INOUT API parameter to an associated RP global buffer after the RP global measurement buffer is updated.](SRS_Rte_00244)

[SWS_Rte_06050] [When `rptLevel3` support is enabled for a `ModeDeclarationGroupPrototype` or a `VariableDataPrototype` accessed using explicit semantics then within RTE APIs the RTE generator shall read the value of the associated OUT and INOUT parameters from the RP global buffers rather than directly using the values received in the generated function.](SRS_Rte_00244)

The `Rte_Call` Example 4.24 is then modified as follows:

Example 4.32

```

1  /* Input-side bypass */
2  volatile <type> SWCA_BypassIN_P_OP_a;
3  volatile <type> SWCA_BypassINMeasurementBuf_P_OP_a;
4  volatile <flag> SWCA_BypassIN_P_OP_Enable = FALSE;
5
6  /* Output-side bypass */
7  volatile <type> SWCA_BypassOUT_P_OP_a;
8  volatile <type> SWCA_BypassOUTMeasurementBuf_P_OP_a;
9  volatile <flag> SWCA_BypassOUT_P_OP_Enable = FALSE;
10
11 Std_ReturnType Rte_Call_P_OP([IN-OUT] <type> a)
12 {
13     /* rptLevel3: Retain input value */
14     <deep-copy>(&SWCA_BypassINMeasurementBuf_P_OP_a, a);
15     if (FALSE == SWCA_BypassIN_P_OP_Enable)
16     {
17         /* RP disabled... use IN value */
18         <deep-copy>(&SWCA_BypassIN_P_OP_a, a);

```

```

19     }
20     else
21     {
22         /* RP enabled... do nothing & use value from RPT */
23     }
24
25     /* Pass reference to RP global buffer to server */
26     Server( &SWCA_BypassIN_P_OP_a );
27
28     /* rptLevel3: Retain server generated value */
29     <deep-copy>( &SWCA_BypassOUTMeasurementBuf_P_OP_a, &
30                 SWCA_BypassIN_P_OP_a );
31
32     if ( FALSE == SWCA_BypassOUT_P_OP_Enable )
33     {
34         /* Output-side bypass disabled: use server value */
35         <deep-copy>( a, &SWCA_BypassIN_P_OP_a );
36     }
37     else
38     {
39         /* Copy RPT-initialized value to client */
40         <deep-copy>( a, &SWCA_BypassOUT_P_OP_a );
41     }
42     return E_OK;
43 }

```

For IN and OUT parameters the generated code is similar to Example 4.32 but with either the input-side or output-side bypass omitted as appropriate.

4.9.4.6 Level 2 and 3 - Non Post-Build Hooking and Implicit Communication

For implicit communication the context-local buffer is updated from the global master via an interception if the RP enabler flag is disabled. For `rptLevel3` the original (master) data is also preserved in the RP global measurement buffer. A typical implementation for the initialization of the context-local buffer within a task (when `rptLevel3` support is enabled) would therefore look like:

Example 4.33

```

1  /* RP global buffer */
2  volatile <type> SWCB_Bypass_P_D;
3
4  /* RP global measurement buffer */
5  volatile <type> SWCB_Bypass_P_D_Original;
6
7  /* RP enabler flag */
8  volatile <flag> SWCB_Bypass_P_D_Enable = FALSE;
9
10 TASK(X)
11 {

```



```

12  /* RP global measurement buffer = global master data */
13  SWCB_Bypass_P_D_Original = global_P_D;
14
15  if ( FALSE == SWCB_Bypass_P_D_Enable )
16  {
17      /* RP global buffer = global master data */
18      SWCB_Bypass_P_D = global_P_D;
19  }
20
21  /* context-local buffer */
22  local_P_D = SWCB_Bypass_P_D;
23  ...
24  }

```

When the `RP enabler flag` is **disabled** the global master data is used to update `SWCB_Bypass_P_D` and hence the RP generated value is not used. Conversely when bypass is **enabled** the value written by the RPT into `SWCB_Bypass_P_D` is used rather than overwriting with the global master.

[SWS_Rte_06051] [When `rptLevel3` is enabled for a `VariableDataPrototype` accessed by implicit semantics the RTE generator shall update the `RP global measurement buffer` before the context-local buffer is updated (via the `RP global buffer`).] ([SRS_Rte_00244](#))

[SWS_Rte_06052] [When `rptLevel2` or `rptLevel3` is enabled for a `VariableDataPrototype` accessed by implicit semantics and the `RP enabler flag` is **disabled** the RTE generator shall write the value from the global master data to the `RP global buffer`.] ([SRS_Rte_00244](#))

[SWS_Rte_06053] [When `rptLevel2` or `rptLevel3` is enabled for a `VariableDataPrototype` accessed by implicit semantics the RTE generator shall write the value from the `RP global buffer` to the context-local buffer after the `RP global buffer` is updated.] ([SRS_Rte_00244](#))

[SWS_Rte_06054] [The RTE generator shall perform the above requirements in the sequence [\[SWS_Rte_06051\]](#) [\[SWS_Rte_06052\]](#) [\[SWS_Rte_06053\]](#).] ([SRS_Rte_00244](#))

After runnable termination the value produced must be written back to the global master. The write-back occurs via an interception if the `RP enabler flag` is disabled. For `rptLevel3` the original data produced by the runnable is also preserved in the `RP global measurement buffer`. A typical implementation for the initialization of the context-local buffer within a task (when `rptLevel3` support is enabled) would therefore look like:

Example 4.34

```

1  /* RP global buffer */
2  volatile <type> SWCB_Bypass_P_D;
3
4  /* RP global measurement buffer */

```

```

5  volatile <type> SWCB_Bypass_P_D_Original;
6
7  /* RP enabler flag */
8  volatile <flag> SWCB_Bypass_P_D_Enable = FALSE;
9
10 TASK(X)
11 {
12     ...
13
14     /* RP global measurement buffer = context-local buffer */
15     SWCB_Bypass_P_D_Original = local_P_D;
16
17     if ( FALSE == SWCB_Bypass_P_D_Enable )
18     {
19         /* RP global buffer = context-local buffer */
20         SWCB_Bypass_P_D = local_P_D;
21     }
22
23     global_P_D = SWCB_Bypass_P_D;
24 }

```

[SWS_Rte_06055] [When `rptLevel3` is enabled for a `VariableDataPrototype` accessed by implicit semantics the RTE generator shall update the `RP global measurement buffer` using the context-local buffer.]([SRS_Rte_00244](#))

[SWS_Rte_06056] [When `rptLevel2` or `rptLevel3` is enabled for a `VariableDataPrototype` accessed by implicit semantics and the `RP enabler flag` is **disabled** the RTE generator shall write the value from the context-local buffer to the `RP global buffer`.]([SRS_Rte_00244](#))

[SWS_Rte_06057] [When `rptLevel2` or `rptLevel3` is enabled for a `VariableDataPrototype` accessed by implicit semantics the RTE generator shall write the value from the `RP global buffer` to the global master after the `RP global buffer` is updated.]([SRS_Rte_00244](#))

[SWS_Rte_06058] [The RTE generator shall perform the above requirements in the sequence [[SWS_Rte_06055](#)] [[SWS_Rte_06056](#)] [[SWS_Rte_06057](#)].]([SRS_Rte_00244](#))

4.9.4.7 Export

The RTE generator must describe the various buffers and flags created to support the configured `RptImplPolicy.rptPreparationLevel` for a `VariableDataPrototype` so that the information can be accessed by the RP system after RTE generation¹².

¹²To be fully used by an RPT system the information exported by the RTE generator may need subsequent augmentation to add details that are not known to the RTE generator, e.g. address information.

A generated RP buffer, flag, etc. is described by a separate `McDataInstance` with a particular role, e.g. `RP-GLOBAL-BUFFER`, that describe its usage. The role can describe the following:

1. `RP global buffer`.
2. `RP enabler flag(s) (rptLevel2/rptLevel3)`.
3. `RP global measurement buffer (rptLevel3)`.
4. `RP stimulation enabler flag`

The `McDataInstance` includes a reference to the relevant `FlatInstanceDescriptor`. This reference is the same one included in the `McDataInstance` for the RTEs buffer and therefore allows RP tools to make an association between the RTE managed buffers and the RP buffers/flags.

4.9.5 Service Based Prototyping

Access to the `RP global buffers` and `RP global measurement buffers` can be implemented by using a service based ECU interface in which an additional `RP service component`, such as an “XCP on CAN” or “XCP on Ethernet” service, is added to the ECU application.

The integration of the service can be performed pre-build by means of source code based integration, for example, by adding an XCP or custom BSW component, or post-build by patching the binary code of an already compiled ECU image.

In a service based scenario data is sampled and/or stimulated at `RP service points`. During either sampling or stimulation the data is read and/or written from the memory associated with the `VariableDataPrototype` to/from a local buffer during the execution of the `RP service point` and hence transferred to/from the RP tool. Within the context of the RTE the data stimulated by the `RP service points` are the `RP global buffers` and `RP global measurement buffers` however any data that is measurable is potentially subject to reading.

A `RP service point` is simply a call of a `RP service function` that is provided by the `RP service component`. The `RP service function` is responsible for sampling (reading) and stimulating (writing) the bypass data. The action of sampling may then trigger the RP system to perform the bypass (this may involve the communication of the sampled data to an external system for computation) ready for reading when the stimulation occurs.

4.9.5.1 Rapid Prototyping Scenarios

The Extended Buffer Access method augments the `RapidPrototypingScenario` to support service-based bypass. A `RapidPrototypingScenario` aggregates one or more `RptContainers` and one or more `RptProfiles`.

- `RptProfile` – Each profile defines an `RP service profile` consisting of:
 - The permitted range of `RP service point id` defined as `minServicePointId` to `maxServicePointId`.
 - The C-Symbols of the `RP service functions` invoked before and after the runnable entity.
- `RptContainer` – Each `RptContainer` defines the entity to be encapsulated by calls to the `RP service function`. A single `RptContainer` instance can reference a complete SW-C (in which case all invocations of its runnable entities are encapsulated by calls to `RP service functions`), a single `RTEEvent` or a single `VariableDataPrototype`.

An `RptContainer` can optionally define one or more `explicitRptProfileSelection` references. When present the references provide a list of `RptProfiles` which needs to be applied when the RPT support is implemented. When no `explicitRptProfileSelection` references are defined then all `RptProfiles` defined in the `RapidPrototypingScenario` are applicable.

The `RptExecutableEntityProperties` within an `RptContainer` aggregates information about the properties of the executable entity(s) to which the `RP service points` apply. This includes `rptServicePoint` which defines a switch for `RP service point` generation and thus permits profiles to define variable preparation and/or service point support.

For each applicable `RptProfile` (i.e. selected through `explicitRptProfileSelection` references or by the use of all profiles when no such references are present) the RTE generator inserts calls to the `RP service function` around the invocation of the runnable entity (or runnable entities) started by the `RTEEvent` referenced by each aggregated `RptContainer`.

Example 4.35

As an example of how `RptProfile` and `RptContainer` interact, consider the following scenario:

- A `RapidPrototypingScenario` instance that aggregates a single `RptProfile` instance.
- An `RptProfile` instance that aggregates two `RP service functions`:
 - `servicePointSymbolPre` defines `ServiceFunc1_pre`.
 - `servicePointSymbolPost` defines `ServiceFunc1_post`.

- A single `RptContainer` instance (with no `explicitRptProfileSelection` references) that:
 - Has zero `explicitRptProfileSelection` references.
 - References, using `byPassPoint`, a single `RTEEvent` `Event1` that triggers runnable `rel`.

The RTE would then generate:

```

1 ServiceFunc1_pre(<rptEventId>, <spId1>, <stim>);
2 rel();
3 ServiceFunc1_post(<rptEventId>, <spId2>, <stim>);

```

Where:

- The `RTE event identifier`, `<rptEventId>`, identifies the RTE event and is within the range specified in the interval `[minRptEventId...maxRptEventId]` of the `RptExecutableEntityProperties`.
- The `RP service point ids`, `<spId1>` and `<spId2>`, identify the service point and are within the interval `[minServicePointId...maxServicePointId]` of the `RptProfile`.
- `<stim>` is the `RP stimulation enabler flag` to control RP stimulation.

To extend Example 4.35, an additional `RptProfile` referencing `RP service function`, `ServiceFunc2` (both pre- and post) is added to the `RapidPrototypingScenario`.

Example 4.36

The RTE would then generate:

```

1 ServiceFunc1_pre(<rptEventId>, <spId1>, <stim>);
2 ServiceFunc2(<rptEventId>, <spId2>, <stim>);
3 rel();
4 ServiceFunc1_post(<rptEventId>, <spId3>, <stim>);
5 ServiceFunc2(<rptEventId>, <spId4>, <stim>);

```

Each `RP service function` use the same `RTE event identifier`, i.e. `<rptEventId>`, since all four calls wrap the same runnable invocation however each uses a different `RP service point id`.

Multiple `RptProfiles` can lead to multiple `RP service functions` for the same `RTEEvent`. All such calls are ordered alphabetically ([SWS_Rte_06061]) and have the same `RTE event identifier` but different `RP service point ids`.

4.9.5.2 Service Functions

The `RP service function` is responsible for sampling the required data. The parameters of the `RP service function` do **not** include the data, instead, the parameters identify the RTE Event and service point:

<rptEventId> – RTE event identifier indicating the associated RTE Event.

This parameter is defined by the `RptContainer`'s `RptExecutableEntityProperties` and is therefore the same for all `RptProfiles` aggregated within the `RptContainer`.

<servicePointId> – The `RP service point id` is used by the `RP service component` to identify the particular service point.

This parameter is defined by the `RptProfile` and is therefore different for each profile.

<stimEnabler> – Calibratable value to control RP Stimulation. This parameter is optional, if not configured zero is passed to the `RP service function`.

This parameter is defined by the `RptProfile` and is therefore different for each profile.

[SWS_Rte_06059] [A `RP service point id` shall have the type `uint16`.] ([SRS_Rte_00244](#))

[SWS_Rte_06060] [An invocation of a `RP service function` shall conform to the prototype:

```
void <RptServiceSymbol>( uint16 <rptEventId>,
                        uint16 <servicePointId>
                        uint8 <stimEnabler> );
```

Where `<RptServiceSymbol>` is specified as the `RptProfile.servicePointSymbolPre` or `RptProfile.servicePointSymbolPost` and `<servicePointId>` is the `RP service point id`. The `<stimEnabler>` provides run-time control of RP stimulation.] ([SRS_Rte_00244](#))

Note that given the defined type the range of `RP service point id` is [0 ... 65535].

[SWS_Rte_06061] [For all `RP service function` defined by the input configuration the RTE generator shall invoke the `RP service function` in alphabetical order (ASCII / ISO 8859-1 code in ascending order).] ([SRS_Rte_00244](#))

To avoid ambiguity two `RptProfiles` are not permitted to declare identical `<RptServiceSymbol>`s.

[SWS_Rte_06076] [The RTE generator shall reject configurations where `RptProfile.servicePointSymbolPre` or `RptProfile.servicePointSymbolPost` are not globally unique.] ([SRS_Rte_00244](#))

The “pre” and “post” positions provide the ability to differentiate `RP service points` that are invoked before and after runnable invocation if this is required. The two calls will have a common `RP event ids` but different `RP service point ids`.

To permit one `RptProfile` to describe variable preparation and/or service points the `rptServicePoint` within the `RptContainer` defines an enable/disable switch:

[SWS_Rte_06120] [The RTE generator shall create calls to `RP service functions` defined by an `RptProfile` only when the `RptContainer`’s `rptServicePoint` parameter is enabled.]([SRS_Rte_00244](#))

4.9.5.2.1 RP Stim Enabler

The `RP stimulation enabler flag` parameter provides runtime control of RP stimulation by the `RP service function`. Example 4.37 shows the same value passed as the `<stimEnabler>` parameter to both pre- and post `RP service points`.

Example 4.37

```

1 ServiceFunc1_pre(<rptEventId>, <spId1>, <stimEnabler>);
2 if (! <rp_disabler_flag>)
3 {
4     rel();
5 }
6 ServiceFunc1_post(<rptEventId>, <spId2>, <stimEnabler>);

```

The `<stimEnabler>` parameter has a fixed datatype of `uint8` and is, when configured, exported into `RptSupportData` as calibratable.

[SWS_Rte_06111] [When `RptProfile.stimEnabler` is `rptEnablerRam` or `rptEnablerRom` the value of the `<stimEnabler>` shall be passed as the third parameter of the `RP service function` invocation.]([SRS_Rte_00244](#))

[SWS_Rte_06112] [When `RptProfile.stimEnabler` is `none` the third parameter of the `RP service function` invocation shall be 0 (zero).]([SRS_Rte_00244](#))

[SWS_Rte_06115] [The RTE generator shall reject configurations where the `RptProfile.stimEnabler` is `rptEnablerRamAndRom`.]([SRS_Rte_00244](#))

Each `RP service point` has its own `<stimEnabler>` parameter. As a consequence, there are as many `<stimEnabler>` parameters as there are enabled `RP service points`, i.e. 1000 Service points with enabled `RptProfile.stimEnabler` will result in 1000 calibratable `<stimEnabler>` parameters.

As well as instantiating the `<stimEnabler>` parameter the RTE generate must output information in the generated `RptSupportData` to enable down-stream tools to locate the calibratable parameter.

[SWS_Rte_06110] [When `RptProfile.stimEnabler` is not `none` the `<stimEnabler>` description shall be exported in the `RptSupportData`.] ([SRS_Rte_00244](#))

The calibratable `<stimEnabler>` parameters are accessed by MC or RP tools. To enable the identification of different parameters the name of the generated calibratable value includes the name of the hooked RTE/BSW Event.

[SWS_Rte_06109] [The name of generated `<stimEnabler>` parameter shall include the name of hooked `SwComponentPrototype` and `RTEEvent/BswEvent` to be referenced.] ([SRS_Rte_00244](#))

4.9.5.3 Integration

There are two possibilities on how to integrate a `RP service point` pre-build; either as *SWC Internal* inserted by the SWC developer or as *RTE Assigned* created by the RTE generator.

SWC Internal In this scenario the `RP service function` signature of the BSW that provides the service is known by the SWC developer.

The SWC developer implements the `RP service function` calls at required positions within the `RunnableEntity` code, typically one right before and a second one right after every area to be prepared for bypassing. This mechanism is typically used in migration scenarios where a single `RunnableEntity` contains multiple functionality.

The SWC developer has to document the integrated `RP service point`, whether used for sampling or stimulating RP data, in the context of the `RunnableEntity` information of the AUTOSAR SWC description.

In this scenario there is no requirement for the RTE generator to insert `RP service point` calls within generated code. In addition, the RTE generator is not responsible for assignment of `RP service point ids` instead these are selected when the `RP service functions` invocations are created. However the RTE generator must ensure that the description of the SWC's service hooks is exported for subsequent tools.

RTE Assigned In this scenario the RTE generator evaluates the SWC descriptions for required SWC `RP service points` and adds them at dedicated positions before and after the invocation of a `RunnableEntity`.

In the following discussion the positions for the invocation of SWC `RP service points` is defined by the following pseudo-code for the invocation of a runnable entity:

Example 4.38

```
1 [Point A]
2 <update context-local buffers>
3 <VFB Runnable Start>();
```

```
4 [runnable invocation]
5 <VFB Runnable Return>();
6 [Point B]
7 <update global buffers>
8 <RTE notifications>
```

[SWS_Rte_06064] [When an [RptContainer](#) references a [SwComponentPrototype](#), the RTE generator shall insert [RP service points](#) at both [Point A] and [Point B] for each [RptProfile](#) for all applicable [RTEEvent/BswEvent\(s\)](#).]([SRS_Rte_00244](#))

[SWS_Rte_06089] [When an [RptContainer](#) references an [RTEEvent/BswEvent](#) in a [SwComponentPrototype](#), the RTE generator shall insert [RP service points](#) at both [Point A] and [Point B] for each applicable [RptProfile](#).]([SRS_Rte_00244](#))

[SWS_Rte_06090] [When an [RptContainer](#) references an [VariableDataPrototype](#), the RTE generator shall insert [RP service points](#) at both [Point A] and [Point B] for each applicable [RptProfile](#) for each [RTEEvent/BswEvent](#) that can read/write the [VariableDataPrototype](#).]([SRS_Rte_00244](#))

The invocation of a [RunnableEntity](#) may be conditional, for example, as a result of an execution pre-scaling when multiple [RTEEvents](#) are mapped to the task. If so then the execution of the [RP service points](#) has the same conditionality.

[SWS_Rte_06065] [The RTE generator shall invoke the SWC [RP service points](#) at [Point A] and [Point B] only if the [ExecutableEntity](#) is subject to invocation at [runnable invocation].]([SRS_Rte_00244](#))

Note that the invocation of the [ExecutableEntity](#) may still be subject to omission if the execution would conflict with the bypass functionality; see below.

4.9.5.4 Service Point IDs

The RTE input configuration may include SWCs from multiple suppliers that each contain SWC-Internal [RP service point ids](#). The same [RP service point id](#) must never be used twice within the same ECU application and therefore the RTE generator is required to reject input configurations that result in duplications – it is not permitted to remap [RP service point ids](#).

[SWS_Rte_06066] [The RTE generator shall reject configurations that contain SWCs with duplicate SWC-Internal [RP service point ids](#).]([SRS_Rte_00244](#))

In addition to SWC-Internal `RP service point ids` the RTE generator is required to assign `RP service point ids` used for RTE hooks. To avoid conflicts with SWC-Internal `RP service point ids` the input configuration describes permitted range for IDs for such `RP service points`.

To enable Pre and Post `RP service point` invocations to be distinguished different `RP service point id` are used – a unique ID is used for each `RP service point` invocation.

[SWS_Rte_06067] [The RTE generator shall assign the next unused `RP service point id` for the `RP service point` invocations at [Point A] and [Point B] from the permitted range.](*SRS_Rte_00244*)

[SWS_Rte_06068] [The permitted range is defined as `minServicePointId` to `maxServicePointId` inclusive.](*SRS_Rte_00244*)

The `RP service point ids` assigned by the RTE generator are documented in the generated configuration as part of the `RptProfile`. See Example 4.38 for locations of [Point A] and [Point B].

4.9.5.5 Conditional RunnableEntity Invocation

In addition to data bypass the invocation of the `RP service function` at [Point A] (see Example 4.38) may trigger computation that replaces the execution of the original `RunnableEntity` either because the execution would be redundant or have unwanted side effects. Thus it is possible to make the execution conditional and thus the `[runnable invocation]` element of the pseudo-code above is replaced by:

Example 4.39

```

1  if ( FALSE == <RPRunnableDisablerFlag> )
2  {
3      [VFB Trace event - runnable start]
4      symbol() /* runnable invocation */
5      [VFB Trace event - runnable return]
6  }
```

The conditional execution of the original `symbol` is unrelated to the normal conditionality of the invocation, e.g. due to the presence of prescalers created by the RTE generator when multiple `RTEEvents` are mapped to the task. Modification, e.g. increment, of the prescalers should occur even when the `RP runnable disabler flag` is `TRUE`. Example 4.40 shows the combination of `RP runnable disabler flag` with RTE generated conditional execution that invokes the runnable once every five task activations.

Example 4.40

```

1  if ( --Rte_RunnableDivide == 0 )
2  {
```

```

3     Rte_RunnableDivide = 5u;
4     if ( FALSE == <RPRunnableDisablerFlag> )
5     {
6         [VFB Trace event - runnable start]
7         symbol() /* runnable invocation */
8         [VFB Trace event - runnable return]
9     }
10 }

```

[SWS_Rte_06069] [When the RP `rptExecutionControl` is `conditional` the RTE generator shall invoke the `symbol` only if the runnable disabler flag is `FALSE`.] (*SRS_Rte_00244*)

Note that there is no ability to control the execution of `RTEEvents` since the intent is to avoid the side effects of the runnable whatever the triggering event therefore the same conditionality applies to all uses of the runnable.

[SWS_Rte_06077] [For each `conditional` in the input `rptExecutionControl` the RTE generator shall document the generated RP `runnable disabler flag` in the exported `RptSupportData`.] (*SRS_Rte_00244*)

4.9.5.6 Interaction with RTE-Managed buffers

The `<update context-local buffers>` pseudo-code is responsible for manipulating the RTE-managed context-local buffers (i.e. those used for implicit communication) based on updates performed by the RP `service function` invocations – it must therefore happen after the invocations at [Point A] and [Point B] ((see Example 4.38 for locations of [Point A] and [Point B])).

The `<update context-local buffers>` pseudo-code uses the RP `global buffers` to update the context-local buffers and thus, potentially, use values provided by the RP `service function` [Point A].

As an example of `rptLevel3` bypass (which includes the ability to enable/disable bypass at run-time) the `<update context-local buffers>` pseudo-code could be implemented as follows:

Example 4.41

```

1  /* RP global measurement buffer = global master data */
2  SWCB_Bypass_P1_D_Original = global_P1_D;
3
4  if ( FALSE == SWCB_Bypass_P1_D_Enable )
5  {
6      /* Bypass disabled */
7      /* RP global buffer = global master data */
8      SWCB_Bypass_P1_D = SWCB_Bypass_P1_D_Original;
9  }
10
11 /* context-local buffer */

```

```
12 local_P1_D = SWCB_Bypass_P1_D;
```

Similarly the <update global buffers> pseudo-code that follows [Point B] uses the RTE-managed context-local buffers to update the RTE-managed global buffers with either RP global buffer values or context-local values (if using rptLevel2 or rptLevel3 bypass which include run-time bypass enable/disable). Consequently the <update global buffers> must occur after RP service point [Point B] but before configured notifications have been made at <RTE notifications>.

Example 4.42

```
1  /* RP global measurement buffer = context-local buffer */
2  SWCB_Bypass_P2_D_Original = local_P2_D;
3
4  if ( FALSE == SWCB_Bypass_P2_D_Enable )
5  {
6      /* Bypass disabled */
7      /* RP global buffer = context-local buffer */
8      SWCB_Bypass_P2_D = local_P2_D;
9  }
10
11 global_P2_D = SWCB_Bypass_P2_D;
```

4.9.5.7 Export

For both SWC-Internal and RTE-Assigned RP service point ids the RTE generator must describe the invoked RP service functions so that the information can be accessed by the RP system after RTE generation¹³.

The exported RTE McSupportData is used to describe the generated configuration and consists of:

- RptSupportData describing RP execution contexts
- Invoked RP service points (whether SWC-Internal or RTE-Assigned).
- Relationship between RptExecutableEntityEvent and pre-functional RP service point.
- Relationship between RptExecutableEntityEvent and post-functional RP service point.
- Relationship between RptExecutableEntityEvent and RP runnable disabler flag.

¹³To be fully used by an RPT system the information exported by the RTE generator may need subsequent augmentation to add details that are not known to the RTE generator, e.g. address information.

In the following requirements [Point A] and [Point B] refer to locations defined in Example 4.38.

[SWS_Rte_06080] [When a `RunnableEntity` has implicit read access to a `VariableDataPrototype` for which RP service points are generated according to [SWS_Rte_06064] then the RTE generator shall export `rptServicePointPre` at the according `RptExecutableEntityEvent` documenting the RP service points generated at [Point A].](SRS_Rte_00244)

[SWS_Rte_06081] [When a `RunnableEntity` has implicit write access to a `VariableDataPrototype` for which RP service points are generated according to [SWS_Rte_06064] then the RTE generator shall export `rptServicePointPost` at the according `RptExecutableEntityEvent` documenting the RP service points generated at [Point B].](SRS_Rte_00244)

[SWS_Rte_06082] [When a `RunnableEntity` has explicit read access to a `VariableDataPrototype` for which RP service points are generated according to [SWS_Rte_06064] then the RTE generator shall export `rptServicePointPost` at the according `RptExecutableEntityEvent` documenting the RP service points generated at [Point B].](SRS_Rte_00244)

[SWS_Rte_06083] [When a `RunnableEntity` has explicit write access to a `VariableDataPrototype` for which service points are generated according to [SWS_Rte_06064], [SWS_Rte_06089] or [SWS_Rte_06090] then the RTE generator shall export `rptServicePointPre` at the according `RptExecutableEntityEvent` documenting the RP service points generated at [Point A].](SRS_Rte_00244)

[SWS_Rte_06084] [When a `RunnableEntity` has explicit read or write access to a `VariableDataPrototype` for which service points are generated according to [SWS_Rte_06064], [SWS_Rte_06089] or [SWS_Rte_06090] then the RTE generator shall export `rptServicePointPre` at the according `RptExecutableEntityEvent` documenting the RP service points generated at [Point A].](SRS_Rte_00244)

[SWS_Rte_06085] [When a `RunnableEntity` has explicit read or write access to a `VariableDataPrototype` for which RP service points are generated according to [SWS_Rte_06064], [SWS_Rte_06089] or [SWS_Rte_06090] then the RTE generator shall export `rptServicePointPost` at the according `RptExecutableEntityEvent` documenting the RP service points generated at [Point B].](SRS_Rte_00244)

4.10 Data Transformation

Transformers enable AUTOSAR systems to use a data transformation mechanism to linearize and transform data. They can be concatenated to transformer chains and are executed by the RTE for inter-ECU communication which is configured to be transformed. The input of the first transformer in the chain gets the data from the RTE. Each following transformer uses the output of the preceding transformer as input. All

transformers following the first one then have a generic signature with just a byte array as IN and OUT parameter. Such an architecture could be used to design systems, where you can flexibly add functionality like safety or security protection to a serialized stream.

The transformers for inter-ECU communication are configured in the System Description.

Furthermore the RTE can execute transformers for intra-ECU communication to transform different representations of data structures between software components or basic software modules within one ECU. Transformers for intra-ECU communication are restricted to unqueued S/R communication. In addition no transformer chains are applicable. Those limitations are formulated since for the currently known use-cases there is no need for introducing this functionality.

The execution of the transformers and the necessary buffer handling is coordinated by the RTE.

4.10.1 Execution of Transformer

4.10.1.1 Transformer for inter-ECU communication

[SWS_Rte_08794] [The RTE shall execute data transformation for inter-ecu communication if a [DataTransformation](#) is referenced by an [ISignal](#) that references a [SystemSignal](#) which

1. is referenced by a [SenderReceiverToSignalMapping](#), [ClientServerToSignalMapping](#) or [TriggerToSignalMapping](#)
2. or is referenced by a [SystemSignalGroup](#) in the role [transformingSystemSignal](#) if the [SystemSignalGroup](#) is referenced by a [SenderReceiverToSignalGroupMapping](#)

]([SRS_Rte_00247](#))

Note:

In case of fan-in of inter-ECU communication where the [ISignals](#) use different data transformations, the RTE has to ensure that it executes the correct transformer chain that belongs to exactly that [ISignal](#). This could be achieved for example by remembering within the Com callback which [DataTransformation](#) belongs to the received data.

[SWS_Rte_08795] [The RTE shall execute all transformers of a transformer chain in their execution order for queued (event semantics) sender-receiver communication even when the queue is empty (because no data are available) if [executeDespiteDataUnavailability](#) of [DataTransformation](#) is enabled and the [Rte_Receive](#) API has non-blocking characteristics according to [\[SWS_Rte_01288\]](#). The input to all the transformers in the chain shall be `NULL` with a `dataLength` equal to 0.]([SRS_Rte_00247](#))

Please note: This functionality is only available on the receiving side of queued Sender/Receiver communication. Furthermore, if Signal fan-in is used, no signal shall have the attribute `executeDespiteDataUnavailability` set to true (see [constr_3208]).

There are two main cases considered when `executeDespiteDataUnavailability` is important: an empty queue in case of queued S/R communication and errors in the COM stack so that the RTE doesn't get data from Com or LdCom.

[SWS_Rte_08796] [For `VariableAccesses` in the roles `dataReceivePointByArgument`, `dataReceivePointByValue` or `dataSendPoint` the RTE shall execute data transformation from within the called RTE API.] (*SRS_Rte_00247*)

In case of explicit sender-receiver communication, the execution of the data transformation takes place inside the RTE API which is called by the SWC.

In case of implicit sender-receiver communication, the execution of the data transformation takes place on sender side between execution of the runnable and handover of the data to the Com stack and on receiver side between reception of the data from the Com stack and start of the runnable.

[SWS_Rte_08570] [For `VariableAccesses` in the `dataReadAccess` role the RTE shall execute data transformation after reception of the data from the Com stack and before start of the runnable/coherency group.] (*SRS_Rte_00247*)

[SWS_Rte_08571] [For `VariableAccesses` in the `dataWriteAccess` role the RTE shall execute data transformation after termination of the runnable/coherency group and before handing the data over to the Com stack.] (*SRS_Rte_00247*)

[SWS_Rte_08596] [For `ExternalTriggeringPoints` the RTE shall execute data transformation from within the called RTE API `Rte_Trigger`.] (*SRS_Rte_00247*)

In case of external trigger communication, the execution of the data transformation takes place inside the RTE API which is called by the SWC.

[SWS_Rte_08797] [If transformer is configured to have access to original data, the RTE shall ensure that these are unchanged until the end of the execution of the transformer chain.] (*SRS_Rte_00247*)

4.10.1.2 Transformer for intra-ECU communication

[SWS_Rte_08105] [The RTE shall execute data transformation for intra-ecu communication if a `DataTransformation` is referenced by a `DataPrototypeMapping`.] (*SRS_Rte_00253*)

[SWS_Rte_08107] [For `VariableAccess` in the roles `dataReceivePointByArgument`, `dataReceivePointByValue` or `dataSendPoint` the RTE shall execute data transformation from within the called RTE API.] (*SRS_Rte_00253*)

In case of implicit sender-receiver communication, the execution of the data transformation takes place on sender side after execution of the [RunnableEntity/BswSchedulableEntity](#) and on receiver side before the start of the [RunnableEntity/BswSchedulableEntity](#).

[SWS_Rte_08108] [For [VariableAccess](#) in the [dataReadAccess](#) role the RTE shall execute data transformation before start of the [RunnableEntity/BswSchedulableEntity](#).] ([SRS_Rte_00253](#))

[SWS_Rte_08109] [For [VariableAccess](#) in the [dataWriteAccess](#) role the RTE shall execute data transformation after termination of the [RunnableEntity/BswSchedulableEntity](#).] ([SRS_Rte_00253](#))

4.10.2 Transformer Chains

[SWS_Rte_08798] [The RTE shall support transformer chains ([DataTransformation](#)) with a length up to 255 transformers [TransformationTechnology](#).] ([SRS_Rte_00247](#))

[SWS_Rte_08110] [The RTE shall support transformer chains ([DataTransformation](#)) only for inter-ecu data transformation.] ([SRS_Rte_00247](#))

[SWS_Rte_08799] [The RTE on sender side shall execute the transformers of the chain in order.] ([SRS_Rte_00247](#))

[SWS_Rte_08588] [The RTE on receiver side shall execute the retransformers of the chain in reverse order.] ([SRS_Rte_00247](#))

[SWS_Rte_08589] [The RTE on client side shall execute the transformers of the chain in order for all IN and IN/OUT arguments of the server call.] ([SRS_Rte_00247](#))

[SWS_Rte_08590] [The RTE on server side shall execute the retransformers of the chain in reverse order for all IN and IN/OUT arguments of the server call.] ([SRS_Rte_00247](#))

Both the IN and the IN/OUT arguments are transferred from the client to the server.

[SWS_Rte_08515] [The RTE on server side shall execute the transformers of the chain in order for all IN/OUT and OUT arguments and return code of the server operation.] ([SRS_Rte_00247](#))

[SWS_Rte_08516] [The RTE on client side shall execute the retransformers of the chain in reverse order for all IN/OUT and OUT arguments and return code of the server operation.] ([SRS_Rte_00247](#))

All the IN/OUT arguments, OUT arguments and the return value are transferred from the server to the client. The IN/OUT arguments have to be included in both communication directions because these arguments represent bi-directional communication.

[SWS_Rte_08517] [If data conversion does not apply, the input of the first transformer (in execution order) on sender side for sender-receiver communication shall be the data from the [VariableDataPrototype](#) by the SWC.] ([SRS_Rte_00247](#))

[SWS_Rte_04540] [If data conversion applies, the input of the first transformer (in execution order) on sender side for sender-receiver communication shall be the converted data from the [VariableDataPrototype](#) by the SWC.] ([SRS_Rte_00247](#))

[SWS_Rte_08518] [The input for the first transformer (in execution order) on receiver side for inter-ECU sender-receiver communication shall be the received data from the Com stack.] ([SRS_Rte_00247](#))

[SWS_Rte_08519] [The input for the first transformer (in execution order) on client side for client-server communication shall be the data from the [ClientServerOperation](#) by the SWC.] ([SRS_Rte_00247](#))

[SWS_Rte_08520] [The input for the first transformer (in execution order) on server side for the request of a client-server communication shall be the received data from the Com stack.] ([SRS_Rte_00247](#))

[SWS_Rte_08521] [The input for the first transformer (in execution order) on server side for the response of a client-server communication shall be the data from the [ClientServerOperation](#) by the SWC.] ([SRS_Rte_00247](#))

[SWS_Rte_08522] [The input for the first transformer (in execution order) on client side for the response of a client-server communication shall be the received data from the Com stack.] ([SRS_Rte_00247](#))

The input for the first transformer (in execution order) on the Trigger Source side for external trigger communication contains no payload data (See [SWS_Xfrm_00102] in [26, ASWS Transformer General]).

[SWS_Rte_08597] [The input for the first transformer (in execution order) on Trigger Sink side for external trigger communication shall be the received data from the Com stack.] ([SRS_Rte_00247](#))

[SWS_Rte_08523] [The output of the last transformer (in execution order) on sender side for inter-ECU sender-receiver communication shall be transmitted to the Com stack.] ([SRS_Rte_00247](#))

[SWS_Rte_08524] [If data conversion does not apply, the output of the last transformer (in execution order) on receiver side for sender-receiver communication shall be handed over to the SWC.] ([SRS_Rte_00247](#))

[SWS_Rte_04541] [If data conversion applies, the RTE shall convert the output of the last transformer (in execution order) on receiver side for sender-receiver communication before handing it over to the SWC.] ([SRS_Rte_00247](#))

[SWS_Rte_08525] [The output of the last transformer (in execution order) on client side for the request of a client-server communication shall be transmitted to the COM or Com stack.] ([SRS_Rte_00247](#))

[SWS_Rte_08598] [The output of the last transformer (in execution order) on Trigger Source side for external trigger communication shall be transmitted to the Com stack.] ([SRS_Rte_00247](#))

[SWS_Rte_08599] [On Trigger Sink side for external trigger communication, the RTE shall trigger the execution of the triggered [RunnableEntity](#) if no transformer in the transformer chain returns a hard error.] ([SRS_Rte_00247](#))

This means that only the [RunnableEntity](#) for the [TransformerHardErrorEvents](#) but not the [RunnableEntitys](#) for [ExternalTriggerOccurredEvents](#) shall be triggered if a hard transformer error occurred.

[SWS_Rte_08526] [On server side for client/server communication, the RTE shall trigger the execution of the triggered [RunnableEntity](#) and hand the output of the last transformer over to the triggered [RunnableEntity](#) if and only if no transformer in the transformer chain returns a hard error.] ([SRS_Rte_00247](#))

[SWS_Rte_08527] [The output of the last transformer (in execution order) on server side for the response of a client-server communication shall be transmitted to the Com stack.] ([SRS_Rte_00247](#))

[SWS_Rte_08528] [The output of the last transformer (in execution order) on client side for the response of a client-server communication shall be handed over to the SWC.] ([SRS_Rte_00247](#))

[SWS_Rte_08529] [The output of a non-last transformer (in execution order) in a transformer chain shall be the input for the next transformer in the execution order of the chain.] ([SRS_Rte_00247](#))

If there is a signal fanout, it is possible to optimize the execution of the transformers. If multiple transformer chains in case of a signal fanout have the same set of transformers at the beginning of the transformer chain, the RTE optimizes and executes those transformers only once for all transformer chains together. The result can be shared between all transformers chains. This is only possible if no [ComBasedTransformer](#) is involved.

[SWS_Rte_08530] [If the [XfrmImplementationMapping](#) (see [ECUC_Xfrm_00001]) maps multiple transformers (which are used to transform different [ISignals](#)) to the same [BswModuleEntry](#), the RTE shall execute those first transformers only once using the mapped [BswModuleEntry](#) and take the result as input for the further transformers for those [ISignals](#).] ([SRS_Rte_00247](#))

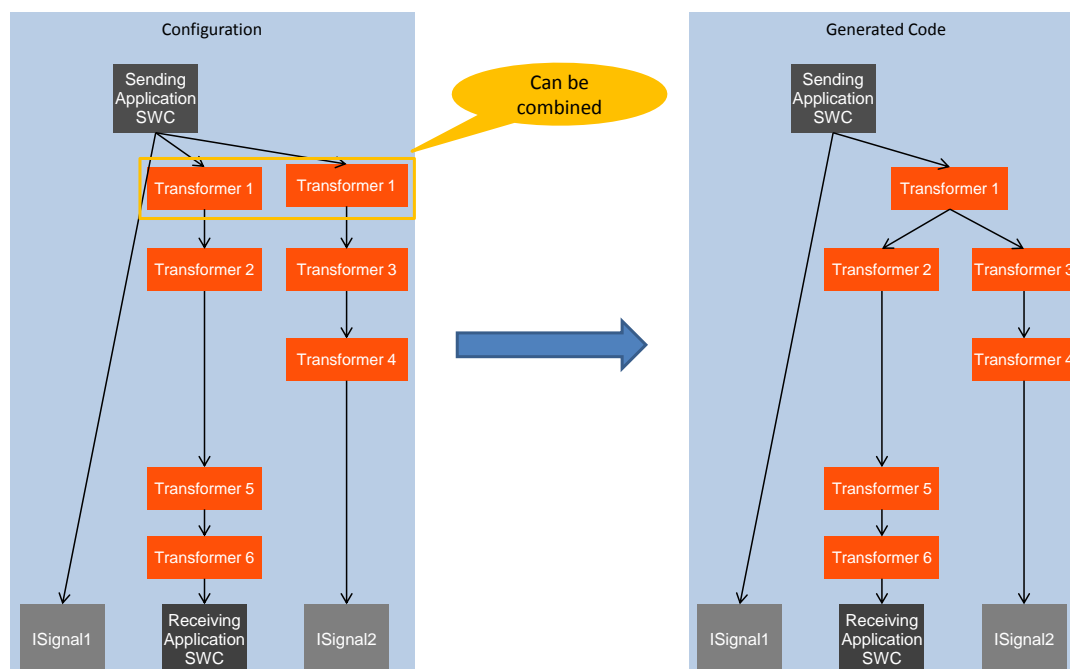


Figure 4.56: Example of a transformer optimization

4.10.3 Buffer Handling

[SWS_Rte_08531] [If the attribute `inPlace` in the `BufferProperties` of a `TransformationTechnology` is set to `FALSE`, the RTE shall provide a separate buffer to the transformers in which they can write their output.] ([SRS_Rte_00248](#))

[SWS_Rte_08532] [If the attribute `inPlace` in the `BufferProperties` of a `TransformationTechnology` is set to `TRUE`, the RTE shall provide one buffer to the transformer.] ([SRS_Rte_00248](#))

Rationale: With inplace buffer handling the transformer will read the input data from a buffer and writes its output into the same buffer. For this, the RTE hands over to the transformer a pointer and a length which represents the buffer both for input and output.

[SWS_Rte_08534] [The RTE shall calculate the needed buffer size for the output buffer size using the formula specified in `bufferComputation`.] ([SRS_Rte_00248](#))

[SWS_Rte_08535] [The RTE shall interpret the formula specified in the `CompuScale` in the role `bufferComputation` as a function: $OutputBufferLength = CompuScale(InputBufferLength)$] ([SRS_Rte_00248](#))

[SWS_Rte_03867] [The RTE shall calculate the *InputBufferLength* (used for output buffer calculation; see [\[SWS_Rte_08535\]](#)) the following way:

- For External Triggers:
The *InputBufferLength* shall be 0.
- For Sender/Receiver communication:
The *InputBufferLength* shall be equal to the size needed for *VariableDataPrototype* of the *dataElement* of the *SenderReceiverInterface* that shall be transformed.
- For Client/Server communication:
The *InputBufferLength* shall be the sum of
 - the size of the *TransactionHandle*
 - for the request: the sizes of the *VariableDataPrototypes* of all IN and INOUT arguments of the *ClientServerOperation* of the *ClientServerInterface*
 - or for the response:
 - * the sizes of the *VariableDataPrototypes* of all INOUT and OUT arguments of the *ClientServerOperation* of the *ClientServerInterface*
 - * 1 Byte for the return code of the *ClientServerOperation* of the *ClientServerInterface* if at least one *possibleError* is defined for the *ClientServerInterface*.

]([SRS_Rte_00248](#))

The *BufferProperties* contain a *CompuScale* in the role *bufferComputation* which describes the computation formula how to create the size of the output buffer depending of the size of the input buffer. Because transformer chains are modeled for the sending side, the formula has to be inversed for the receiving side.

The input of this formula is the size of the AUTOSAR data type of the interface.

[SWS_Rte_08536] [The RTE shall consider the *headerLength* information in the *BufferProperties* if *inPlace* in the *BufferProperties* is set:

- On the sending side (transformation) the RTE shall increase the buffer from the beginning by the size given in *headerLength*.
- On the receiving side (retransformation) the RTE shall decrease the buffer from the beginning by the size given in *headerLength*.

]([SRS_Rte_00248](#))

If a transformer with in-place buffering on the sending side for example is configured to add a header, the RTE is responsible for handing over a buffer which is large enough. So the buffer grows between two transformers if the second of those adds a header

with in-place buffering. To realize this, the RTE can have a buffer which stays the same size and is large enough to hold the output of the last transformer but only subsets of the buffer are handed over to the transformers depending on the buffer size needs of the specific transformers in the chain. This can be achieved by pointers. A free space in front of the existing data to insert the header there can be provided by the RTE by decreasing the pointer address which is handed over to the transformer. This adds a free space to the beginning of the buffer. It can be determined how long the header shall be by `headerLength` of `BufferProperties`.

The corresponding retransformer on the receiving side (which implements the inverse operation) has to remove the header. For this, the transformer simply has to make sure that no part of its output is inside the place of the header which shall be removed. From this transformer to the next one, the RTE increases the pointer address by the length of the header and hence removes the header using that mechanism.

[SWS_Rte_08537] [If the attribute `inPlace` in the `BufferProperties` of a `TransformationTechnology` is set and a fanout in the transformer optimization is directly done before this transformer, the RTE shall duplicate the buffer beforehand.]([SRS_Rte_00248](#))

[SWS_Rte_08550] [The RTE shall hand over the original data provided by a software component to a transformer on the sender side if the attribute `needsOriginalData` is set to `true`.]([SRS_Rte_00248](#))

4.10.4 Interfaces to Transformer

The interfaces of the transformers depend on the transformer chain in which the transformer is placed and the transformed data. They are specified in [26, ASWS Transformer General].

Also see chapter [5.10.4](#).

[SWS_Rte_08538] [The RTE shall determine which data are passed up from a transformer to the SWC by using the `PortInterfaceMapping` or `ISignal.TransformationISignalProps`. `DataPrototypeTransformationProps.networkRepresentationProps` (See Chapter [4.3.6.2](#).]([SRS_Rte_00247](#))

4.10.5 Error Handling

[SWS_Rte_08539] [The RTE shall evaluate the return codes of transformers.]([SRS_Rte_00249](#))

Transformers have a fixed set of errors depending on their transformer class. Each transformer of a transformer class can only produce those errors.

Errors can be soft errors and hard errors. Soft errors correspond to warnings and hard errors stop the execution of the transformer chain. For client server communication it

is possible on the server side to trigger an autonomous error reaction which generates the response of the client server communication automatically without involvement of any runnable.

[SWS_Rte_03608] [If there is a `PortAPIOption` with the attribute `errorHandling` set to `transformerErrorHandling` referencing a `PortPrototype` to which no data transformation applies, the `Std_TransformerClass` shall be set to `STD_TRANSFORMER_UNSPECIFIED` and `Std_TransformerErrorCode` to `E_OK`.] (*SRS_Rte_00249*)

Rationale: The generation condition of the optional OUT parameter `transformerError` only depends on the attribute `errorHandling`. Nevertheless it is possible to integrate such SW-Cs supporting `transformerErrorHandling` without any transformers. And in this case the data transformation is always logically assumed to be successful.

[SWS_Rte_08540] [The RTE shall continue with the execution of a transformer chain if a transformer returns a soft error.] (*SRS_Rte_00249*)

[SWS_Rte_08541] [The RTE shall abort the execution of a transformer chain if a transformer returns a hard error and `executeDespiteDataUnavailability` of the `DataTransformation` is set to false.] (*SRS_Rte_00249*)

[SWS_Rte_08424] [The RTE shall continue with the execution of a transformer chain if a transformer returns a hard error and `executeDespiteDataUnavailability` of the `DataTransformation` is set to true.] (*SRS_Rte_00249*)

A transformer shall not modify its output buffer, when it returns a hard error to the RTE (see [SWS_Xfrm_00051]).

To return the transformer errors to the runnables, the RTE APIs which can trigger transformer executions have a parameter which is written by the RTE and read by the SWC if the attribute `errorHandling` of `PortAPIOption` is set to `transformerErrorHandling`.

[SWS_Rte_08558] [If a transformer which doesn't transform the request of a client server communication on the server side (i.e., a transformer that either transforms the request of a client server communication on the client side or transforms the response of a client server communication or transforms an sender receiver communication) returns a hard error, the Rte shall notify this hard error to the runnable which called the RTE API that triggered the transformer execution.] (*SRS_Rte_00249*)

[SWS_Rte_07417] [If a transformer which transforms the request of a client server communication on the server side returns a hard error, the Rte shall not trigger the assigned `OperationInvokedEvents` for the server runnables.] (*SRS_Rte_00249*)

[SWS_Rte_07418] [If a transformer which transforms the request of a client server communication on the server side returns a hard error, the Rte shall trigger the assigned `TransformerHardErrorEvents`.] (*SRS_Rte_00249*)

[SWS_Rte_07419] [If a transformer which transforms the request of a client server communication on the server side returns a hard error, and the corresponding `csErrorReaction` is set to `autonomous`, the Rte shall trigger an autonomous error reaction.]([SRS_Rte_00249](#))

[SWS_Rte_07420] [For an autonomous error reaction the Rte shall execute the transformer chain of the response of the client server communication on the server side with the following arguments:

- `TransactionHandle` shall be handed over in an unaltered fashion
- As return value the error code of the transformer which issued the hard error shall be used
- All parameters passed by value shall be equal to 0
- All parameters passed by reference shall be equal to `NULL_PTR`

]([SRS_Rte_00249](#))

Note: The result of this executed transformer chain can be treated by the Rte like a regular response.

[SWS_Rte_08559] [If no transformer in the transformer chain returned a hard error and at least one transformer returned a soft error, the Rte shall notify the first soft error (in transformer execution order) to the SWC.]([SRS_Rte_00249](#))

[SWS_Rte_08584] [If multiple custom transformers in a transformer chain (`TransformationTechnology` with `transformerClass` set to `custom`) produce more than one error and all errors are soft errors, the RTE shall hand over to the SWC the first soft error of all custom transformers (in execution order).]([SRS_Rte_00249](#))

[SWS_Rte_08585] [If multiple custom transformers in a transformer chain (`TransformationTechnology` with `transformerClass` set to `custom`) produce more than one error and on of those is a hard error, the RTE shall hand over to the SWC this hard error (which caused the abortion of the execution of the transformer chain).]([SRS_Rte_00249](#))

4.10.6 Transformer Status Forwarding

There exist use-cases where the application software needs to influence the behavior of the sending transformer chain. One prominent example is a signal to service translation application where the forwarding of E2E status information into the E2ETransformer on the sending side is required. In case E2E protection is to be applied for a communication path with signal to service translation on the way, then the E2E status assessed for the received data needs to be forwarded to the E2E information generated for the sending side. Thus the application which is going to use the data can identify data exchange faults by using the standard E2E check function.

[SWS_Rte_04572]{DRAFT} [If there is a `PortAPIOption` with the attribute `transformerStatusForwarding` set to `transformerStatusForwarding` referencing a `PortPrototype` then this `PortPrototype` is used to set the status of the transformer according to the API defined in ASWS TransformerGeneral [26].] (*SRS_Rte_00249*)

4.10.7 Transformer Transaction Handling

There are use-cases where a transformer and its corresponding inverse transformer are not completely independent, but actually are part of a transaction chain. One prominent example of this is the inverse transformer for the reception of the request and the transformer for the transmission of the reply in the handling of an inter-ECU call of a `ClientServerOperation`. In those scenarios it is often required that information is propagated between the corresponding transformers of such a transaction chain. In case of the an inter-ECU call of a `ClientServerOperation` information propagation from the inverse transformer for the reception to the transformer for the transmission of the reply is sometimes needed.

To address this need, each implementation of a transformer may advertise this need of information propagation via the dedicated configuration element `XfrmCSTansactionHandleImplementationDataTypeRef`. If existing, this configuration element refers to an `ImplementationDataType` of category `STRUCTURE` in the transformer's BSWMD. This referenced `ImplementationDataType` defines the type (according to [SWS_Rte_07114] and [SWS_Rte_06812]) of a so-called transaction handle which is allocated by the RTE, filled by the inverse transformer for the reception of the request, and forwarded by the RTE without modification to the transformer for the transmission of the response.

[SWS_Rte_03885] Ensuring correct type of the transaction handle [The RTE generator shall reject configuration where an existing `XfrmCSTansactionHandleImplementationDataTypeRef` attribute (see [ECUC_Xfrm_00021]) of an `XfrmImplementationMapping` (see [ECUC_Xfrm_00001]) refers to something different than an `ImplementationDataType` of category `STRUCTURE`.] (*SRS_Rte_00018*)

[SWS_Rte_03886] Ensuring consistency of the transaction handle [The RTE generator shall reject configuration where the `XfrmCSTansactionHandleImplementationDataTypeRef` attributes (see [ECUC_Xfrm_00021]) of the `XfrmImplementationMappings` (see [ECUC_Xfrm_00001]) of the corresponding transformer implementations (i.e., implementation of the inverse transformer handling the received request and the transformer handling the to be transmitted response) refer to different `ImplementationDataTypes`.] (*SRS_Rte_00018*)

[SWS_Rte_03887] Allocation of transaction handle [If the `XfrmImplementationMapping` (see [ECUC_Xfrm_00001]) of a transformer contains an `XfrmCSTansactionHandleImplementationDataTypeRef` attribute (see [ECUC_Xfrm_00021]), the RTE shall allocate a transaction handle of the type (according to

[SWS_Rte_07114] and [SWS_Rte_06812]) defined by the referenced [ImplementationDataType](#).] ([SRS_Rte_00249](#))

[SWS_Rte_03888] Passing the transaction handle - inverse transformer - server [If the [XfrmImplementationMapping](#) (see [ECUC_Xfrm_00001]) of the inverse transformer contains an [XfrmCSTransactionHandleImplementationDataTypeRef](#) attribute (see [ECUC_Xfrm_00021]), the RTE shall pass a reference to the allocated transaction handle (see [SWS_Rte_03887]) as additional argument `csTransactionHandle` to the call of `<Mip>_Inv_<transformerId>` (see [SWS_Xfrm_00044] and [SWS_Xfrm_00046]).] ([SRS_Rte_00249](#))

Note: `<Mip>_Inv_<transformerId>` will fill the transaction handle passed via `csTransactionHandle` according to its needs.

[SWS_Rte_03889] Propagating the transaction handle [The RTE shall propagate the content of the transaction handle to the corresponding `<Mip>_<transformerId>` without altering its content.] ([SRS_Rte_00249](#))

[SWS_Rte_03890] Passing the transaction handle - transformer - server [If the [XfrmImplementationMapping](#) (see [ECUC_Xfrm_00001]) of the transformer contains an [XfrmCSTransactionHandleImplementationDataTypeRef](#) attribute (see [ECUC_Xfrm_00021]), the RTE shall pass a reference to the allocated transaction handle (see [SWS_Rte_03887]) as additional argument `csTransactionHandle` to the call of `<Mip>_<transformerId>` (see [SWS_Xfrm_00038] and [SWS_Xfrm_00040]).] ([SRS_Rte_00249](#))

4.10.8 Transformer Protocol Header Peeking

In addition to the need to propagate information between corresponding transformers, some use-cases require a transformer to peek into protocol header fields of another transformer in a transformer chain and extract required information from there.

To address this need, each implementation of a transformer may advertise this need to obtain information from some other transformer in a transformer chain via the dedicated configuration element [XfrmTransformerClassExtractProtocolHeaderFields](#). If existing, this configuration element defines the [transformerClass](#) of the other transformer the particular transformer needs protocol header information from (e.g., in case the [XfrmTransformerClassExtractProtocolHeaderFields](#) configuration attribute of an [XfrmImplementationMapping](#) contains the value `SERIALIZER`, this means that the particular transformer requires protocol header information of the transformer associated with the [TransformationTechnology](#) with [transformerClass](#) `serializer` within its transformer chain (i.e., within the ordered [transformerChain](#) of a [DataTransformation](#))).

If such a need is expressed by a certain transformer, the RTE invokes this transformer's function passing `<Mip>_ExtractProtocolHeaderFields` of the other transformer as an additional argument in order to extract the required information and provide it in a canonical form.

[SWS_Rte_03891] Passing the protocol header field extraction function [If the [XfrmImplementationMapping](#) (see [ECUC_Xfrm_00001]) of the transformer contains an [XfrmTransformerClassExtractProtocolHeaderFields](#) attribute (see [ECUC_Xfrm_00022]), the RTE shall pass `<Mip>_ExtractProtocolHeaderFields` as additional argument `extractProtocolHeaderFields` to the call of `<Mip>_<transformerId>` (see [SWS_Xfrm_00040]) and `<Mip>_Inv_<transformerId>` (see [SWS_Xfrm_00040]).

Hereby `<Mip>` shall be the module implementation prefix of the transformer implementation associated with the [TransformationTechnology](#) within the ordered [transformerChain](#) of a [DataTransformation](#), which has a [transformerClass](#) equal to [XfrmTransformerClassExtractProtocolHeaderFields](#).] ([SRS_Rte_00249](#))

Note: [XfrmTransformerClassExtractProtocolHeaderFields](#) does not directly reference a [BswModuleEntry](#) or a [BswModuleDescription](#) since this would imply a concrete knowledge of the structure of the transformer chain at the individual transformer and thus introduce a tight coupling between the different transformers in a transformer chain.

4.10.9 COM Based Transformer

The COM Based Transformer approach is an alternative transformation handling which has several aspects:

- the first transformer is the 'COM Based Transformer' [23] for the 'serialization' of data,
- the further transformers are invoked normally and enhance the array representation of the data element,
- the handling of the transformed data towards the COM Module [3] is done via a specific array based signal group API.

The 'COM Based Transformer' [23] serializes the data elements into the array representation exactly as the COM module would have done it.

The System Template [8] provides means to define which data elements shall be handled by the 'COM Based Transformer' and - via the communication matrix section - also how the data shall be serialized. This is the basis for the COM module's configuration and 'COM Based Transformer' behavior.

The RTE interacts with the COM module via dedicated array based signal group APIs for sending and receiving the transformed data.

5 RTE Reference

“Everything should be as simple as possible, but no simpler.”

– *Albert Einstein*

5.1 Scope

This chapter presents the RTE API from the perspective of AUTOSAR applications and basic software – the same API applies to all software whether they are AUTOSAR software-components or basic software.

Section 5.2 presents basic principles of the API including naming conventions and supported programming languages. Section 5.3 describes the header files used by the RTE and the files created by an RTE generator. The data types used by the API are described in Section 5.5 and Sections 5.6 and 5.7 provide a reference to the RTE API itself including the definition of runnable entities. Section 5.11 defines the events that can be monitored during VFB tracing.

5.1.1 Programming Languages

The RTE is required to support components written using the C and C++ programming languages [SRS_Rte_00126] as well as legacy software modules. The ability for multiple languages to use the same generated RTE is an important step in reducing the complexity of RTE generation and therefore the scope for errors.

[SWS_Rte_01167] [The RTE shall be generated in C.] (SRS_Rte_00126)

[SWS_Rte_01168] [All RTE code, whether generated or not, shall conform to the MISRA C standard [27]. In technically reasonable, exceptional cases MISRA violations are permissible. Except for MISRA rules #5.1 to #5.5 and directive #1.1, such violations shall be clearly identified and documented. Specified MISRA violations are defined in Appendix C. In realistic use cases, the RTE will generate C identifiers (functions, types, variables, etc) whose name will be longer than the maximum size supported by the MISRA C standard (rules #5.1 to #5.5 and directive #1.1). Users should configure the RTE to indicate the maximum C identifiers' size supported by their tool chain to make sure that no issues will be caused by these MISRA violations.] (SRS_BSW_00007)

Specified MISRA violations are defined in Appendix C.

In realistic use cases, the RTE will generate C identifiers (functions, types, variables, etc) whose name will be longer than the maximum size supported by the MISRA C standard. Users should configure the RTE to indicate the maximum C identifiers' size supported by their tool chain to make sure that no issues will be caused by these MISRA violation.

[SWS_Rte_07300] [If a `RteToolChainSignificantCharacters` limit has been configured, the RTE generator shall provide the list of C RTE identifiers whose name is not unique when only the first `RteToolChainSignificantCharacters` characters are considered.] ([SRS_BSW_00007](#))

The RTE API presented in Section 5.6 is described using C. The API is also directly accessible from an AUTOSAR software-component written using C++ provided all API functions and instances of data structures are imported with C linkage.

[SWS_Rte_01011] [The RTE generator shall ensure that, for a component written in C++, all imported RTE symbols are declared using C linkage.] ([SRS_Rte_00138](#))

For the RTE API for C and C++ components the import of symbols occurs within the application header file (Section 5.3.3).

5.1.2 Generator Principles

5.1.2.1 Operating Modes

An object-code component is compiled against an application header file that is created during the first “RTE Contract” phase of RTE generation. The object code is then linked against an RTE created during the second “RTE Generation” phase. To ensure that the object-code component and the RTE code are compatible the RTE generator supports *compatibility mode* that uses well-defined data structures and types for the component data structure. In addition, an RTE generator may support a *vendor* operating mode that removes compatibility between RTE generators from different vendors but permits implementation specific, and hence potentially more efficient, data structures and types.

[SWS_Rte_01195] [All RTE operating modes shall be source-code compatible at the SW-C level.] ([SRS_Rte_00024](#), [SRS_Rte_00140](#))

Requirement [\[SWS_Rte_01195\]](#) ensures that a SW-C can be used in any operating mode as long as the source is available. The converse is not true – for example, an object-code SW-C compiled after the “RTE Contract” phase must be linked against an RTE created by an RTE generator operating in the same operating mode. If the vendor mode is used in the “RTE Contract” phase, an RTE generator from the same vendor (or one compatible to the vendor-mode features of the RTE generator used in the “RTE Contract” phase) has to be used for the “RTE Generation” phase.

5.1.2.1.1 Compatibility Mode

Compatibility mode is either enabled in the default operating mode for an RTE generator or specific for a SW-C that is delivered as object code (i.e. object-code SW-C) and guarantees compatibility even between RTE generators from different vendors through

the use of well-defined, “standardized”, data structures. The data structures that are used by the generated RTE in the compatibility mode are defined in Section 5.4.

Support for compatibility mode is required and therefore is guaranteed to be implemented by all RTE generators.

[SWS_Rte_01151] [The *compatibility mode* shall be the default operating mode and shall be supported by all RTE generators, whether they are for the “RTE Contract” or “RTE Generation” phases.] ([SRS_Rte_00145](#))

[SWS_Rte_03871] [The RTE generator shall enable the *compatibility mode* for all SW-Cs that are delivered as object code.] ([SRS_Rte_00145](#))

Note: Whether a SW-C is delivered as source code or object code can be determined from the `codeDescriptor` of the respective SW-C implementation.

The compatibility mode uses custom (generated) functions with standardized names and data structures that are defined during the “RTE Contract” phase and used when compiling object-code components.

[SWS_Rte_01216] [SW-Cs that are compiled against an “RTE Contract” phase application header file (i.e. object-code SW-Cs) generated in compatibility mode shall be compatible with an RTE that was generated in compatibility mode.] ([SRS_Rte_00145](#))

The use of well-defined data structures imposes tight constraints on the RTE implementation and therefore restricts the freedom of RTE vendors to optimize the solution of object-code components but have the advantage that RTE generators from different vendors can be used to compile a binary-component and to generate the RTE.

Note that even when an RTE generator is operating in compatibility mode the data structures used for *source-code* components are not defined thus permitting vendor-specific optimizations to be applied.

5.1.2.1.2 Vendor Mode

Vendor mode is an optional operating mode where the data structures defined in the “RTE Contract” phase and used in the “RTE Generation” phase are implementation specific rather than “standardized”.

[SWS_Rte_01152] [An RTE generator may optionally support *vendor mode*.] ([SRS_Rte_00083](#))

The data structures defined and declared when an RTE generator operates in vendor mode are implementation specific and therefore *not* described in this document. This omission is deliberate and permits vendor-specific optimizations to be implemented for object-code components. It also means that RTE generators from different vendors are unlikely to be compatible when run in the vendor mode.

[SWS_Rte_01234] [An AUTOSAR software-component shall be assumed to be operating in “compatibility” mode unless “vendor mode” is explicitly requested.] ([SRS_Rte_00145](#), [SRS_Rte_00146](#))

The potential for more efficient implementations of object-code components offered by the vendor mode comes at the expense of requiring high cohesion between object-code components (compiled after the “RTE Contract” phase) and the generated RTE. However, this is not as restrictive as it may seem at first sight since the tight coupling is also reflected in many other aspects of the AUTOSAR methodology, not least of which is the requirement that the same compiler (and compatible options) is used when compiling both the object-code component and the RTE.

5.1.2.2 Optimization Modes

The actual RTE code is generated – based on the input information – for each ECU individually. To allow optimization during the RTE generation one of the two general optimization directions can be specified: `MEMORY` consumption or execution `RUNTIME`.

[SWS_Rte_05053] [The RTE Generator shall optimize the generated RTE code either for memory consumption or execution runtime depending on the provided input information `RteOptimizationMode`.] ([SRS_Rte_00023](#))

5.1.2.3 Build support

The generated RTE code has to respect several rules in order to be integrated with other AUTOSAR software in the build process.

[SWS_Rte_05088] [All memory¹ allocated by the RTE shall be wrapped in the Memory Allocation Keyword as defined in the *Specification of Memory Mapping* [28] using `RTE_<SCOPE>` as the `<PREFIX>` where `<SCOPE>` is either

- the `shortName` of the `AtomicSwComponentType`
or
- the `shortName` of the `EcucPartition` the allocated memory object belongs to
or
- one of the defined `<SCOPE>`s in [[SWS_Rte_07421](#)], [[SWS_Rte_07422](#)], [[SWS_Rte_07423](#)], [[SWS_Rte_07424](#)], or [[SWS_Rte_07425](#)].

] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

Due to the structure of the AUTOSAR Meta Model the input configuration might contain several `DataPrototypes` which are resulting only in one memory object. In this case

¹memory refers to all elements in the generated RTE which will later occupy space in the ECU's memory and is directly associated with the RTE. This includes code, static data, parameters, etc.

it is required to define rules which `SwAddrMethod` is used to allocate the memory and to decide about its initialization. Therefore precedence rules for `SwAddrMethods` are defined by [SWS_Rte_07590] and [SWS_Rte_07591].

In order to ensure proper allocation of the variables and code instantiated by RTE, the RTE code utilizes the memory mapping mechanism described in document [28]. The requirements below follow the principles of the document [28], section "Requirements on implementations using memory mapping header files for BSW Modules and Software Components". However the basic granularity of constants and variables created due to `DataPrototypes` in the input configuration is driven by the properties of the applied data types and the applied `SwAddrMethods`.

[SWS_Rte_07421] [For component data structure (CDS) instances the `<SCOPE>` for the Memory Allocation Keyword shall be set to the `shortName` of the `AtomicSwComponentType` they belong to.] (*SRS_Rte_00148, SRS_Rte_00169*)

[SWS_Rte_07422] [For `AutosarDataPrototype` implementations the `<SCOPE>` for the Memory Allocation Keyword shall be set to the `shortName` of the `AtomicSwComponentType` they belong to.] (*SRS_Rte_00148, SRS_Rte_00169*)

[SWS_Rte_07423] [For `mode machine instance` implementations the `<SCOPE>` for the Memory Allocation Keyword shall be set to the `shortName` of the `AtomicSwComponentType` they belong to.] (*SRS_Rte_00148, SRS_Rte_00169*)

[SWS_Rte_07424] [For RTE APIs implemented as functions the `<SCOPE>` for the Memory Allocation Keyword shall be set to the `shortName` of the `AtomicSwComponentType` they belong to.] (*SRS_Rte_00148, SRS_Rte_00169*)

[SWS_Rte_07425] [For RTE Call-back implementations the `<SCOPE>` for the Memory Allocation Keyword shall be set according table 5.1 where:

`<sn>` is the name of the COM signal,

`<sg>` is the name of the COM signal group,

`<sn>` is the name of the LdCom signal/I-PDU,

`<c>` is the `shortName` of the `NvBlockSwComponentType`, and

`<d>` is the `shortName` of the `NvBlockDescriptor`

] (*SRS_Rte_00148, SRS_Rte_00169*)

Callback Function	SCOPE
<code>Rte_PartitionTerminated</code>	<code>shortName</code> of the <code>EcucPartition</code>
<code>Rte_PartitionRestarting</code>	<code>shortName</code> of the <code>EcucPartition</code>





Callback Function	SCOPE
Rte_RestartPartition	shortName of the EcucPartition
Rte_COMCbktAck_<sn>	SIG_<sn>
Rte_COMCbktErr_<sn>	SIG_<sn>
Rte_COMCbktInv_<sn>	SIG_<sn>
Rte_COMCbktRxTOut_<sn>	SIG_<sn>
Rte_COMCbktTxTOut_<sn>	SIG_<sn>
Rte_COMCbkt_<sg>	SIG_<sg>
Rte_COMCbktAck_<sg>	SIG_<sg>
Rte_COMCbktErr_<sg>	SIG_<sg>
Rte_COMCbktInv_<sg>	SIG_<sg>
Rte_COMCbktRxTOut_<sg>	SIG_<sg>
Rte_COMCbktTxTOut_<sg>	SIG_<sg>
Rte_COMCbkt_<sn>	SIG_<sg>
Rte_LdComCbktRxIndication_<sn>	SIG_<sn>
Rte_LdComCbktStartOfReception_<sn>	SIG_<sn>
Rte_LdComCbktCopyRxData_<sn>	SIG_<sn>
Rte_LdComCbktTpRxIndication_<sn>	SIG_<sn>
Rte_LdComCbktCopyTxData_<sn>	SIG_<sn>
Rte_LdComCbktTpTxConfirmation_<sn>	SIG_<sn>
Rte_LdComCbktTriggerTransmit_<sn>	SIG_<sn>
Rte_LdComCbktTxConfirmation_<sn>	SIG_<sn>
Rte_SetMirror	<c>_<d>
Rte_GetMirror	NVM_<c>_<d>
Rte_NvMNotifyJobFinished	<c>_<d>
Rte_NvMNotifyInitBlock	<c>_<d>

Table 5.1: <SCOPE> for the Memory Allocation Keywords of RTE Call-back implementations

[SWS_Rte_07589] [For [AutosarDataPrototype](#) implementations the <SEGMENT> infix for the Memory Allocation Keyword shall be set to the [shortName](#) of the preceding [SwAddrMethod](#) if there is one defined and if [\[SWS_Rte_07592\]](#) is not applicable.] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_07426] [For RTE APIs implemented as functions the <SEGMENT> infix for the Memory Allocation Keyword shall be set to CODE.] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_07427] [For RTE Call-back implementations the <SEGMENT> infix for the Memory Allocation Keyword shall be set to CODE.] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_07047] [If the `memoryAllocationKeywordPolicy` of the preceding `SwAddrMethod` is set to `addrMethodShortName` the `<ALIGNMENT>` suffix with leading underscore of the Memory Allocation Keyword used by the `AutosarDataPrototype` implementations and `PerInstanceMemory` implementations shall be omitted.]([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_07048] [If the `memoryAllocationKeywordPolicy` of the preceding `SwAddrMethod` is set to `addrMethodShortNameAndAlignment` the `<ALIGNMENT>` suffix with leading underscore of the Memory Allocation Keyword used by the `AutosarDataPrototype` implementations and `PerInstanceMemory` implementations shall be set to the resulting alignment as defined in [\[SWS_Rte_07049\]](#), [\[SWS_Rte_07050\]](#), [\[SWS_Rte_07051\]](#), [\[SWS_Rte_07052\]](#) and [\[SWS_Rte_07053\]](#).]([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_08303] [The alignment of a `PerInstanceMemory` shall be set to `UNSPECIFIED`.]([SRS_Rte_00013](#), [SRS_Rte_00077](#))

[SWS_Rte_07049] [The alignment defined by the preceding (see [\[SWS_Rte_07196\]](#)) `swAlignment` attribute of a `AutosarDataPrototype` precedes the alignment defined by the `ImplementationDataType` related to the `AutosarDataPrototype` as defined in [\[SWS_Rte_07050\]](#), [\[SWS_Rte_07051\]](#), [\[SWS_Rte_07052\]](#) and [\[SWS_Rte_07053\]](#).]([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_07050] [The alignment of a `AutosarDataPrototype` related to a `Primitive Implementation Data Type` or `Array Implementation Data Type` shall be set to the `baseTypeSize` of the referred `SwBaseType`.]([SRS_Rte_00148](#), [SRS_Rte_00169](#))

Note: Requirement [\[SWS_Rte_07050\]](#) uses "size" rather than "alignment" as it is considered to be the integrator's job to ensure via appropriate memory mapping configuration (i.e. using the proper alignment `#pragmas` or omitting them at all to let the compiler decide) that the platform specific alignment requirements of objects of the respective size are honored.

[SWS_Rte_07051] [The alignment of a `AutosarDataPrototype` related to a `Structure Implementation Data Type` or `Union Implementation Data Type` shall be set to to biggest `baseTypeSize` of the `SwBaseTypes` used by the elements.]([SRS_Rte_00148](#), [SRS_Rte_00169](#))

Note: According [\[SWS_Rte_07051\]](#) structures and unions are aligned according the size of the biggest primitive element in the structure.

[SWS_Rte_07052] [The alignment of a `AutosarDataPrototype` related to a `Redefinition Implementation Data Type` shall be determined from the redefined `ImplementationDataType`.]([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_07053] [The alignment of a `AutosarDataPrototype` related to a `Pointer Implementation Data Type` shall be set to `PTR`.]([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_03868] [The alignment of an `AutosarDataPrototype` typed by an `Array Implementation Data Type`, or `Structure Implementation Data Type`, or `Union Implementation Data Type` which solely contains elements typed by `Pointer Implementation Data Type` shall be set to `PTR`.] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

Note: If the RTE generator does not implement the memory objects related to `VariableDataPrototypes` and `ParameterDataPrototypes` for instance due to communication via IOC the assigned `SwAddrMethods` might have no effect on the generated RTE code.

[SWS_Rte_07592] [If the RTE Generator requires several non automatic memory objects per `AutosarDataPrototypes` (e.g. due to partitioning) the RTE Generator is permitted to select the `<SEGMENT>` infix for the auxiliary memory objects.] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

Note: For definitions and declarations for memory objects allocated by the RTE and implementing `AutosarDataPrototypes` without an assigned `SwAddrMethod` the RTE Generator is permitted to select the `<SEGMENT>` infix but still has to follow [\[SWS_Rte_05088\]](#).

[SWS_Rte_08787] [The `<NAME>` part of the memory allocation keyword shall adhere to the following pattern: `<SEGMENT>[_<ALIGNMENT>]`] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_07590] [The `SwAddrMethod` of a `AutosarDataPrototype` in the `PPortPrototype` precedes the assigned `SwAddrMethod(s)` of the `AutosarDataPrototype` in the `RPortPrototype` and `PRPortPrototype`.] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_06741] [The `SwAddrMethod` of a `AutosarDataPrototype` in the `PRPortPrototype` precedes the assigned `SwAddrMethod(s)` of the `AutosarDataPrototype` in the `RPortPrototype`.] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_07591] [The `SwAddrMethod` of the `ramBlocks` has always higher precedence as the assigned `SwAddrMethods` of the `VariableDataPrototypes` in the `PortPrototypes`.] ([SRS_Rte_00148](#), [SRS_Rte_00169](#))

[SWS_Rte_05089] [The RTE Generator shall provide information on the used memory segments and their attributes from [\[SWS_Rte_05088\]](#) in the generated *Basic Software Module Description* (see [\[SWS_Rte_05086\]](#)). The information shall be provided in the `MemorySection` elements of the *Basic Software Module Description* [\[9\]](#).] ([SRS_Rte_00148](#), [SRS_Rte_00169](#), [SRS_Rte_00170](#))

[SWS_Rte_05090] [The RTE Generator shall provide information about the generated artifacts which are produced during the RTE generation, using the generated *Basic Software Module Description* (see [\[SWS_Rte_05086\]](#)). The information shall be provided in the `BswImplementation::generatedArtifact` elements of the *Basic Software Module Description* [\[9\]](#).] ()

5.1.2.4 Software Component Namespace

The concept of RTE requires that objects and definitions which are related to one software component are generated in a global name space. Nevertheless in this global name space labels have to be unique for instance to support a correct linkage by C Linker Locator. To ensure unique labels such objects and definitions related to a specific software component are typically prefixed or infixed with the component type symbol.

When `AtomicSwComponentTypes` of several vendors are integrated in the same ECU name clashes might occur if the identical component type name is accidentally used twice. To ease the dissolving of name clashes the RTE supports the superseding of the `AtomicSwComponentType.shortName` with the `SymbolProps.symbol` attribute.

The resulting name related to an `AtomicSwComponentType` is called `component type symbol` in this document.

[SWS_Rte_06714] [The `component type symbol` shall be the value of the `SymbolProps.symbol` attribute of the `AtomicSwComponentType` if the `symbol` attribute is defined.]()

[SWS_Rte_06715] [The `component type symbol` shall be the `shortName` of the `AtomicSwComponentType` if no `symbol` attribute for this `AtomicSwComponentType` is defined.]()

Please note that the `component type symbol` is not applied for file names, e.g. *Application Header File* or includes of Memory Mapping Header files. Its expected that a build environment can handle two equally named files.

5.1.3 Generator external configuration switches

There are use-cases where there is need to influence the behavior of the RTE Generator without changing the RTE Configuration description. In order to support such use-cases this section collects the *external configuration switches*.

Note: it is not specified how these switches shall be implemented in the actual RTE Generator implementation.

Unconnected R-Port check

[SWS_Rte_05099] [The RTE Generator shall support the *external configuration switch* `strictUnconnectedRPortCheck` which, when enabled, forces the RTE Generator to consider unconnected R-Ports as an error.]([SRS_Rte_00139](#))

Missing input configuration check

[SWS_Rte_05148] [The RTE Generator shall support the *external configuration switch* `strictConfigurationCheck` which, when enabled, forces the RTE Generator to

consider missing input configuration information as an error. If the *external configuration switch* `strictConfigurationCheck` is not provided the value shall be considered as *true*.]()

For Details on the use-cases please refer to section 3.7.

Missing initialization values

[SWS_Rte_07680] [The RTE Generator shall support the *external configuration switch* `strictInitialValuesCheck`. This switch, when enabled, forces the RTE Generator to check initial values against constraints defined in [TPS_SYST_02011], [SWS_Rte_07642] and [SWS_Rte_07681]. Not fulfilled constraints shall be considered as errors by the RTE Generator.](SRS_Rte_00108)

5.2 API Principles

[SWS_Rte_01316] [The RTE shall be configured and/or generated for each ECU.](SRS_Rte_00021)

Part of the process is the customization (i.e. configuration or generation) of the RTE API for each AUTOSAR software-component on the ECU. The customization of the API implementation for each AUTOSAR software-component, whether by generation anew or configuration of library code, permits improved run-time efficiency and reduces memory overheads.

The design of the RTE API has been guided by the following core principles:

- The API should be orthogonal – there should be only one way of performing a task.
- **[SWS_Rte_01314]** [The API shall be compiler independent.](SRS_Rte_00100)
- **[SWS_Rte_03787]** [The RTE implementation shall use the compiler abstraction.](SRS_Rte_00149)

The consequence of [SWS_Rte_03787] is that no additional memory modifiers (e.g. volatile) are permitted in the signatures of the RTE APIs.

- **[SWS_Rte_01315]** [The API shall support components where the source-code is available [SRS_Rte_00024] and where only object-code is available [SRS_Rte_00140].](SRS_Rte_00024, SRS_Rte_00140)
- The API shall support the multiple instantiation of AUTOSAR software-components [SRS_Rte_00011] that share code [SRS_Rte_00012].

Two forms of the RTE API are available to software-components; direct and indirect. The direct API has been designed with regard to efficient invocation and includes an API mapping that can be used by an RTE generator to optimize a component's API, for example, to permit the direct invocation of the generated API functions or even eliding the generated RTE completely. The indirect API cannot be optimized using the API

mapping but has the advantage that the handle used to access the API can be stored in memory and accessed, via an iterator, to apply the same API to multiple ports.

[SWS_Rte_03619] [If the RTE emits a `<suffix>` as a result of an `Autosar-DataType` being used (See [\[SWS_Rte_08802\]](#) for the meaning of the term "used") in the input, it shall

- be set to "U" if the `ImplementationDataType` boils down to a `SwBaseType` with `baseTypeEncoding` set to `NONE` and the `baseTypeSize` ≤ 16
- be set to "UL" if the `ImplementationDataType` boils down to a `SwBaseType` with `baseTypeEncoding` set to `NONE` and the `baseTypeSize` > 16 and ≤ 32
- be set to "ULL" if the `ImplementationDataType` boils down to a `SwBaseType` with `baseTypeEncoding` set to `NONE` and the `baseTypeSize` > 32
- be set to "L" if the `ImplementationDataType` boils down to a `SwBaseType` with `baseTypeEncoding` set to `2C` and the `baseTypeSize` > 16 and ≤ 32
- be set to "LL" if the `ImplementationDataType` boils down to a `SwBaseType` with `baseTypeEncoding` set to `2C` and the `baseTypeSize` > 32
- be set to "F" if the `ImplementationDataType` boils down to a `SwBaseType` with `baseTypeEncoding` set to `IEEE754` and the `baseTypeSize` ≤ 32
- be left empty if the `ImplementationDataType` boils down to
 - a `SwBaseType` with `baseTypeEncoding` set to `BOOLEAN`
 - or
 - a `SwBaseType` with `baseTypeEncoding` set to `IEEE754` and the `baseTypeSize` > 32
 - or
 - a `SwBaseType` with `baseTypeEncoding` set to `2C` and `baseTypeSize` ≤ 16

.

]([SRS_Rte_00167](#))

5.2.1 RTE Namespace

All RTE symbols (e.g. function names, global variables, etc.) visible within the global namespace are required to use the "Rte" prefix.

[SWS_Rte_01171] [All externally visible symbols created by the RTE generator shall use the prefix `Rte_`.

This rule shall not be applied for the following symbols:

- type names representing AUTOSAR Data Types (specified in [SWS_Rte_07104], [SWS_Rte_07109], [SWS_Rte_07110], [SWS_Rte_07111], [SWS_Rte_07148])
- enumeration literals of implementation data types (specified in [SWS_Rte_03810])
- range limits of `ApplicationDataTypes` (specified in [SWS_Rte_05052])

This rule shall be applied for RTE internal types to avoid name clashes with other modules and SWCs.] (*SRS_BSW_00307*, *SRS_BSW_00300*, *SRS_Rte_00055*)

In order to maintain control over the RTE namespace the creation of symbols in the global namespace using the prefix `Rte_` is reserved for the RTE generator.

The generated RTE is required to work with components written in several source languages and therefore should not use language specific features, such as C++ namespaces, to ensure symbol name uniqueness.

5.2.2 Direct API

The direct invocation form is the form used to present the RTE API in Section 5.6. The RTE direct API mapping is designed to be optimizable so that the instance handle is elided (and therefore imposes zero run-time overhead) when the RTE generator can determine that exactly one instance of a component is mapped to an ECU.

All runnable entities for a AUTOSAR software-component type are passed the same instance handle type (as the first formal parameter) and can therefore use the same type definition from the component's application header file.

The direct API can also be further optimized for source code components via the API mapping.

The direct API is typically implemented as macros that are modified by the RTE generator depending on configuration. This technique places certain restrictions on how the API can be used within a program, for example, it is not possible in C to take the address of a macro and therefore direct API functions cannot be placed within a function table or array. If it is required by the implementation of a software-component to derive a pointer to an object for the port API the `PortAPIOption enableTakeAddress` can be used. For instance in an implementation of an AUTOSAR `Service` this feature might be used to setup a constant function pointer table storing the configuration of callback functions per ID. Additionally the indirect API provides support for API addresses and iteration over ports.

[SWS_Rte_07100] [If a `PortPrototype` is referenced by `PortAPIOption` with `enableTakeAddress` = `TRUE` the RTE generator shall provide true/native C functions (as opposed to function-like preprocessor macros) for the API related to this port.] ()

The `PortAPIOption enableTakeAddress` = `TRUE` is not supported for software-components supporting multiple instantiation.

5.2.3 Indirect API

The indirect API is an optional form of API invocation that uses indirection through a port handle to invoke RTE API functions rather than direct invocation. This form is less efficient (the indirection cannot be optimized away) but supports a different programming style that may be more convenient. For example, when using the indirect API, an array of port handles of the same interface and provide/require direction is provided by RTE and the same RTE API can be invoked for multiple ports by iterating over the array.

Both direct and indirect forms of API call are equivalent and result in the same generated RTE function being invoked.

Whether the indirect API is generated or not can be specified for each software component and for each port prototype of the software component separately with the `indirectAPI` attribute.

The semantics of the port handle must be the same in both the “RTE Contract” and “RTE Generation” phases since the port handle accesses the standardized data structures of the RTE.

It is possible to mix the indirect and direct APIs within the same SW-C, if the indirect API is present for the SW-C.

The indirect API uses port handles during the invocation of RTE API calls. The type of the port handle is determined by the port interface that types the port which means that if a component declares multiple ports typed by the same port interface the port handle points to an array of port data structures and the same API invoked for each element.

The port handle type is defined in Section 5.4.2.5.

5.2.3.1 Accessing Port Handles

An AUTOSAR SW-C needs to obtain port handles using the instance handle before the indirect API can be used. The definition of the instance handle in Section 5.4.2 defines the “Port API” section of the component data structure and these entries can be used to access the port handles in either object-code or source-code components.

The API `Rte_Ports` and `Rte_NPorts` provides port data handles of a given interface. Example 5.1 shows how the indirect API can be used to apply the same operation to multiple ports in a component within a loop.

Example 5.1

The port handle points to an array that can be used within a loop to apply the same operation to each port. The following example sends the same data to each receiver:

```
1 void TT1(Rte_Instance instance)
2 {
```

```
3  Rte_PortHandle_interface1_P my_array;  
4  my_array=Rte_Ports_interface1_P(instance);  
5  uint8 s;  
6  for(s = 0u; s < Rte_NPorts_interface1_P(instance); s++) {  
7      my_array[s].Send_a(23);  
8  }  
9 }
```

Note that if `csInterface1` is a client/server interface with an operation `op`, the mechanism sketched in Example 5.1 only works if `op` is invoked either by all clients synchronously or by all clients asynchronously, since the signature of `Rte_Call` and the existence of `Rte_Result` depend on the kind of invocation (see restriction [SWS_Rte_03605]).

5.2.4 VariableAccess in the dataReadAccess and dataWriteAccess roles

The RTE is required to support access to data with implicit semantics. The required semantics are subject to two constraints:

- For `VariableAccess` in the `dataReadAccess` role, the data accessed by a runnable entity must not change during the lifetime of the runnable entity.
- For `VariableAccess` in the `dataWriteAccess` role, the data written by a runnable entity is only visible to other runnable entities after the accessing runnable entity has terminated.

The generated RTE satisfies both requirements through data copies that are created when the RTE is generated based on the known task and runnable mapping.

Example 5.2

Consider a data element, `a`, of port `p` which is accessed using a `VariableAccess` in the `dataReadAccess` role by runnable `re1` and a `VariableAccess` in the `dataWriteAccess` role by runnable `re2`. Furthermore, consider that `re1` and `re2` are mapped to different tasks and that execution of `re1` can pre-empt `re2`.

In this example, the RTE will create two different copies to contain `a` to prevent updates from `re2` ‘corrupting’ the value access by `re1` since the latter must remain unchanged during the lifetime of `re1`.

The RTE API includes three API calls to support `VariableAccesses` in the `dataReadAccess` and `dataWriteAccess` roles for a software-component; `Rte_IRead` (see Section 5.6.18), `Rte_IWrite`, and `Rte_IWriteRef` (see Section 5.6.20 and 5.6.21). The API calls `Rte_IRead` and `Rte_IWrite` access the data copies (for read and write access respectively). The API call `Rte_IWriteRef` returns a reference to the data copy, thus enabling the runnable to write the data directly. This

is especially useful for [Structure Implementation Data Type](#) and [Array Implementation Data Type](#). The use of an API call for reading and writing enables the definition to be changed based on the task and runnable mapping without affecting the software-component code.

Example 5.3

Consider a data element, *a*, of port *p* which is declared as being accessed using [VariableAccesses](#) in the [dataWriteAccess](#) role by runnables *re1* and *re2* within component *c*. The RTE API for component *c* will then contain four API functions to write the data element;

```
1 void Rte_IWrite_re1_p_a(Rte_Instance instance, <type> val);
2 void Rte_IWrite_re2_p_a(Rte_Instance instance, <type> val);
3 <type> Rte_IWriteRef_re1_p_a(Rte_Instance instance);
4 <type> Rte_IWriteRef_re2_p_a(Rte_Instance instance);
```

The API calls are used by *re1* and *re2* as required. The definitions of the API depend on where the data copies are defined. If both *re1* and *re2* are mapped to the same task then each can access the same copy. However, if *re1* and *re2* are mapped to different (pre-emptable) tasks then the RTE will ensure that each API access a different copy.

The [Rte_IRead](#) and [Rte_IWrite](#) use the “data handles” defined in the component data structure (see Section [5.4.2](#)).

5.2.5 Per Instance Memory

The RTE is required to support Per Instance Memory [[SRS_Rte_00013](#)].

The component’s instance handle defines a particular instance of a component and is therefore used when accessing the *Per Instance Memory* using the [Rte_Pim](#) API.

The [Rte_Pim](#) API does not impose the RTE to apply a data consistency mechanism for the access to *Per Instance Memory*. An application is responsible for consistency of accessed data by itself. This design decision permits efficient (zero overhead) access when required. If a component possesses multiple runnable entities that require concurrent access to the same *Per Instance Memory*, an exclusive area can be used to ensure data consistency, either through explicit [Rte_Enter](#) and [Rte_Exit](#) API calls or by declaring that, implicitly, the runnable entities run inside an exclusive area.

Thus, the *Per Instance Memory* is exclusively used by a particular software-component instance and needs to be declared and allocated (statically).

In general there are two different kinds of *Per Instance Memory* available which are varying in the typing mechanisms. ‘C’ typed [PerInstanceMemory](#) is typed by the description of a ‘C’ typedef whereas [arTypedPerInstanceMemory](#) ([AUTOSAR](#)

Typed Per Instance Memory) is typed by the means of an [AutosarDataType](#). Nevertheless both kinds of *Per Instance Memory* are accessed via the [Rte_Pim](#) API.

[SWS_Rte_07161] [The generated RTE shall declare [arTypedPerInstanceMemory](#) in accordance to the associated [ImplementationDataType](#) of a particular [arTypedPerInstanceMemory](#).] ([SRS_Rte_00013](#), [SRS_Rte_00077](#))

Note: The related *AUTOSAR data type* will generated in the RTE Types Header File (see chapter [5.3.6](#)).

[SWS_Rte_02303] [The generated RTE shall declare 'C' typed [PerInstanceMemory](#) in accordance to the attribute [type](#) of a particular [PerInstanceMemory](#).] ([SRS_Rte_00013](#), [SRS_Rte_00077](#))

In addition, the attribute [type](#) needs to be defined in the corresponding software-component header. Therefore, the attribute [typeDefinition](#) of the [PerInstanceMemory](#) contains its definition as plain text string. It is assumed that this text is valid 'C' syntax, because it will be included verbatim in the application header file.

[SWS_Rte_02304] [The generated RTE shall define the type of a 'C' typed [PerInstanceMemory](#) by interpreting the text string of the attribute [typeDefinition](#) of a particular [PerInstanceMemory](#) as the 'C' definition. This type shall be named according to the attribute [type](#) of the [PerInstanceMemory](#).] ([SRS_Rte_00013](#), [SRS_Rte_00077](#))

[SWS_Rte_07133] [The type of a 'C' typed [PerInstanceMemory](#) shall be defined in the *RTE Types Header File* as

```
typedef <typedefinition> Rte_PimType_<cts>_<type>;
```

where <typedefinition> is the content of the [typeDefinition](#) attribute of the [PerInstanceMemory](#),
 <type> is the type name defined in the [type](#) attribute of the the [PerInstanceMemory](#) and
 <cts> the [component type symbol](#) of the [AtomicSwComponentType](#) to which the [PerInstanceMemory](#) belongs..] ([SRS_Rte_00013](#), [SRS_Rte_00077](#))

[SWS_Rte_03782] [The type of a 'C' typed [PerInstanceMemory](#) shall be defined in the *Application Header File* as

```
typedef Rte_PimType_<cts>_<type> <type>;
```

where <cts> is the [component type symbol](#) of the [AtomicSwComponentType](#) to which the [PerInstanceMemory](#) belongs and
 <type> is the type name defined in the [type](#) attribute of the [PerInstanceMemory](#).] ([SRS_Rte_00013](#), [SRS_Rte_00077](#))

[SWS_Rte_07134] [The RTE generator shall generate type definitions for 'C' typed [PerInstanceMemory](#) (see [\[SWS_Rte_07133\]](#) and [\[SWS_Rte_03782\]](#)) only once for all 'C' typed [PerInstanceMemory](#)s of same Software Component Type defining identical couples of [type](#) and [typeDefinition](#) attributes.] ([SRS_Rte_00013](#), [SRS_Rte_00165](#))

Note: This shall support, that a Software Component Type can define several `PerInstanceMemory`'s using the identical 'C' type.

[SWS_Rte_07135] [The RTE generator shall reject configurations, violating [constr_-2007], where 'C' typed `PerInstanceMemory`s with identical `type` attributes but different `typeDefinition` attributes in the same Software Component Type are defined.] (*SRS_Rte_00013*, *SRS_Rte_00018*)

Note: This would lead to an compiler error due to incompatible redefinition of a 'C' type.

[SWS_Rte_02305] [The generated RTE shall instantiate (or allocate) declared `PerInstanceMemory`.] (*SRS_Rte_00013*, *SRS_Rte_00077*)

[SWS_Rte_07182] [The generated RTE shall initialize declared `PerInstanceMemory` according the `initValue` attribute if

- an `initValue` is defined
- AND
- no `SwAddrMethod` is defined for `PerInstanceMemory`.

] (*SRS_Rte_00013*, *SRS_Rte_00077*)

[SWS_Rte_08304] [Variables implementing `PerInstanceMemory` shall be initialized by RTE if

- an `initValue` is defined
- AND
- a `SwAddrMethod` is defined for `PerInstanceMemory`
- AND
- the `RteInitializationStrategy` for the `sectionInitializationPolicy` of the related `SwAddrMethod` is NOT configured to `RTE_INITIALIZATION_STRATEGY_NONE`.

] (*SRS_Rte_00013*, *SRS_Rte_00077*)

[SWS_Rte_07183] [The generated RTE shall instantiate (or allocate) declared `arTypedPerInstanceMemory`.] (*SRS_Rte_00013*, *SRS_Rte_00077*)

[SWS_Rte_07184] [The generated RTE shall initialize declared `arTypedPerInstanceMemory` according the `ValueSpecification` of the `VariableDataPrototype` defining the `arTypedPerInstanceMemory` if the general initialization conditions in [SWS_Rte_07046] are fulfilled.] (*SRS_Rte_00013*, *SRS_Rte_00077*)

[SWS_Rte_05062] [In case the `PerInstanceMemory` or `arTypedPerInstanceMemory` is used as a permanent RAM Block for the *NvRam manager* the name for the instantiated `PerInstanceMemory` or `arTypedPerInstanceMemory` shall be taken from the input information `RteNvmRamBlockLocationSymbol`. Otherwise the RTE generator is free to choose an arbitrary name.] (*SRS_Rte_00013*, *SRS_Rte_00077*)

Note that, in cases where a `PerInstanceMemory` is not initialized due to [SWS_Rte_07182] or [SWS_Rte_07184], the memory allocated for a `PerInstanceMemory` is not initialized by the generated RTE, but by the corresponding software-component instances.

[SWS_Rte_07693] [In case a `ParameterDataPrototype` in the role `perInstanceParameter` is used as a ROM Block for the NVRam Manager, then the name for the instantiated `ParameterDataPrototype` shall be taken from the input information `RteNvmRomBlockLocationSymbol`. Otherwise the RTE generator is free to choose an arbitrary name.] (SRS_Rte_00154)

Example 5.4

This description of a software component

```
<AR-PACKAGE>
  <SHORT-NAME>SWC</SHORT-NAME>
  <ELEMENTS>
    <APPLICATION-SW-COMPONENT-TYPE>
      <SHORT-NAME>TheSwc</SHORT-NAME>
      <INTERNAL-BEHAVIORS>
        <SWC-INTERNAL-BEHAVIOR>
          <SHORT-NAME>TheSwcInternalBehavior</SHORT-NAME>
          <PER-INSTANCE-MEMORYS>
            <PER-INSTANCE-MEMORY>
              <SHORT-NAME>MyPIM</SHORT-NAME>
              <TYPE>MyMemType</TYPE>
              <TYPE-DEFINITION>struct {uint16 val1; uint8 * val2;}</
                TYPE-DEFINITION>
            </PER-INSTANCE-MEMORY>
          </PER-INSTANCE-MEMORYS>
        </SWC-INTERNAL-BEHAVIOR>
      </INTERNAL-BEHAVIORS>
    </APPLICATION-SW-COMPONENT-TYPE>
  </ELEMENTS>
</AR-PACKAGE>
```

will e. g. result in the following code:

In the *RTE Types Header File*:

```
1  /* typedef to ensure unique typename */
2  /* according to the attributes */
3  /* 'type' and 'typeDefinition' */
4  typedef struct{
5      uint16 val1;
6      uint8 * val2;
7  } Rte_PimType_TheSwc_MyMemType;
```

In the respective *Application Header File*:

```
1  /* typedef visible within the scope */
2  /* of the component according to the attributes */
3  /* 'type' and 'typeDefinition' */
4  typedef Rte_PimType_TheSwc_MyMemType MyMemType;
```

In Rte.c:

```
1 /* declare and instantiate mem1 */  
2 /* "mem1" name may be taken from RteNvmRamBlockLocationSymbol */  
3 Rte_PimType_TheSwc_MyMemType mem1;
```

Note that the name used for the definition of the [PerInstanceMemory](#) may be used outside of the RTE. One use-case is to support the definition of the link between the NvRam Manager's permanent blocks and the software-components. The name in [RteNvmRamBlockLocationSymbol](#) is used to configure the location at which the NvRam Manager shall store and retrieve the permanent block content. For a detailed description please refer to the AUTOSAR Software Component Template [2].

5.2.6 API Mapping

The RTE API is implemented by macros and generated API functions that are created (or configured, depending on the implementation) by the RTE generator during the “RTE Generation” phase. Typically one customized macro or function is created for each “end” of a communication though the RTE generator may elide or combine custom functions to improve run-time efficiency or memory overheads.

[SWS_Rte_01274] [The API mapping shall be implemented in the application header file.] ([SRS_BSW_00330](#), [SRS_Rte_00027](#), [SRS_Rte_00051](#), [SRS_Rte_00083](#), [SRS_Rte_00087](#))

The RTE generator is required to provide a mapping from the RTE API name to the generated function [[SRS_Rte_00051](#)]. The API mapping provides a level of indirection necessary to support binary components and multiple component instances. The indirection is necessary for two reasons. Firstly, some information may not be known when the component is created, for example, the component's instance name, but are necessary to ensure that the names of the generated functions are unique. Secondly, the names of the generated API functions should be unique (so that the ECU image can link correctly) and the steps taken to ensure this may make the names not “user-friendly”. Therefore, the primary rationale for the API mapping is to provide the required abstraction that means that a component does not need to concern itself with the preceding problems.

The requirements on the API mapping depend on the phase in which an RTE generator is operating. The requirements on the API mapping are only binding for RTE generators operating in compatibility mode.

5.2.6.1 “RTE Contract” Phase

Within the “RTE Contract” phase the API mapping is required to convert from the source API call (as defined in Section [5.6](#)) to the runnable entity provided by a software-component or the implementation of the API function created by the RTE generator.

When compiled against a “RTE Contract” phase header file a software-component that can be multiple instantiated is required to use a general API mapping that uses the instance handle to access the function table defined in the component data structure.

[SWS_Rte_03706] [If a software-component [supportsMultipleInstantiation](#), the “RTE Contract” phase API mapping shall access the generated RTE functions using the instance handle to indirect through the generated function table in the component data structure.]([SRS_Rte_00051](#))

Example 5.5

For a require client-server port ‘p1’ with operation ‘a’ with a single argument, the general form of the API mapping would be:

```
1 #define Rte_Call_p1_a(instance,v) ((instance)->p1.Call_a(v))
```

Where *s* is the instance handle.

[SWS_Rte_06516] [The RTE Generator shall wrap each API mapping and API function definition of a variant existent API according table [4.23](#) if the variability shall be implemented.

```
1 #if (<condition> [||<condition>])
2
3 <API Mapping>
4
5 #endif
```

where *condition* are the condition value macro(s) of the [VariationPoints](#) relevant for the conditional existence of the RTE API (see table [4.23](#)), *API Mapping* is the code according an invariant API Mapping (see also [\[SWS_Rte_01274\]](#), [\[SWS_Rte_03707\]](#), [\[SWS_Rte_03837\]](#), [\[SWS_Rte_01156\]](#))]([SRS_Rte_00201](#))

Note: In case of explicit communication any existent access points in the meta model might result in the related API which results in a or condition for the pre processor.

Example 5.6

For a require client-server port ‘p1’ with operation ‘a’ with a single argument of the component ‘c1’ defining a [ServerCallPoint](#) which is subject of variability in runnable ‘run1’, the general form of the conditional API mapping would be:

```
1
2 #if (Rte_VPCon_c1_run1_p1_a==TRUE)
3
4 #define Rte_Call_p1_a(instance,v) ((instance)->p1.Call_a(v))
5
6 #endif
```

[SWS_Rte_03707] [If a software-component does not [supportsMultipleInstantiation](#), the “RTE Contract” phase API mapping shall access the generated RTE functions directly.] ([SRS_Rte_00051](#))

[SWS_Rte_08073] [In compatibility mode or “RTE Contract” phase, the API mapping for [Rte_PBCon](#) shall access the generated RTE functions directly.] ([SRS_Rte_00051](#))

When accessed directly, the names of the generated functions are formed according to the following rule:

[SWS_Rte_03837] [The function generated for API calls `Rte_<name>_<api_extension>` that are intended to be called by the software component shall be

`Rte_<name>_<cts>_<api_extension>`,

where `<name>` is the API root (e.g. `Receive`),
`<cts>` the [component type symbol](#) of the [AtomicSwComponentType](#),
and `<api_extension>` is the extension of the API dependent on `<name>` (e.g. `<re>_<p>_<o>`).] ([SRS_Rte_00051](#))

[SWS_Rte_01156] [In compatibility mode, the following API calls shall be implemented as macros:

- [Rte_Pim](#)
- [Rte_IrvIRead](#)
- [Rte_IrvIWrite](#)
- [Rte_IrvIWriteRef](#)

The generated macros for these API calls shall map to the relevant fields of the component data structure.] ([SRS_Rte_00051](#))

For APIs not mentioned in [\[SWS_Rte_01156\]](#), and not subject to [enableTakeAddress](#), requirement [\[SWS_Rte_03707\]](#) means that in contract phase a function must be generated for single instantiated SWCs. Likewise for multiple instantiated SWCs a function must also be generated in contract phase as the relevant fields in the CDS are omitted and therefore macros cannot be used in the API mapping. In compatibility mode and RTE phase the same limitations apply due to the constraints of the CDS.

Note that the rule described in [\[SWS_Rte_03837\]](#) does not apply for the life cycle APIs, nor for the callback APIs, nor for the APIs that are implemented as macros (see [\[SWS_Rte_01156\]](#)).

[SWS_Rte_06831] [In compatibility mode, the following API calls shall be implemented either as macros (that map directly to the relevant field of the component data structure) or as a C function (that may use the fields of the component data structure) based on the state of the [enableTakeAddress](#) attribute [\[SWS_Rte_07100\]](#):

- [Rte_IRead](#)

- [Rte_IWrite](#)
- [Rte_IWriteRef](#)
- [Rte_IStatus](#)
- [Rte_IFeedback](#)
- [Rte_IInvalidate](#)

]([SRS_Rte_00051](#))

Note: For [[SWS_Rte_01156](#)] and [[SWS_Rte_06831](#)] when the APIs are implemented as macros the API mapping in the application header file directly uses relevant fields of the component data structure. However the [enableTakeAddress](#) attribute only applies for single instantiated SWCs and therefore the body of the generated function can directly access the relevant data if required without indirection through the component data structure.

The functions generated that are the destination of the API mapping, which is created during the “RTE Contract” phase, are created by the RTE generator during the second “RTE Generation” phase.

[SWS_Rte_01153] [The generated function (or runnable) shall take the same parameters, in the same order, as the API mapping.]([SRS_Rte_00051](#))

Example 5.7

For a require client-server port ‘p1’ with operation ‘a’ with a single argument for component type ‘c1’ for which multiple instantiation is forbidden, the following mapping would be generated:

```
1 #define Rte_Call_p1_a Rte_Call_c1_p1_a
```

5.2.6.2 “RTE Generation” Phase

There are no requirements on the *form* that the API mapping created during the “RTE Generation” phase should take. This is because the application header files defined during this phase are used by source-code components and therefore compatibility between the generated RTE and source-code components is automatic.

The RTE generator is required to produce the component data structure instances required by object-code components and multiple instantiated source-code components.

If multiple instantiation of a software-component is forbidden, then the API mapping specified for the “RTE Contract” phase (Section [5.2.6.1](#)) defines the names of the generated functions. If multiple instantiation is possible, there are no corresponding requirements that define the name of the generated function since all accesses to the generated functions are performed via the component data structure which contains well-defined entries (Sections [5.4.2.5](#) and [5.4.2.5](#)).

5.2.6.3 Function Elision

Using the “RTE Generation” phase API mapping, it is possible for the RTE generator to elide the use of generated RTE functions.

[SWS_Rte_01146] [If the API mapping elides an RTE function the “RTE Generation” phase API mapping mechanism shall ensure that the invoking component still receives a “return value” so that no changes to the AUTOSAR software-component are necessary.] ([SRS_Rte_00051](#))

In C, the elision of API calls can be achieved using a comma expression²

Example 5.8

As an example, consider the following component code:

```
1 Std_ReturnType s;  
2 s = Rte_Send_p1_a(instance, 23);
```

Furthermore, assume that the communication attributes are specified such that the sender-receiver communication can be performed as a direct assignment and therefore no RTE API call needs to be generated. However, the component source cannot be modified and expects to receive an `Std_ReturnType` as the return. The “RTE Generation” phase API mapping could then be rewritten as:

```
1 #define Rte_Send_p1_a(s,a) (<var> = (a), RTE_E_OK)
```

Where `<var>` is the implementation dependent name for an RTE created cache between sender and receiver.

5.2.6.4 API Naming Conventions

An AUTOSAR software-component communicates with other components (including basic software) through ports and therefore the names that constitute the RTE API are formed from the combination of the API call’s functionality (e.g. Call, Send) that defines the API root name and the access point through which the API operates.

For any API that operates through a port, the API’s access point includes the port name.

A [SenderReceiverInterface](#) can support multiple data items and a [ClientServerInterface](#) can support multiple operations, any of which can be invoked through the requiring port by a client. The RTE API therefore needs a mechanism to indicate which data item/operation on the port to access and this is implemented by including the data item/operation name in the API’s access point.

²This is contrary to MISRA Rule 12.3 “*The comma operator should not be used*”. However, a comma expression is valid, legal, C and the elision cannot be achieved without a comma expression and therefore the rule must be relaxed.

As described above, the RTE API mapping is responsible for mapping the RTE API name to the correct generated RTE function. The API mapping permits an RTE generator to include targeted optimization as well as removing the need to implement functions that act as routing functions from generic API calls to particular functions within the generated RTE.

For C and C++ the RTE API names introduce symbols into global scope and therefore the names are required to be prefixed with `Rte_` [SWS_Rte_01171].

5.2.6.5 API Parameters

All API parameters fall into one of two classes; parameters that are strictly read-only (“In” parameters) and parameters whose value may be modified by the API function (“In/Out” and “Out” parameters).

The type of these parameters is taken from the data element prototype or operation prototype in the interface that characterizes the port for which the API is being generated.

In the following, requirement [SWS_Rte_06806] reflects the standard defined by [29]. The remaining requirements are included to ensure the consistency between different RTE implementations. The rules described below regarding the default argument passing strategy may be overwritten by more specific requirements, e.g. `ServerArgumentImplPolicy`.

[SWS_Rte_06804] [All input parameters using the `P2CONST` macro shall use `memclass` `AUTOMATIC` and `ptrclass` `RTE_APPL_DATA`.] (SRS_Rte_00060, SRS_BSW_00007)

[SWS_Rte_06805] [All parameters using the `VAR` macro shall use `memclass` `AUTOMATIC`.] (SRS_Rte_00059, SRS_BSW_00007)

[SWS_Rte_06806] [All output and bi-directional parameters (i.e. both input and output) parameters shall use the `P2VAR` macro.] (SRS_Rte_00061, SRS_BSW_00007)

[SWS_Rte_06807] [All parameters using the `P2VAR` macro shall use `memclass` `AUTOMATIC` and `ptrclass` `RTE_APPL_DATA`.] (SRS_Rte_00059, SRS_Rte_00060, SRS_BSW_00007)

- “In” Parameters

[SWS_Rte_01017] [All input parameters that are a `Primitive Implementation Data Type` shall be passed by value.] (SRS_Rte_00059, SRS_Rte_00061)

[SWS_Rte_01018] [All input parameters that are of type `Structure Implementation Data Type` or `Union Implementation Data Type` shall be passed by reference.] (SRS_Rte_00060, SRS_Rte_00061)

[SWS_Rte_05107] [All input parameters that are an [Array Implementation Data Type](#) shall be passed as an array expression (that is a pointer to the array base type).] ([SRS_Rte_00060](#), [SRS_Rte_00061](#))

[SWS_Rte_07661] [All input parameters that are a data type of category `DATA_REFERENCE` shall be passed as a pointer to the data type specified by the `SwPointerTargetProps`.] ([SRS_Rte_00059](#), [SRS_Rte_00061](#))

[SWS_Rte_07086] [All input parameters that are passed by reference ([\[SWS_Rte_01018\]](#)) or passed as an array expression ([\[SWS_Rte_05107\]](#)) shall be declared as pointer to const with the means of the `P2CONST` macro.] ([SRS_Rte_00060](#), [SRS_BSW_00007](#))

Please note that the description of the `P2CONST` macro can be found in [\[30\]](#).

- “Out” Parameters

[SWS_Rte_01019] [All output parameters that are of type [Primitive Implementation Data Type](#) shall be passed by reference.] ([SRS_Rte_00061](#))

[SWS_Rte_07082] [All output parameters that are of type [Structure Implementation Data Type](#) or [Union Implementation Data Type](#) shall be passed by reference.] ([SRS_Rte_00060](#), [SRS_Rte_00061](#))

[SWS_Rte_05108] [All output parameters that are an [Array Implementation Data Type](#) shall be passed as an array expression (that is a pointer to the array base type).] ([SRS_Rte_00060](#), [SRS_Rte_00061](#))

[SWS_Rte_07083] [All output parameters that are of type [Pointer Implementation Data Type](#) shall be passed as a pointer to the [Pointer Implementation Data Type](#).] ([SRS_Rte_00059](#), [SRS_Rte_00061](#))

- “In/Out” Parameters

[SWS_Rte_01020] [All bi-directional parameters (i.e. both input and output) that are of type [Primitive Implementation Data Type](#) or [Structure Implementation Data Type](#) or [Union Implementation Data Type](#) shall be passed by reference.] ([SRS_Rte_00059](#), [SRS_Rte_00061](#))

[SWS_Rte_05109] [All bi-directional parameters (i.e. both input and output) that are an [Array Implementation Data Type](#) shall be passed as an array expression (that is a pointer to the array base type).] ([SRS_Rte_00061](#))

[SWS_Rte_07084] [All input, output and bi-directional parameters which related [DataPrototype](#) is typed or mapped to an [Redefinition Implementation Data Type](#) shall be treated according the kind of data type redefined by the [Redefinition Implementation Data Type](#). The possible kinds of data types supported by RTE are listed in [5.3.4.2](#).] ([SRS_Rte_00059](#), [SRS_Rte_00060](#), [SRS_Rte_00061](#))

In order to indicate the direction of the individual API parameters, the descriptions of the API signatures in this API reference chapter use the direction qualifiers “IN”,

"OUT", and "INOUT". These direction qualifiers are not part of the actual API prototypes. Especially, the user cannot expect that these direction qualifiers are available for the application.

Example 5.9

This would be the `Rte_Write` API generated for the example 5.5 (example of a two dimension array typed by an `ImplementationDataType`):

```
1 FUNC(Std_ReturnType, RTE_CODE) Rte_Write_<p>_<o>(P2CONST(uint8,
    AUTOMATIC, AUTOMATIC) data)
```

Which can be used in the SWC code:

```
1 status = Rte_Write_<p>_<o> (&array[0][0]);
```

5.2.6.6 Return Values

A subset of the RTE API's returning the values instead of using OUT Parameters. In the API section these API signatures defining a `<return>` value. In addition to the following rules some of the APIs might specify additionally const qualifiers.

[SWS_Rte_07069] [The RTE Generator shall determine the `<return>` type according the applicable `ImplementationDataType` of the `DataPrototype` for which the API provides access.]([SRS_Rte_00059](#))

[SWS_Rte_08300] [A pointer return value of an RTE API shall be declared as pointer to const with the means of the `FUNC_P2CONST` macro or `P2CONST` if the pointer is not used to modify the addressed object.]([SRS_Rte_00059](#))

Please note that the `FUNC_P2CONST` macro is applicable if the RTE API is implemented as an real function and the `P2CONST` might be used if the RTE API is implemented as a macro.

Requirement **[SWS_Rte_08300]** applies for instance for the RTE APIs `Rte_Prm`, `Rte_CData`, `Rte_IrvRead`, `Rte_IrvIRead` in the cases where the API grants access to composite data (arrays, structures, unions).

Please note, that the the implementation of the C data types are specified in section 5.3.4 "RTE Types Header File".

[SWS_Rte_07070] [If the `DataPrototype` is associated to a `Primitive Implementation Data Type` the RTE API shall return the value of the `DataPrototype` for which the API provides access. The type name shall be equal to the `shortName` of these `ImplementationDataType`.]([SRS_Rte_00059](#))

Example 5.10

Consider an RTE API call return a primitive as defined in the example 5.2 for a singly instantiated SW-C. The signature of the API will be:

```
1 MyUint8 Rte_IRead_<re>_<p>_<o>(void);
```

Please note that the usage of Compiler Abstraction is not shown in the example.

[SWS_Rte_07071] [If the [DataPrototype](#) is associated to a [Structure Implementation Data Type](#) or [Union Implementation Data Type](#), the RTE API shall return a pointer to a variable holding the [DataPrototype](#) value provided by the API. The type name shall be equal to the [shortName](#) of these [Implementation-DataType](#).] ([SRS_Rte_00059](#))

Example 5.11

Consider an RTE API call return a structure as defined in the example 5.6 for a singly instantiated SW-C. The signature of the API will be:

```
1
2 FUNC_P2CONST(RecA, RTE_VAR_FAST_INIT, RTE_CODE)
3           Rte_IRead_<re>_<p>_<o>(void);
```

Please note that the usage of Compiler Abstraction assumes that the [SwAddrMethod](#) of the accessed [VariableDataPrototype](#) is named "VAR_FAST_INIT". Further on the example does not respect the principles of API mapping.

[SWS_Rte_07072] [If the [DataPrototype](#) is associated to an [Array Implementation Data Type](#) the RTE API shall return an array expression (that is a pointer to the array base type) pointing to variable holding the value of the [DataPrototype](#) for which the API provides access. If the leaf [ImplementationDataTypeElement](#) is typed by a [SwBaseType](#) the array type name shall be equal to the [nativeDeclaration](#) attribute of the [SwBaseType](#). If the leaf [ImplementationDataTypeElement](#) is typed by an [ImplementationDataType](#) the type name shall be equal to the [shortName](#) of this [ImplementationDataType](#). If the leaf [ImplementationDataTypeElement](#) is of category STRUCTURE or UNION the type name shall be equal to the [shortName](#) of this [ImplementationDataTypeElement](#).] ([SRS_Rte_00059](#))

Example 5.12

Consider an RTE API call return an array as defined in the example 5.4 for a singly instantiated SW-C. The signature of the API will be:

```
1 FUNC_P2CONST(unsigned char, RTE_VAR_POWER_ON_INIT, RTE_CODE)
2           Rte_IRead_<re>_<p>_<o>(void);
```

Please note that the usage of Compiler Abstraction assumes that the [SwAddrMethod](#) of the accessed [VariableDataPrototype](#) is named "VAR_POWER_ON_INIT". Further on the example does not respect the principles of API mapping.

Example 5.13

Consider an RTE API call return an array as defined in the example 5.5 for a singly instantiated SW-C. The signature of the API will be:

```
1 FUNC_P2CONST(uint8, RTE_VAR_NO_INIT, RTE_CODE)
2           Rte_IRead_<re>_<p>_<o>(void);
```

Please note that the usage of Compiler Abstraction assumes that the `SwAddrMethod` of the accessed `VariableDataPrototype` is named "VAR_NO_INIT". Further on the example does not respect the principles of API mapping.

[SWS_Rte_07073] [If the `DataPrototype` is associated to a `Pointer Implementation Data Type` the RTE API shall return the value of the `DataPrototype` for which the API provides access. The type name shall be equal to the `shortName` of these `ImplementationDataType`.] (*SRS_Rte_00059*) Please note that in this case the value is a pointer.

[SWS_Rte_07074] [If the `DataPrototype` is associated to a `Redefinition Implementation Data Type` the RTE Generator shall determine the API return value behaviour as described in [SWS_Rte_07070], [SWS_Rte_07071], [SWS_Rte_07072], [SWS_Rte_07073], [SWS_Rte_07074] according the referenced `ImplementationDataType`. Nevertheless except for `Array Implementation Data Type` the type name shall be equal to the `shortName` of these `ImplementationDataType`.] (*SRS_Rte_00059*)

Please note that `Redefinition Implementation Data Type` might redefine an other `Redefinition Implementation Data Type` again.

5.2.6.7 Return References

A subset of the RTE API's returning a reference to the memory location where the data can be accessed instead of using IN/OUT Parameters. In the API section these API signatures defining a `<return reference>` value.

[SWS_Rte_06808] [A `<return reference>` shall use the `FUNC_P2VAR` or `P2VAR` macro.] (*SRS_BSW_00007*)

[SWS_Rte_06809] [A `<return reference>` which uses either the `P2VAR` or the `FUNC_P2VAR` macro shall use `memclass AUTOMATIC` and `ptrclass RTE_DATA`.] (*SRS_BSW_00007*)

[SWS_Rte_07076] [The RTE Generator shall determine the `<return reference>` type according the applicable `ImplementationDataType` of the `DataPrototype` for which the API provides access.] (*SRS_Rte_00059*)

Please note, that the the implementation of the C data types are specified in section 5.3.4 "RTE Types Header File".

[SWS_Rte_07077] [If the `DataPrototype` is associated to a `Primitive Implementation Data Type` the RTE API shall return a pointer to variable holding the

data of the value of the [DataPrototype](#) for which the API provides access. The type name shall be equal to the [shortName](#) of these [ImplementationDataType](#).] ([SRS_Rte_00059](#))

Example 5.14

Consider an RTE API call return a reference to a primitive as defined in the example [5.2](#) for a singly instantiated SW-C. The signature of the API will be:

```
1 MyUInt8 * Rte_IWriteRef_<re>_<p>_<o>(void);
```

Please note that the usage of Compiler Abstraction is not shown in the example.

[SWS_Rte_07078] [If the [DataPrototype](#) is associated to a [Structure Implementation Data Type](#) or [Union Implementation Data Type](#) the RTE API shall return a pointer to variable holding the value of the [DataPrototype](#) for which the API provides access. The type name shall be equal to the [shortName](#) of these [ImplementationDataType](#).] ([SRS_Rte_00059](#))

Example 5.15

Consider an RTE API call return a reference to a structure as defined in the example [5.6](#) for a singly instantiated SW-C. The signature of the API will be:

```
1 RecA * Rte_IWriteRef_<re>_<p>_<o>(void);
```

Please note that the usage of Compiler Abstraction is not shown in the example.

[SWS_Rte_07079] [If the [DataPrototype](#) is associated to an [Array Implementation Data Type](#) the RTE API shall return an array expression (that is a pointer to the array base type) pointing to variable holding the value of the [DataPrototype](#) for which the API provides access. If the leaf [ImplementationDataTypeElement](#) is typed by a [SwBaseType](#) the array type name shall be equal to the [nativeDeclaration](#) attribute of the [SwBaseType](#). If the leaf [ImplementationDataTypeElement](#) is typed by an [ImplementationDataType](#) the type name shall be equal to the [shortName](#) of these [ImplementationDataType](#).] ([SRS_Rte_00059](#))

Example 5.16

Consider an RTE API call return a reference to an array as defined in the example [5.4](#) for a singly instantiated SW-C. The signature of the API will be:

```
1 unsigned char * Rte_IWriteRef_<re>_<p>_<o>(void);
```

Example 5.17

Consider an RTE API call return a reference to an array as defined in the example [5.5](#) for a singly instantiated SW-C. The signature of the API will be:

```
1 uint8 * Rte_IWriteRef_<re>_<p>_<o>(void);
```


Please note that the usage of Compiler Abstraction is not shown in the examples.

[SWS_Rte_07080] [If the `DataPrototype` is associated to a `Pointer Implementation Data Type` the RTE API shall return a pointer pointing to variable holding the value of the `DataPrototype` for which the API provides access. The type name shall be equal to the `shortName` of these `ImplementationDataType`.] (*SRS_Rte_00059*) Please note that in this case the value is a pointer again.

[SWS_Rte_07081] [If the `DataPrototype` is associated to a `Redefinition Implementation Data Type` the RTE Generator shall determine the API return value behaviour as described in [SWS_Rte_07077], [SWS_Rte_07078], [SWS_Rte_07079], [SWS_Rte_07080], [SWS_Rte_07081] according to the referenced `ImplementationDataType`. Nevertheless except for `Array Implementation Data Type` the type name shall be equal to the `shortName` of these `ImplementationDataType`.] (*SRS_Rte_00059*)

Please note that `Redefinition Implementation Data Type` might redefine another `Redefinition Implementation Data Type` again.

5.2.6.8 Error Handling

In RTE, error and status information is defined with the data type `Std_ReturnType`, see Section 5.5.1.

It is possible to distinguish between infrastructure errors and application errors. Infrastructure errors are caused by a resource failure or an invalid input parameter. Infrastructure errors usually occur in the basic software or hardware along the communication path of a data element. Application errors are reported by a SW-C or by AUTOSAR services. RTE has the capability to treat application errors that are forwarded

- by return value in client server communication or
- by signal invalidation in sender receiver communication with `data semantics`.

Errors that are detected during an RTE API call are notified to the caller using the API's return value.

[SWS_Rte_01034] [Error states (including 'no error') shall only be passed as return value of the RTE API to the AUTOSAR SW-C.] (*SRS_Rte_00094*)

Requirement [SWS_Rte_01034] ensures that, irrespective of whether the API is blocking or non-blocking, the error is collected at the same time the data is made available to the caller thus ensuring that both items are accessed consistently.

Certain RTE API calls operate asynchronously from the underlying communication mechanism. In this case, the return value from the API indicates only errors detected during that API call. Errors detected after the API has terminated are returned using a different mechanism [SWS_Rte_01111]. RTE also provides an 'implicit' API for direct access to virtually shared memory. This API does not return any errors. The underlying

communication is decoupled. Instead, an API is provided to pick up the current status of the corresponding data element.

5.2.6.9 Success Feedback

The RTE supports the notification of results of transmission attempts to an AUTOSAR software-component.

The `Rte_Feedback` API [SWS_Rte_01083] or the `Rte_IFeedback` API [SWS_Rte_07367] can be configured to return the transmission result as either a blocking or non-blocking API or via activation of a runnable entity.

5.2.7 Unconnected Ports

[SWS_Rte_01329] [The RTE shall handle both require and provide ports that are not connected.] (SRS_Rte_00139)

The handling of require ports as an error is described in requirement [SWS_Rte_05099].

[SWS_Rte_06030] [The RTE shall consider a `PRPortPrototype` as always connected.] (SRS_Rte_00139)

Note: [SWS_Rte_06030] is the consequence of [TPS_SWCT_01573]. This is because a `PRPortPrototype` is logically an overlay of require and provide semantics hence the `PRPortPrototype` needs no further explicitly defined connection in the form of an `SwConnector` or signal mapping.

RTE event handling and the API calls for unconnected ports are specified to behave as if the port was connected but the remote communication point took no action.

Unconnected require ports are regarded by the RTE generator as an invalid configuration (see [SWS_Rte_03019]) if the strict handling has been enabled (see [SWS_Rte_05099]).

5.2.7.1 Data Elements

5.2.7.1.1 Explicit Communication

[SWS_Rte_01330] [A `Rte_Read` API for an unconnected require port typed by a `SenderReceiverInterface` or `NvDataInterface` shall return the `RTE_E_UNCONNECTED` code and provide the `initValue` as if a sender was connected but did not transmit anything.] (SRS_Rte_00094, SRS_Rte_00139, SRS_Rte_00200)

[SWS_Rte_07663] [A `Rte_DRead` API for an unconnected require port typed by a `SenderReceiverInterface` or `NvDataInterface` shall return the `initValue` as if a sender was connected but did not transmit anything.] (*SRS_Rte_00139*, *SRS_Rte_00200*)

Requirements [\[SWS_Rte_01330\]](#) and [\[SWS_Rte_07663\]](#) apply to elements with "data" semantics and therefore "last is best" semantics. This means that the initial value will be returned.

[SWS_Rte_01331] [A blocking or non-blocking `Rte_Receive` API for an unconnected require port typed by a `SenderReceiverInterface` shall return `RTE_E_UNCONNECTED` immediately.] (*SRS_Rte_00094*, *SRS_Rte_00107*, *SRS_Rte_00110*, *SRS_Rte_00139*, *SRS_Rte_00200*)

The existence of blocking and non-blocking `Rte_Read`, `Rte_DRead` and `Rte_Receive` API calls is controlled by the presence of `VariableAccesses` in the `dataReceivePointByValue` or `dataReceivePointByArgument` role, `DataReceivedEvents` and `WaitPoints` within the SW-C description [\[SWS_Rte_01288\]](#), [\[SWS_Rte_01289\]](#) and [\[SWS_Rte_01290\]](#).

[SWS_Rte_01344] [A blocking or non-blocking `Rte_Feedback` API for a `VariableDataPrototype` of an unconnected provide port shall return `RTE_E_UNCONNECTED` immediately.] (*SRS_Rte_00094*, *SRS_Rte_00122*, *SRS_Rte_00139*)

The existence of blocking and non-blocking `Rte_Feedback` API is controlled by the presence of `VariableAccesses` in the `dataSendPoint` role, `DataSendCompletedEvents` and `WaitPoints` within the SW-C description for a `VariableDataPrototype` with acknowledgement enabled, see [\[SWS_Rte_01283\]](#), [\[SWS_Rte_01284\]](#), [\[SWS_Rte_01285\]](#) and [\[SWS_Rte_01286\]](#).

[SWS_Rte_01332] [The `Rte_Send` or `Rte_Write` API for an unconnected provide port typed by a `SenderReceiverInterface` or `NvDataInterface` shall discard the input parameters and return `RTE_E_OK`.] (*SRS_Rte_00139*)

The existence of `Rte_Send` or `Rte_Write` is controlled by the presence of `VariableAccesses` in the `dataSendPoint` role within the SW/C description [\[SWS_Rte_01280\]](#) and [\[SWS_Rte_01281\]](#).

[SWS_Rte_03783] [The `Rte_Invalidate` API for an unconnected provide port typed by a `SenderReceiverInterface` shall return `RTE_E_OK`.] (*SRS_Rte_00139*)

The existence of `Rte_Invalidate` is controlled by the presence of `VariableAccesses` in the `dataSendPoint` role within the SW/C description for a `VariableDataPrototype` which is marked as invalidatable by an associated `InvalidationPolicy`. The `handleInvalid` attribute of the `InvalidationPolicy` has to be set to `keep`, `replace` or `externalReplacement` to enable the invalidation support for this `dataElement` ([\[SWS_Rte_01282\]](#)).

5.2.7.1.2 Implicit Communication

[SWS_Rte_07378] [An `Rte_IFeedback` API for a `VariableDataPrototype` of an unconnected provide port shall return `RTE_E_UNCONNECTED` immediately.] (*SRS_Rte_00139*, *SRS_Rte_00185*)

The existence of an `Rte_IFeedback` API is controlled by the presence of `VariableAccesses` in the `dataWriteAccess` role, and `DataWriteCompletedEvents` within the SWC description for a `VariableDataPrototype` with acknowledgement enabled, see [SWS_Rte_07646], [SWS_Rte_07647].

[SWS_Rte_01346] [An `Rte_IRead` API for an unconnected require port typed by a `SenderReceiverInterface` or `NvDataInterface` shall return the initial value.] (*SRS_Rte_00139*)

The existence of `Rte_IRead` is controlled by the presence of a `VariableAccess` in the `dataReadAccess` role in the SW-C description [SWS_Rte_01301].

[SWS_Rte_01347] [An `Rte_IWrite` API for an unconnected provide port typed by a `SenderReceiverInterface` or `NvDataInterface` shall discard the written data.] (*SRS_Rte_00139*)

The existence of `Rte_IWrite` is controlled by the presence of a `VariableAccess` in the `dataWriteAccess` role in the SW-C description [SWS_Rte_01302].

[SWS_Rte_03784] [An `Rte_IInvalidate` API for an unconnected provide port typed by a `SenderReceiverInterface` shall perform no action.] (*SRS_Rte_00139*)

The existence of `Rte_IInvalidate` is controlled by the presence of a `VariableAccess` in the `dataWriteAccess` role in the SW-C description for a `VariableDataPrototype` which is marked as invalidatable by an associated `InvalidationPolicy`. The `handleInvalid` attribute of the `InvalidationPolicy` has to be set to `keep`, `replace` or `externalReplacement` to enable the invalidation support for this `dataElement` ([SWS_Rte_03801]).

[SWS_Rte_03785] [An `Rte_IStatus` API for an unconnected require port typed by a `SenderReceiverInterface` shall return `RTE_E_UNCONNECTED`.] (*SRS_Rte_00094*, *SRS_Rte_00139*, *SRS_Rte_00200*)

The existence of `Rte_IStatus` is controlled by the presence of a `VariableAccess` in the `dataReadAccess` role in the SW-C description for a `VariableDataPrototype` with data element outdated notification or data element invalidation [SWS_Rte_02600].

5.2.7.2 Mode Switch Ports

For the mode user an unconnected mode switch port behaves as if it was connected to a mode manager that never sends a mode switch notification.

[SWS_Rte_02638] [A [Rte_Mode](#) API for an unconnected mode switch port of a mode user shall return the initial state.]([SRS_Rte_00139](#))

[SWS_Rte_02639] [Regarding the modes of an unconnected mode switch port of a mode user, the mode disabling dependencies on the initial mode shall be permanently active and the mode disabling dependencies on all other modes shall be inactive.]([SRS_Rte_00139](#))

[SWS_Rte_02640] [Regarding the modes of an unconnected mode switch port of a mode user, RTE will only generate a [SwcModeSwitchEvent](#) for entering the initial mode which occurs directly after startup.]([SRS_Rte_00139](#))

[SWS_Rte_02641] [The [Rte_Switch](#) API for an unconnected mode switch port of the mode manager shall discard the input parameters and return `RTE_E_OK`.]([SRS_Rte_00139](#))

[SWS_Rte_02642] [A blocking or non blocking [Rte_SwitchAck](#) API for an unconnected mode switch port of the mode manager shall return `RTE_E_UNCONNECTED` immediately.]([SRS_Rte_00139](#))

[SWS_Rte_01375] [A provided [mode switch port](#) of a [mode manager](#) shall be considered unconnected only if there are no connections at the composition level and no [ModeAccessPoint](#) exists for the provided [mode switch port](#) and no [synchronizedModeGroup](#) refers to the provided [mode switch port](#).]([SRS_Rte_00139](#))

5.2.7.3 Client-Server

[SWS_Rte_01333] [The [Rte_Result](#) API for an unconnected asynchronous require port typed by a [ClientServerInterface](#) shall return `RTE_E_UNCONNECTED` immediately.]([SRS_Rte_00094](#), [SRS_Rte_00139](#), [SRS_Rte_00200](#))

[SWS_Rte_01334] [The [Rte_Call](#) API for an unconnected require port typed by a [ClientServerInterface](#) shall return `RTE_E_UNCONNECTED` immediately.]([SRS_Rte_00094](#), [SRS_Rte_00139](#), [SRS_Rte_00200](#))

[SWS_Rte_04530] [If a client/server communication is inter-ECU, then for each [ClientServerOperation](#) the [DataMappings](#) element shall contain a mapping to at least one COM signal or being referenced at least by a [LdCom I-PDU](#), otherwise the [ClientServerOperation](#) shall be treated as if it is part of an unconnected port.]([SRS_Rte_00094](#), [SRS_Rte_00139](#), [SRS_Rte_00200](#))

5.2.7.4 External Triggers

For unconnected [RPortPrototypes](#) the associated [ExternalTriggerOccurredEvents](#) will never get fired (i.e. it behaves as if the remote communication partner never triggers the event).

[SWS_Rte_06210] [The `Rte_Trigger` API for an unconnected `PPortPrototypes` typed by a `TriggerInterface` shall discard the trigger request and return `RTE_E_OK`.] ([SRS_Rte_00094](#), [SRS_Rte_00139](#), [SRS_Rte_00162](#), [SRS_Rte_00200](#))

5.2.8 Non-identical port interfaces

Two ports are permitted to be connected provided that they are characterized by compatible, but not necessarily identical, interfaces. For the full definition of whether two interfaces are compatible, see the Software Component Template [2].

[SWS_Rte_01368] [The RTE generator shall report an error if the `[constr_1036]` and the `[constr_1069]` are violated so if two connected ports are connected by incompatible interfaces.] ([SRS_Rte_00137](#))

A significant issue in determining whether two interfaces are compatible is that the interface characterizing the require port may be a strict subset of the interface characterizing the provide port. This means that there may be provided data elements or operations for which there is no corresponding element in the require port. This can be imagined as a multi-strand wire between the two ports (the assembly connector) where each strand represents the connection between two data elements or operations, and where some of the strands from the ‘provide’ end are not connected to anything at the ‘require’ end.

Define, for the purposes of this section, an “unconnected element” as a data element or operation that occurs in the provide interface, but for which no corresponding data element or operation occurs in a particular R-Port’s interface.

[SWS_Rte_01369] [For each data element or operation within the provide interface, every connected requirer with an “unconnected element” must be treated as if it were not connected.] ([SRS_Rte_00137](#))

Note that requirement [\[SWS_Rte_01369\]](#) means that in the case of a 1:n Sender-Receiver the `Rte_Write` call may transmit to some but not all receivers.

The extreme is if all connected requirers have an “unconnected element”:

[SWS_Rte_01370] [For a data element or operation in a provide interface which is an unconnected element in every connected R-Port, the generated `Rte_Send`, `Rte_Write`, `Rte_IWrite`, or `Rte_IWriteRef` APIs must act as if the port were unconnected.] ([SRS_Rte_00137](#))

See Section [5.2.7](#) for the required behavior in this case.

5.2.9 Return type `Std_ReturnType`

Many APIs use a return value of type `Std_ReturnType` to indicate communication errors. Such errors can occur because a port is unconnected, the CAN bus is not

functioning, the OS cannot accept more task activations etc. There are integration scenarios however in which just no error can occur. E.g. if a `trigger` source raises a trigger with lower frequency than the `trigger` sinks can consume it or if a Sender-Receiver communication is a pure intra-partition communication without transformers. Many components in an ECU are designed for a specific system and can therefore assume a certain integration scenario and omit the evaluation of the error code returned by the RTE APIs. This way those components can reduce CPU resource consumption by omitting the status evaluation and also the RTE does not have to compute the status.

The RTE can usually not check if such an optimization is valid in a given SWC integration as it does not have the full knowledge about e.g. the call frequency of a trigger or write API. It is the SWC's integrator who has to ensure that the SWC's assumptions are fulfilled. But the RTE offers the technical possibility to omit the `Std_ReturnType` and generate an API with return type `void` instead. This is achieved via the attribute `returnValueProvision` which can be set to `noReturnValueProvided`. If it is not set or set to `returnValueProvided` the standard behavior of return type `Std_ReturnType` will be used. Please note that `returnValueProvision` is only meaningful for `AccessPoints` resulting in an API with return type `Std_ReturnType`. Also note that APIs with the purpose of retrieving the communication status (e.g. `Rte_Feedback` or `Rte_IStatus`) are not affected by any setting of `returnValueProvision` as it doesn't make sense to ask for a status and at the same time ignoring it.

5.3 RTE Modules

Figure 5.1 defines the relationship between header files and how those files are included by modules implementing AUTOSAR software-components and by general, non-component, code.

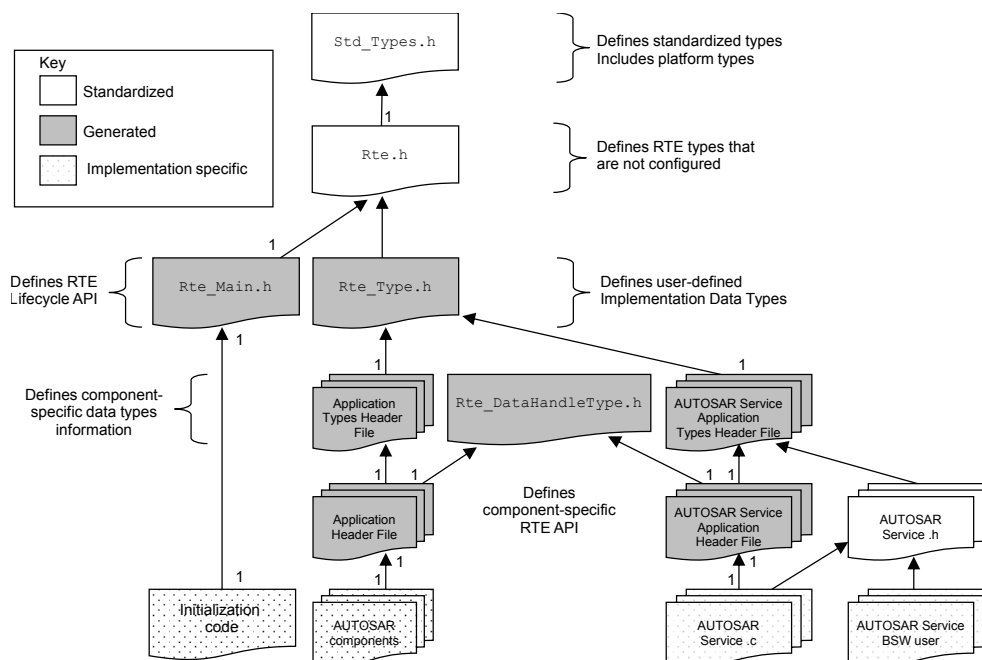


Figure 5.1: Relationships between RTE Header Files

The output of an RTE generator can consist of both generated code and configuration for “library” code that may be supplied as either object code or source code. Both configured and generated code reference standard definitions that are defined in the *RTE Header File*.

The relationship between the *RTE header file*, *Application Header Files*, the *Lifecycle Header File* and AUTOSAR software-components is illustrated in Figure 5.1.

In general a RTE can be partitioned in several files. The partitioning depends from the RTE vendors software design and generation strategy. Nevertheless it shall be possible to clearly identify code and header files which are part of the RTE module.

[SWS_Rte_07139] [Every file of the RTE beside Rte.h and Rte.c shall be named with the prefix `Rte_.`.] ([SRS_BSW_00300](#))

5.3.1 RTE Header File

The RTE header file defines fixed elements of the RTE that do not need to be generated or configured for each ECU.

[SWS_Rte_01157] [For C/C++ AUTOSAR software-components, the name of the RTE header file shall be `Rte.h`.] ([SRS_BSW_00300](#))

Typically the contents of the RTE header file are fixed for any particular implementation and therefore it is not created by the RTE generator. However, customization for each generated RTE is not forbidden.

[SWS_Rte_01164] [The RTE header file shall include the file `Std_Types.h`.] ([SRS_Rte_00149](#), [SRS_Rte_00150](#), [SRS_BSW_00353](#))

The file `Std_Types.h` is the standard AUTOSAR file [31] that defines basic data types including platform specific definitions of unsigned and signed integers and provides access to the compiler abstraction.

The contents of the RTE header file are not restricted to standardized elements that are defined within this document – it can also contain definitions specific to a particular implementation.

5.3.2 Lifecycle Header File

[SWS_Rte_08309] [The RTE generator shall provide declarations for RTE and SchM Lifecycle APIs (see Section 5.8 and 6.7) through the Lifecycle header file.] ([SRS_Rte_00051](#))

[SWS_Rte_01158] [For C/C++ AUTOSAR software-components, the name of the lifecycle header file shall be `Rte_Main.h`.] ([SRS_BSW_00300](#))

[SWS_Rte_01159] [The lifecycle header file shall include the *RTE header file*.] ([SRS_Rte_00051](#))

5.3.3 Application Header File

The application header file [[SRS_Rte_00087](#)] is central to the definition of the RTE API. An application header file defines the RTE API and any associated data structures that are required by the SW-C to use the RTE implementation. But the application header file is not allowed to create objects in memory.

[SWS_Rte_01000] [The RTE generator shall create an application header file for each software-component type (excluding `ParameterSwComponentTypes` and `NvBlock-SwComponentTypes`) defined in the input.] ([SRS_Rte_00087](#), [SRS_Rte_00024](#), [SRS_Rte_00140](#))

[SWS_Rte_03786] [The application header file shall not contain code that creates objects in memory.] ([SRS_Rte_00087](#), [SRS_BSW_00308](#))

RTE generation consists of two phases; an initial “RTE Contract” phase and a second “RTE Generation” phase (see Section 2.3). Object-code components are compiled after the first phase of RTE generation and therefore the application header file should conform to the form of definitions defined in Sections 5.4.1 and 5.5.2. In contrast, source-code components are compiled after the second phase of RTE generation and therefore the RTE generator produces an optimized application header file based on knowledge of component instantiation and deployment.

5.3.3.1 File Name

[SWS_Rte_01003] [The name of the *Application Header File* of an AUTOSAR software component shall be `Rte_[Byps_]<name>.h`. `<name>` is the AUTOSAR software component type name. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] ([SRS_BSW_00300](#))

Example 5.18

The following declaration in the input XML:

```
<APPLICATION-SW-COMPONENT-TYPE>
  <SHORT-NAME>Source</SHORT-NAME>
</APPLICATION-SW-COMPONENT-TYPE>
```

should result in the application header file `Rte_Source.h` being generated when the component wrapper method for bypass support is disabled.

The component type name is used rather than the component instance name for two reasons; firstly the same component code is used for all component instances and, secondly, the component instance name is an internal identifier, and should not appear outside of generated code.

5.3.3.2 Scope

RTE supports two approaches for the scope of the application header file, a SW-C based, and a runnable based approach.

1. Always, the application header file provides only the API that is specific for one atomic SW-C, see [\[SWS_Rte_01004\]](#).
2. The scope of the application header file can be further reduced to one runnable by using the mechanism described in [\[SWS_Rte_02751\]](#).

Many of the RTE APIs are specific to runnables. The restrictions for the usage of the generated APIs are defined in the 'Existence' parts of each API subsection in 5.6. To prevent run time errors by the misuse of APIs that are not supported for a runnable, it is recommended to use the runnable based approach of the application header file.

[SWS_Rte_01004] [The application header file for a component shall contain only information relevant to that component.] ([SRS_Rte_00087](#), [SRS_Rte_00017](#), [SRS_Rte_00167](#))

[SWS_Rte_02751] [If the pre-compiler Symbol `RTE_RUNNABLEAPI_<rn>` is defined for a runnable with short name `<rn>` when the application header file is included, the application header file shall not declare APIs that are not valid to be used by the runnable `rn`.] ([SRS_Rte_00017](#))

For example, to restrict the application header file of the SW-C `mySwc` to the API of the runnable `myRunnable`, the following sequence can be used:

```
1 #define RTE_RUNNABLEAPI_myRunnable
2 #include <Rte_mySwc.h>
3
4 // runnable source code
```

Note that this mechanism does not support to restrict the application header file to the super set of two or more runnable APIs. In other words, runnables should be kept in separate source files, if the runnable based approach is used.

Requirements [SWS_Rte_01004] and [SWS_Rte_02751] mean that compile time checks ensure that a component (or runnable) that uses the application header file only accesses the generated data structures and functions to which it has been configured. Any other access, e.g. to fields not defined in the customized data structures or RTE API, will fail with a compiler error [SRS_Rte_00017].

The definitions of the RTE API contained in the application header file can be optimized during the “RTE Generation” phase when the mapping of software-components to ECUs and the communication matrix is known. Consequently multiple application header files must not be included in the same source module to avoid conflicting definitions of the RTE API definitions that the files contains.

Listing 5.1 illustrates the code structure for the declaration of the entry point of a runnable entity that provides the implementation for a ServerPort in component `c1`. The RTE generator is responsible for creating the API and tasks used to execute the server and the symbol name of the entry point is extracted from the attribute symbol of the runnable entity. The example shows that the first parameter of the entry point function is the software-component’s instance handle [SWS_Rte_01016].

Listing 5.1: Skeleton server runnable entity

```
1 #include <Rte_c1.h>
2
3 void runnable_entry(Rte_Instance instance)
4 {
5     /* ... server code ... */
6 }
```

Listing 5.1 includes the component-specific application header file `Rte_c1.h` created by the RTE generator. The RTE generator will also create the supporting data structures and the task body to which the runnable is mapped.

The RTE is also responsible for preventing conflicting concurrent accesses when the runnable entity implementing the server operation is triggered as a result of a request from a client received via the communication service or directly via inter-task communication.

5.3.3.3 File Contents

Multiple application header file must not be included in the same module ([SWS_Rte_01004]) and therefore the file contents should contain a mechanism to enforce this requirement.

[SWS_Rte_01006] [An application header file shall include the following mechanism before any other definitions.

```
1  #ifndef RTE_APPLICATION_HEADER_FILE
2  #error Multiple application header files included.
3  #endif /* RTE_APPLICATION_HEADER_FILE */
4  #define RTE_APPLICATION_HEADER_FILE
```

](SRS_Rte_00087)

[SWS_Rte_07131] [The application header file shall include the *Application Types Header File*.](SRS_Rte_00087)

The name of the *Application Types Header File* is defined in Section 5.3.6.

[SWS_Rte_07924] [The application header file shall include the *RTE Data Handle Types Header File* (see Section 5.3.5).](SRS_Rte_00087)

[SWS_Rte_01005] [The application header file shall be valid for both C and C++ source.](SRS_Rte_00126, SRS_Rte_00138)

Requirement [SWS_Rte_01005] is met by ensuring that all definitions within the application header file are defined using C linkage if a C++ compiler is used.

[SWS_Rte_03709] [All definitions within in the application header file shall be preceded by the following fragment;

```
1  #ifdef __cplusplus
2  extern "C" {
3  #endif /* __cplusplus */
```

](SRS_Rte_00126, SRS_Rte_00138)

[SWS_Rte_03710] [All definitions within the application header file shall be suffixed by the following fragment;

```
1  #ifdef __cplusplus
2  } /* extern "C" */
3  #endif /* __cplusplus */
```

](SRS_Rte_00126, SRS_Rte_00138)

[SWS_Rte_03628] [The Rte shall generate the APIs [SWS_Rte_03622], [SWS_Rte_03624] and [SWS_Rte_03626] as macros in the Application Header File of each software component.](SRS_Rte_00322)

5.3.3.3.1 Instance Handle

The RTE uses an instance handle to identify different instances of the same component type. The definition of the instance handle type [SWS_Rte_01148] is unique to each component type and therefore should be included in the application header file.

[SWS_Rte_01007] [The application header file shall define the type of the instance handle for the component.] (SRS_Rte_00012)

All runnable entities for a component are passed the same instance handle type (as the first formal parameter [SWS_Rte_01016]) and can therefore use the same type definition from the component's application header file.

The example 5.23 illustrates the definition of an instance handle.

5.3.3.3.2 Runnable Entity Prototype

The application header file also includes a prototype for each runnable entity entry point ([SWS_Rte_01132]) and the API mapping ([SWS_Rte_01274]).

5.3.3.3.3 Initial Values

[SWS_Rte_05078] [The *Application Header File* shall define the init value of non-queued `VariableDataPrototypes` of sender receiver or non volatile data ports and typed by an `ImplementationDataType` or `ApplicationDataType` of category VALUE.

```
1 #define Rte_InitValue_<Port>_<DEPTYPE> <initValue><suffix>
```

where <Port> is the `PortPrototype shortName`, <DEPTYPE> is the `short-Name` of the `VariableDataPrototype`, and <initValue> is the `initValue` specified in the `NonqueuedReceiverComSpec` respectively `NonqueuedSenderComSpec`. <suffix> shall be set according to [SWS_Rte_03619].] (SRS_Rte_00068, SRS_Rte_00087, SRS_Rte_00108)

Note that the `initValue` defined may be subject to change due to the fact that for COM configuration it may be possible to change this value during ECU Configuration or even post-build time.

5.3.3.3.4 PerInstanceMemory

The *Application Header File* shall type definitions for `PerInstanceMemory`'s as defined in Chapter 5.2.5, [SWS_Rte_07133].

5.3.3.3.5 RTE-Component Interface

The application header file defines the “interface” between a component and the RTE. The interface consists of the RTE API for the component and the prototypes for runnable entities. The definition of the RTE API requires that both relevant data structures and API calls are defined.

The data structures required to support the API are defined in the Application Header file (CDS) (see chapter 5.3.3), in the Application Types Header file (see chapter 5.3.6), in the RTE Types Header file (see chapter 5.3.1) and in the RTE Data Handle Types Header file (see chapter 5.3.5).

The data structure types are declared in the header files whereas the instances are defined in the generated RTE. The necessary data structures for object-code software-components are defined in chapter 5.5.2 and chapter 5.4.2.

The RTE generator is required [SWS_Rte_01004] to limit the contents of the application header file to only that information that is relevant to that component type. This requirement includes the definition of the API mapping. The API mapping is described in chapter 5.2.6.

Requirement [SWS_Rte_01004] and [SWS_Rte_01006] ensure that attempts to invoke invalid API calls will be rejected as a compile-time error [SRS_Rte_00017].

5.3.3.3.6 Application Errors

The concept of client server supports application specific error codes. Symbolic names for Application Errors are defined in the application header file to avoid conflicting definitions between several `AtomicSwComponentTypes` mapped one ECU. See [SWS_Rte_02575] and [SWS_Rte_02576].

5.3.4 RTE Types Header File

The *RTE Types Header File* includes the RTE specific type declarations derived from the `ImplementationDataTypes` created from the definitions of AUTOSAR meta-model classes within the RTE generator’s input. The available meta-model classes are defined by the AUTOSAR software-component template and include classes for defining primitive values, structures, arrays and pointers.

The types declared in the *RTE Types Header File* intend to be used for the implementation of RTE internal data buffers as well as for RTE API.

[SWS_Rte_01160] [The RTE generator shall create the *RTE Types Header File* including the type declarations corresponding to the `ImplementationDataTypes` defined in the input configuration as well as the RTE implementation types.]()

The RTE Data Types header file should be output for “RTE Contract” and “RTE Generation” phases.

5.3.4.1 File Contents

[SWS_Rte_02648] [The *RTE Types Header File* shall include the type declarations, structure definitions, and union definitions for all the AUTOSAR Data Types according to [\[SWS_Rte_07104\]](#), [\[SWS_Rte_07110\]](#), [\[SWS_Rte_06706\]](#), [\[SWS_Rte_06707\]](#), [\[SWS_Rte_06708\]](#), [\[SWS_Rte_07111\]](#), [\[SWS_Rte_07114\]](#), [\[SWS_Rte_06812\]](#), [\[SWS_Rte_07144\]](#), [\[SWS_Rte_06813\]](#), [\[SWS_Rte_07109\]](#) and [\[SWS_Rte_07148\]](#) depending on the values of attributes `typeEmitter` and `nativeDeclaration` but irrespective of their use by the generated RTE.]()

The attribute `typeEmitter` controls which part of the AUTOSAR toolchain is supposed to provide data type definitions. For legacy reasons the RTE generator is supposed to generate the corresponding data type if the `ImplementationDataType` defines no `typeEmitter`.

[SWS_Rte_06709] [The RTE generator shall generate the corresponding data type definition if the value of attribute `typeEmitter` is NOT defined.]()

[SWS_Rte_06710] [The RTE generator shall generate the corresponding data type definition if the value of attribute `typeEmitter` is set to "RTE".]()

[SWS_Rte_06711] [The RTE generator shall reject configurations where the attribute `typeEmitter` is not defined or set to "RTE", and the `ImplementationDataType` references a `SwBaseType` without defined `nativeDeclaration`.]()

[SWS_Rte_06712] [The RTE generator shall silently not generate the corresponding data type definition if the value of attribute `typeEmitter` is set to anything else but "RTE".]()

This requirement ensures the availability of `ImplementationDataTypes` for the internal use in AUTOSAR software components.

Nevertheless the *RTE Types Header File* does not contain any data type belonging to an `ImplementationDataType` where `typeEmitter` is set to anything else but "RTE" regardless if the `ImplementationDataType` references `SwBaseTypes` and if this `SwBaseTypes` define `nativeDeclarations`.

[SWS_Rte_08732] [The RTE generator shall generate the type `Rte-Cs_TransactionHandleType` of the transaction handle for inter-ECU Client-Server communication as a structure:

```
typedef struct {
    uint16 clientId;
    uint16 sequenceCounter;
} Rte-Cs_TransactionHandleType;
```


where `clientId` and `sequenceCounter` contain the client identifier and sequence counter as specified in [SWS_Rte_02649].

]()

The types header file may need types in terms of BSW types (from the file `Std_Types.h`) or from the implementation specific RTE header file to declare types. However, since the RTE header file includes the file `Std_Types.h` already so only the RTE header file needs direct inclusion within the types header file.

[SWS_Rte_01163] [The *RTE Types Header File* shall include the *RTE Header File*.]
(SRS_BSW_00353)

5.3.4.2 Classification of Implementation Data Types

The type model `ImplementationDataTypes` is able to express following kinds of data types:

- `Primitive Implementation Data Type`
- `Array Implementation Data Type`
- `Structure Implementation Data Type`
- `Union Implementation Data Type`
- `Redefinition Implementation Data Type`
- `Pointer Implementation Data Type`

A *Primitive Implementation Data Type* is classified that it directly refers by its `SwDataDefProps` to a `SwBaseType` in the role `baseType`. The `category` attribute is set to `VALUE`.

An *Array Implementation Data Type* is classified that it defines `ImplementationDataTypeElements` for each dimension of the array. The `swArraySize` specifies the number of array elements of the dimension. The `category` attribute *Array Implementation Data Type* is set to `ARRAY`.

A *Structure Implementation Data Type* is categorized that it has `ImplementationDataTypeElement`'s. The `category` attribute of the `ImplementationDataType` is set to `STRUCTURE`. Each `ImplementationDataTypeElement` it self can be one of the listed kinds again.

A *Union Implementation Data Type* is categorized that it has `ImplementationDataTypeElement`'s. The `category` attribute of the `ImplementationDataType` is set to `UNION`. Each `ImplementationDataTypeElement` it self can be one of the listed kinds again.

A *Redefinition Implementation Data Type* is classified that it refers to other *ImplementationDataTypes*. The *category* attribute of the referring *ImplementationDataType* has to be set to `TYPE_REFERENCE`.

A *Pointer Implementation Data Type* is classified that its *SwDataDefProps* has a *swPointerTargetProps* attribute. The *swDataDefProps* in the role *swPointerTargetProps* is specifying the target to which the pointer refers. The *category* attribute of the *ImplementationDataType* has to be set to `DATA_REFERENCE`.

5.3.4.3 Primitive Implementation Data Type

The *RTE Types Header File* declares C types for all *Primitive Implementation Data Types* where the referred *BaseType* has a *nativeDeclaration* attribute.

[SWS_Rte_07104] [For each *Primitive Implementation Data Type* with a *nativeDeclaration* attribute, the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef <nativeDeclaration> <name>;
```

where <nativeDeclaration> is the *nativeDeclaration* attribute of the referred *BaseType* and <name> is the *Implementation Data Type* symbol of the *Primitive Implementation Data Type*.] (*SRS_Rte_00055*, *SRS_Rte_00166*, *SRS_Rte_00168*, *SRS_BSW_00353*)

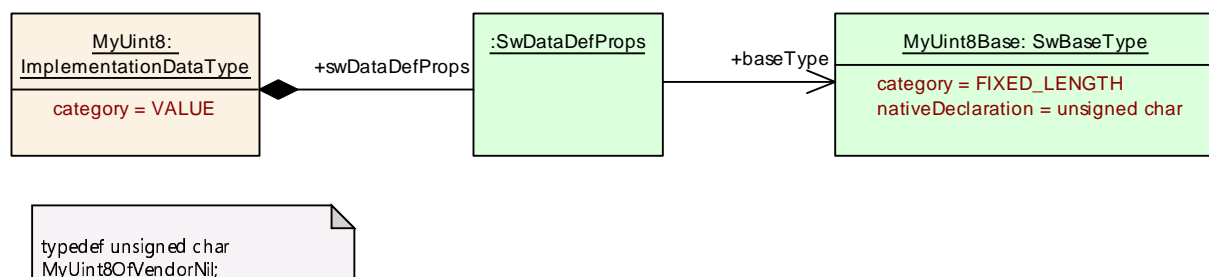


Figure 5.2: Primitive Implementation Data Type

Note: All *Primitive Implementation Data Types* where the referred *BaseType* has **no** *nativeDeclaration* attribute resulting not in a type declaration. This is intended to prevent the redeclaration of the predefined Standard Types and Platform Types.

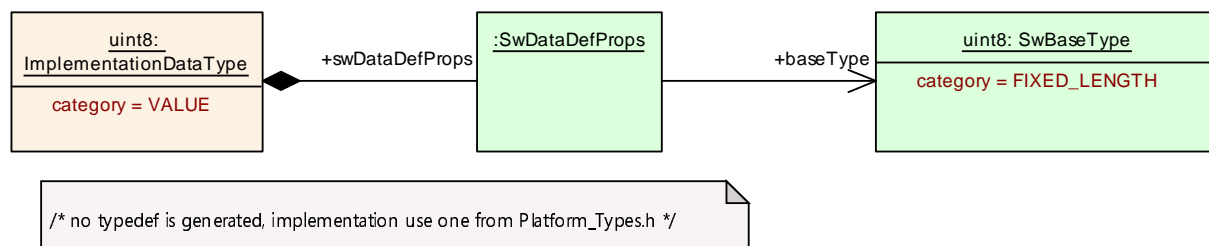


Figure 5.3: Primitive Implementation Data Type included from Platform_Types.h

[SWS_Rte_07105] [If more than one [Primitive Implementation Data Type](#) with equal [shortName](#) and equal [nativeDeclaration](#) attribute of the referred [BaseType](#) are defined, the *RTE Types Header File* shall include only once the corresponding type declaration according to [\[SWS_Rte_07104\]](#).] ([SRS_Rte_00165](#))

Note: This avoids the redeclaration of C types due to the multiple descriptions of equivalent [Primitive Implementation Data Types](#) in the ECU extract.

5.3.4.4 Array Implementation Data Type

In addition to the primitive data-types defined in the previous section, it is also necessary for the RTE generator to declare composite data-types: arrays and records.

An array definition following information:

- the array type
- the number of dimensions
- the number of elements for each dimension.

[SWS_Rte_07110] [For each [Array Implementation Data Type](#) which leaf [ImplementationDataTypeElement](#) is typed by a [BaseType](#) and the respective [arrayImplPolicy](#) is not defined or set to [payloadAsArray](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef <nativeDeclaration> <name> [<size 1>] { [<size 2>] ...
[<size n>] };
```

where [<nativeDeclaration>](#) is the [nativeDeclaration](#) attribute of the referred [BaseType](#),

[<name>](#) is the [Implementation Data Type](#) symbol of the [Array Implementation Data Type](#),

[\[<size x>\]](#) is the [arraySize](#) of the Array's [ImplementationDataTypeElement](#).

For each array dimension defined by one Array's [ImplementationDataTypeElement](#) one array dimension definition [\[<size x>\]](#) is defined. The array dimension definitions [\[<size 1>\]](#), [\[<size 2>\]](#) ... [\[<size n>\]](#) ordered from the root to the leaf [ImplementationDataTypeElement](#).] ([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_02317] [For each [Array Implementation Data Type](#) which leaf [ImplementationDataTypeElement](#) is typed by a [BaseType](#) and the respective [arrayImplPolicy](#) is set to [payloadAsPointerToArray](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef <nativeDeclaration> * <name>;
```

where [<nativeDeclaration>](#) is the [nativeDeclaration](#) attribute of the referred [BaseType](#),

<name> is the [Implementation Data Type](#) symbol of the [Array Implementation Data Type](#).]([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_07111] [For each [Array Implementation Data Type](#) which leaf [ImplementationDataElement](#) is typed by an [ImplementationDataElement](#) and the respective [arrayImplPolicy](#) is not defined or set to [payloadAsArray](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef <type> <name>[<size 1>]{[<size 2>]...[<size n>]};
```

where <type> is the [shortName](#) of the referred [ImplementationDataElement](#),

<name> is the [Implementation Data Type](#) symbol of the [Array Implementation Data Type](#),

[<size x>] is the [arraySize](#) of the Array's [ImplementationDataElement](#). For each array dimension defined by one Array's [ImplementationDataElement](#) one array dimension definition [<size x>] is defined.

The array dimension definitions [<size 1>], [<size 2>] ... [<size n>] ordered from the root to the leaf [ImplementationDataElement](#).]([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_02318] [For each [Array Implementation Data Type](#) which leaf [ImplementationDataElement](#) is typed by an [ImplementationDataElement](#) and the respective [arrayImplPolicy](#) is set to [payloadAsPointerToArray](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef <type> * <name>;
```

where <type> is the [shortName](#) of the referred [ImplementationDataElement](#),

<name> is the [Implementation Data Type](#) symbol of the [Array Implementation Data Type](#).]([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_03609] [For each [Array Implementation Data Type](#) which last [ImplementationDataElement](#) is of category [STRUCTURE](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef struct { <elements> } <name>;
```

where <elements> is the record element specification and

<name> is the [Implementation Data Type Element shortName](#) of the [Array Implementation Data Type](#).

For each record element defined by one [ImplementationDataElement](#) one record element specification <elements> is defined. The record element specifications are ordered according the order of the related [ImplementationDataElements](#) in the input configuration.

Sequent record elements are separated with a semicolon.]([SRS_Rte_00055](#), [SRS_Rte_00164](#))

The definition of the record element specification is defined in section 5.3.4.5.

[SWS_Rte_06706] [For each [Array Implementation Data Type](#) which last [ImplementationDataTypeElement](#) is of category STRUCTURE, the RTE *Types Header File* shall include the corresponding type declaration as:

```
typedef <type> <name>[<size 1>]{[<size 2>]...[<size n>]};
```

where <type> is the [Implementation Data Type Element](#) shortName, <name> is the [Implementation Data Type symbol](#) of the [Array Implementation Data Type](#), [<size x>] is the [arraySize](#) of the [Array's ImplementationDataTypeElement](#).

For each array dimension defined by one [Array's ImplementationDataTypeElement](#) one array dimension definition [<size x>] is defined.

The array dimension definitions [<size 1>], [<size 2>] ... [<size n>] ordered from the root to the last [ImplementationDataTypeElement](#) belonging to the array definition.]([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_03610] [For each [Array Implementation Data Type](#) which last [ImplementationDataTypeElement](#) is of category UNION, the RTE *Types Header File* shall include the corresponding type declaration as:

```
typedef union { <elements> } <name>;
```

where <elements> is the union element specification and <name> is the [Implementation Data Type Element shortName](#) of the [Array Implementation Data Type](#).

For each union element defined by one [ImplementationDataTypeElement](#) one union element specification <elements> is defined. The union element specifications are ordered according the order of the related [ImplementationDataTypes](#) in the input configuration.

Sequent union elements are separated with a semicolon.]([SRS_Rte_00055](#), [SRS_Rte_00164](#))

The definition of the union element specification is defined in section 5.3.4.6.

[SWS_Rte_06707] [For each [Array Implementation Data Type](#) which last [ImplementationDataTypeElement](#) is of category UNION, the RTE *Types Header File* shall include the corresponding type declaration as:

```
typedef <type> <name>[<size 1>]{[<size 2>] ... [<size n>]};
```

where <type> is the [Implementation Data Type Element](#) shortName, <name> is the [Implementation Data Type symbol](#) of the [Array Implementation Data Type](#), [<size x>] is the [arraySize](#) of the [Array's ImplementationDataTypeElement](#). For each array dimension defined by one [Array's ImplementationDataTypeElement](#) one array dimension definition [<size x>] is defined.

The array dimension definitions [`<size 1>`], [`<size 2>`] ... [`<size n>`] ordered from the root to the last `ImplementationDataTypeElement` belonging to the array definition.] ([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_06708] [For each `Array Implementation Data Type` which last `ImplementationDataTypeElement` is of category `DATA_REFERENCE`, the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef <tqlA> <addtqlA> <type> * <tqlB> <addtqlB> <name> [<size 1>]{[<size 2>]...[<size n>]};
```

where `<name>` is the `Implementation Data Type` symbol of the `Array Implementation Data Type` and

[`<size x>`] is the `arraySize` of the `Array's ImplementationDataTypeElement`. For each array dimension defined by one `Array's ImplementationDataTypeElement` one array dimension definition [`<size x>`] is defined. The array dimension definitions [`<size 1>`], [`<size 2>`] ... [`<size n>`] ordered from the root to the last `ImplementationDataTypeElement` belonging to the array definition.] ([SRS_Rte_00055](#), [SRS_Rte_00164](#))

For the definition of `<tqlA>` and `<tqlB>` see [\[SWS_Rte_07149\]](#) and [\[SWS_Rte_07166\]](#).

For the definition of `<addtqlA>` and `<addtqlB>` see [\[SWS_Rte_07036\]](#) and [\[SWS_Rte_07037\]](#).

[SWS_Rte_07112] [If more than one `Array Implementation Data Type` with equal `shortName` of the `ImplementationDataType` and equal `nativeDeclaration` attribute of the referred `BaseType` are defined, the *RTE Types Header File* shall include only once the corresponding type declaration according to [\[SWS_Rte_07110\]](#).] ([SRS_Rte_00165](#))

[SWS_Rte_07113] [If more than one `Array Implementation Data Type` with equal `shortName` of the `ImplementationDataType` and equal `shortName` of the referred `ImplementationDataType` are defined, the *RTE Types Header File* shall include only once the corresponding type declaration according to [\[SWS_Rte_07111\]](#).] ([SRS_Rte_00165](#))

Note: This avoids the redeclaration of C types due to the multiple descriptions of equivalent `Array Implementation Data Types` in the ECU extract.

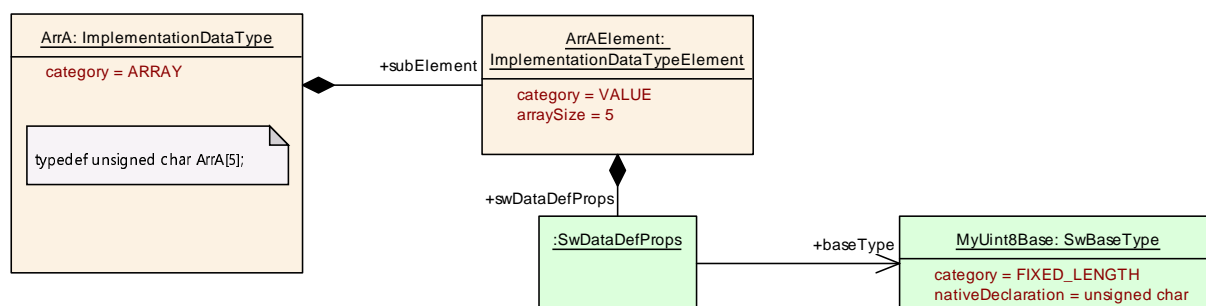


Figure 5.4: Example of a single dimension array typed by an `BaseType`

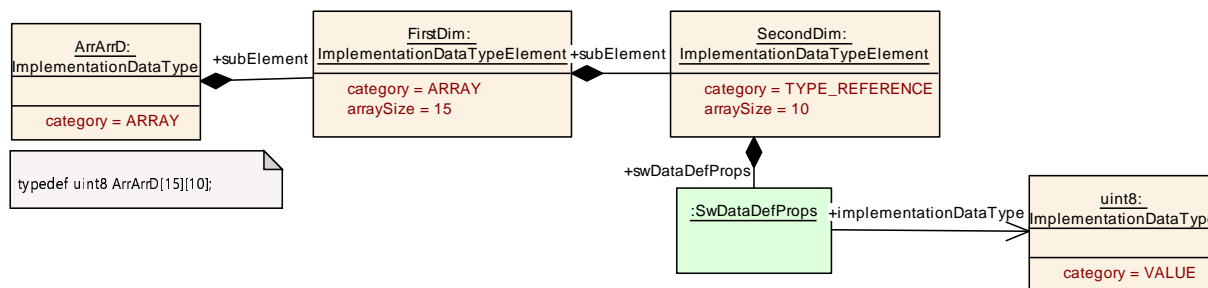


Figure 5.5: Example of a two dimension array typed by an [ImplementationDataType](#)

ANSI C does not allow a type declaration to have zero elements and therefore we require that the “number of elements” to be a positive integer.

[SWS_Rte_CONSTR_09042] [Array Implementation Data Types](#) needs at least one element [The [arraySize](#) defining number of elements in one dimension of an *Array Implementation Data Type* shall be an integer that is ≥ 1 for each dimension.]
()

5.3.4.5 Structure Implementation Data Type

[SWS_Rte_07114] [For each [Structure Implementation Data Type](#), the *RTE Types Header File* shall include the corresponding structure declaration as:

```
struct Rte_struct_<name> { <elements> };
```

where [<elements>](#) is the record element specification and [<name>](#) is the [Implementation Data Type](#) symbol of the [Structure Implementation Data Type](#).

For each record element defined by one [ImplementationDataTypeElement](#) one record element specification [<elements>](#) is defined. The record element specifications are ordered according the order of the related [ImplementationDataTypeElements](#) in the input configuration. Sequent record elements are separated with a semicolon.]
([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_06812] [For each [Structure Implementation Data Type](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef struct Rte_struct_<name> <name>;
```

where [<name>](#) is the [Implementation Data Type](#) symbol of the [Structure Implementation Data Type](#).]([SRS_Rte_00055](#), [SRS_Rte_00164](#))

An example is listed as ARXML and 'C'-code in Appendix [F.4](#).

5.3.4.6 Union Implementation Data Type

[SWS_Rte_07144] [For each [Union Implementation Data Type](#), the *RTE Types Header File* shall include the corresponding union declaration as:

```
union Rte_union_<name> { <elements> };
```

where <elements> is the union element specification and <name> is the [Implementation Data Type symbol](#) of the [Union Implementation Data Type](#).

For each union element defined by one [ImplementationDataTypeElement](#) one union element specification <elements> is defined. The union element specifications are ordered according the order of the related [ImplementationDataTypeElements](#) in the input configuration. Sequent union elements are separated with a semicolon.] ([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_06813] [For each [Union Implementation Data Type](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef union Rte_union_<name> <name>;
```

where <name> is the [Implementation Data Type symbol](#) of the [Union Implementation Data Type](#).] ([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_07115] [Record and Union element specifications <elements> shall be generated as

```
<nativeDeclaration> <name>;
```

if the [ImplementationDataTypeElement](#) has the category attribute set to VALUE and if it refers to an [BaseType](#). The meaning of the fields is identical to [\[SWS_Rte_07104\]](#)] ([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_07116] [Record and Union element specifications <elements> shall be generated as

```
<type> <name>;
```

if the [ImplementationDataTypeElement](#) has the category attribute set to TYPE_REFERENCE and if it refers to an [ImplementationDataType](#). <type> is the [Implementation Data Type symbol](#) of the referred [ImplementationDataType](#) and <name> is the [shortName](#) of the [ImplementationDataTypeElement](#).] ([SRS_Rte_00055](#), [SRS_Rte_00164](#))

[SWS_Rte_07117] [Record and Union element specifications <elements> shall be generated as

```
<nativeDeclaration> <name>[<size 1>]{[<size 2>]...[<size n>]};
```

if the [ImplementationDataTypeElement](#) has the category attribute set to ARRAY and which leaf [ImplementationDataTypeElement](#) has the category attribute set

to `VALUE` and the respective `arrayImplPolicy` is not defined or set to `payloadAsArray` and is typed by an `BaseType`. The meaning and order of the fields is identical to [SWS_Rte_07110].] (SRS_Rte_00055, SRS_Rte_00164)

[SWS_Rte_02319] [Record and Union element specifications `<elements>` shall be generated as

```
<nativeDeclaration> * <name>;
```

if the `ImplementationDataTypeElement` has the `category` attribute set to `ARRAY` and which leaf `ImplementationDataTypeElement` has the `category` attribute set to `VALUE` and the respective `arrayImplPolicy` is set to `payloadAsPointerToArray` and is typed by an `BaseType`. The meaning and order of the fields is identical to [SWS_Rte_07110].] (SRS_Rte_00055, SRS_Rte_00164)

[SWS_Rte_07118] [Record and Union element specifications `<elements>` shall be generated as

```
<type> <name>[<size 1>]{[<size 2>]...[<size n>]};
```

if the `ImplementationDataTypeElement` has the `category` attribute set to `ARRAY` and which leaf `ImplementationDataTypeElement` has the `category` attribute set to `TYPE_REFERENCE` and the respective `arrayImplPolicy` is not defined or set to `payloadAsArray` and is typed by an `ImplementationDataType`. The meaning and order of the fields is identical to [SWS_Rte_07111].] (SRS_Rte_00055, SRS_Rte_00164)

[SWS_Rte_02320] [Record and Union element specifications `<elements>` shall be generated as

```
<type> * <name>;
```

if the `ImplementationDataTypeElement` has the `category` attribute set to `ARRAY` and which leaf `ImplementationDataTypeElement` has the `category` attribute set to `TYPE_REFERENCE` and the respective `arrayImplPolicy` is set to `payloadAsPointerToArray` and is typed by an `ImplementationDataType`. The meaning and order of the fields is identical to [SWS_Rte_07111].] (SRS_Rte_00055, SRS_Rte_00164)

[SWS_Rte_07119] [Record and Union element specifications `<elements>` shall be generated as

```
struct { <elements> } <name>;
```

if the `ImplementationDataTypeElement` has the `category` attribute set to `STRUCTURE`. The meaning and order of the fields is identical to [SWS_Rte_07114] Subsequent elements are separated with a semicolon.] (SRS_Rte_00055, SRS_Rte_00164)

[SWS_Rte_07145] [Record and Union element specifications `<elements>` shall be generated as

```
union { <elements> } <name>;
```

if the `ImplementationDataTypeElement` has the `category` attribute set to `UNION`. The meaning and order of the fields is identical to [SWS_Rte_07144]. Sequent elements are separated with a semicolon.](SRS_Rte_00055, SRS_Rte_00164)

[SWS_Rte_07146] [Pointer element specifications `<elements>` shall be generated as

```
<tqlA> <addtqlA> <type> * <tqlB> <addtqlB> <name>;
```

if the `ImplementationDataTypeElement` has the `category` attribute set to `DATA_REFERENCE` where `<name>` is the `shortName` of the `ImplementationDataTypeElement`.](SRS_Rte_00055, SRS_Rte_00164)

For the definition of `<tqlA>` and `<tqlB>` see [SWS_Rte_07149] and [SWS_Rte_07166].

For the definition of `<addtqlA>` and `<addtqlB>` see [SWS_Rte_07036] and [SWS_Rte_07037].

For the definition of `<type>` see [SWS_Rte_07162], [SWS_Rte_07163].

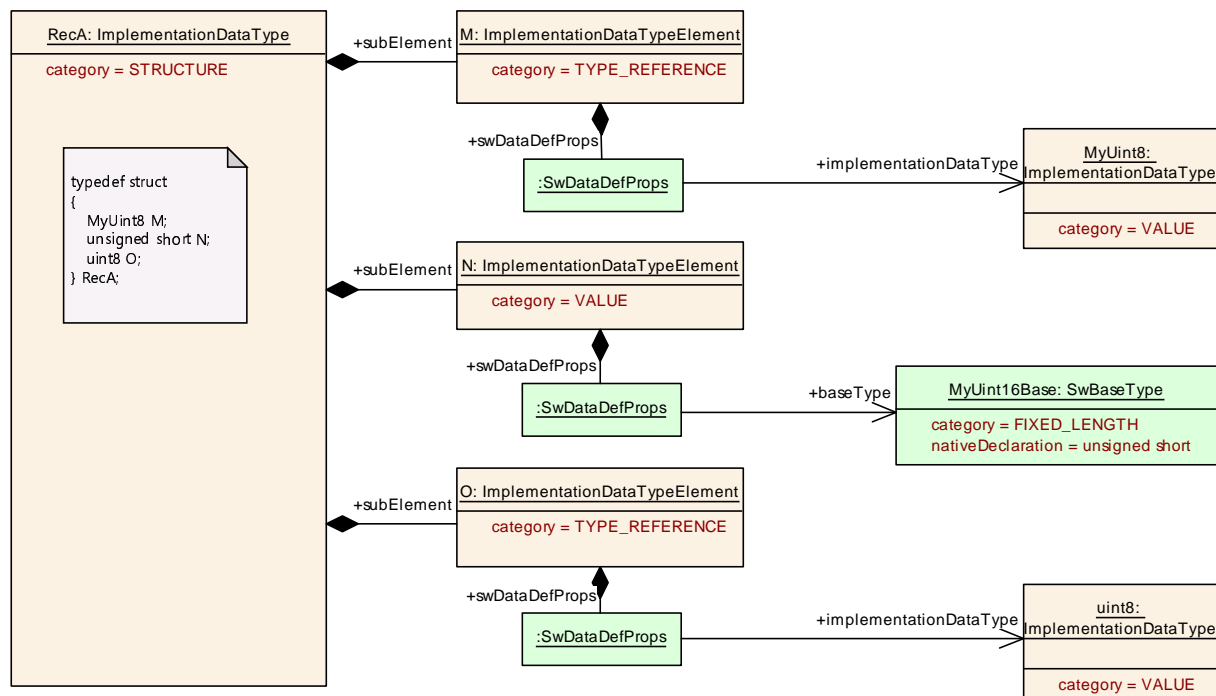


Figure 5.6: Example of a structure type

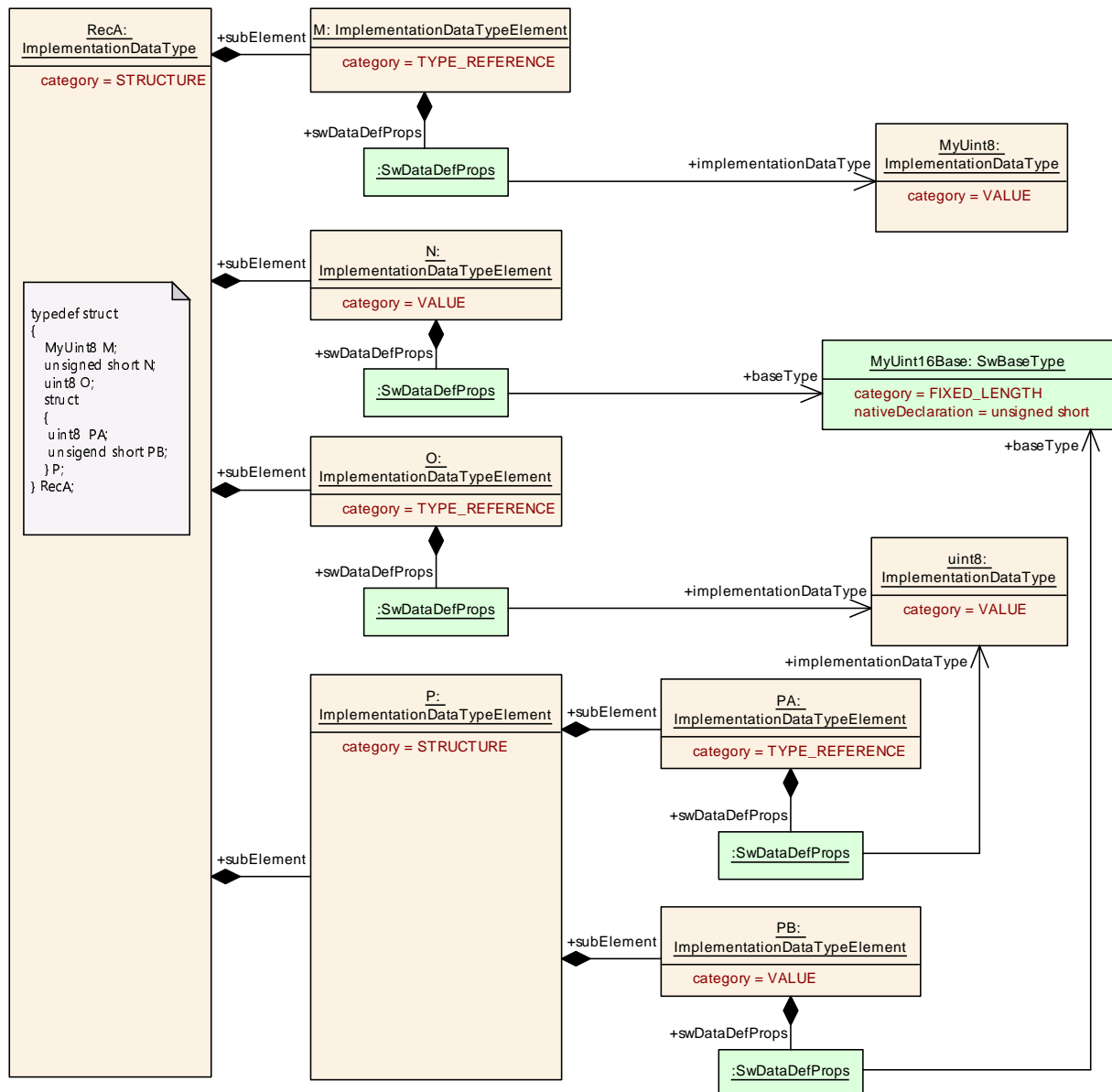


Figure 5.7: Example of a nested structure type

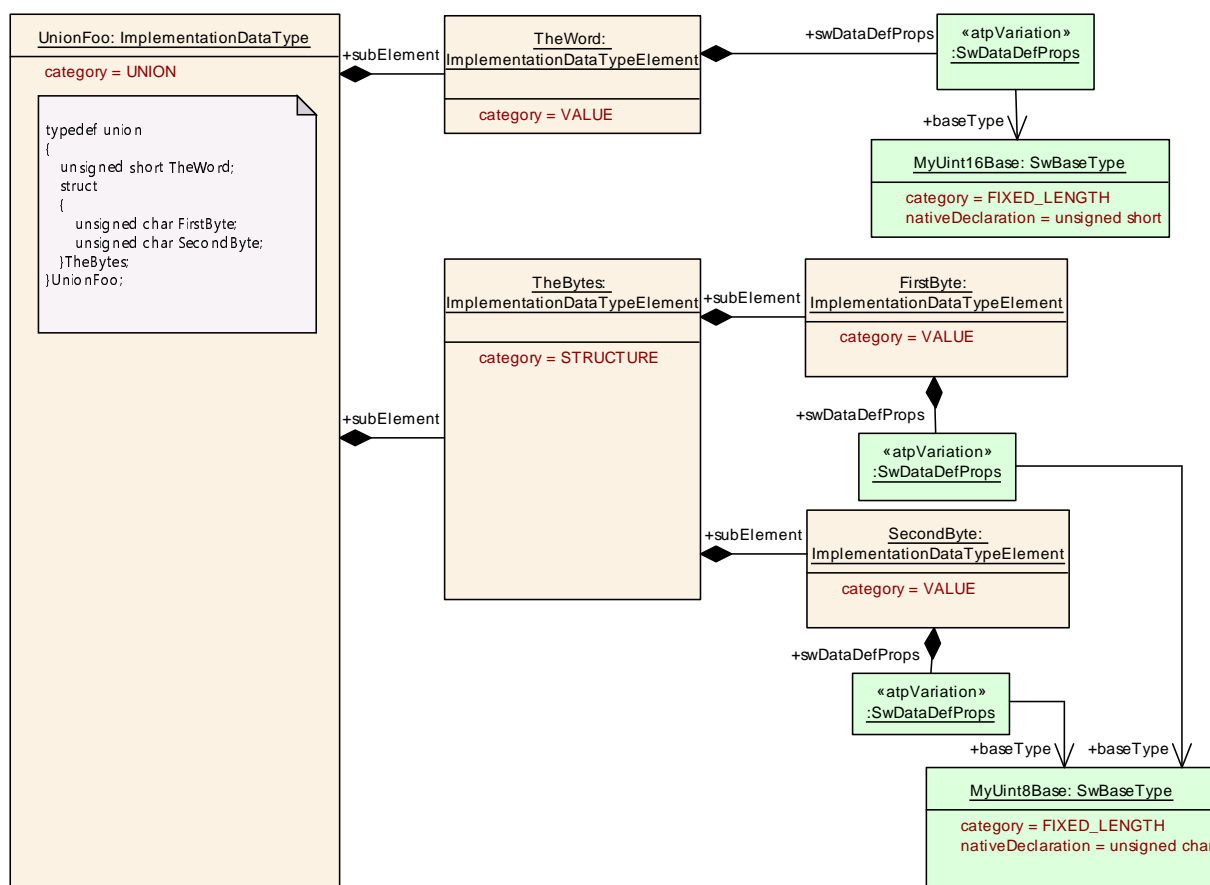


Figure 5.8: Example of a union type

[SWS_Rte_07107] [If more than one *Structure Implementation Data Type* or *Union Implementation Data Type* with equal *shortName* of the *ImplementationDataType* are defined, the *RTE Types Header File* shall include only once the corresponding type declaration according to [SWS_Rte_07114] or [SWS_Rte_07144].] (*SRS_Rte_00165*)

Note: This avoids the redeclaration of C types due to the multiple descriptions of equivalent *Structure Implementation Data Types* and *Union Implementation Data Types* in the ECU extract.

ANSI C does not allow a `struct` to have zero elements and therefore we require that a record include at least one element.

[SWS_Rte_CONSTR_09043] *Structure Implementation Data Types* needs at least one element [A structure shall include at least one element defined by a *ImplementationDataTypeElement*.] ()

A union data type describes a kind of structural overlay. Defining only one sub element of a `union` is therefore not reasonable and indicates an error.

5.3.4.7 Implementation Data Type redefinition

[SWS_Rte_07109] [For each [Redefinition Implementation Data Type](#) which is typed by an [ImplementationDataType](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef <type> <name>;
```

where <type> is the [Implementation Data Type](#) symbol of the referred [ImplementationDataType](#) and <name> is the [Implementation Data Type](#) symbol of the [Primitive Implementation Data Type](#).]([SRS_Rte_00055](#), [SRS_Rte_00166](#))

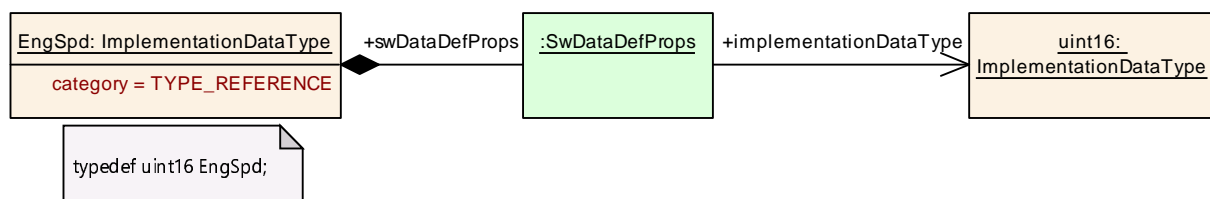


Figure 5.9: Example of an Implementation Data Type redefinition

[SWS_Rte_07167] [If more than one [Redefinition Implementation Data Types](#) with equal [shortNames](#) which are referring to compatible [Implementation-DataTypes](#) with identical [shortNames](#) are defined, the *RTE Types Header File* shall include only once the corresponding type declaration according to [\[SWS_Rte_07109\]](#).]([SRS_Rte_00165](#))

Note: This avoids the redeclaration of C types due to the multiple descriptions of equivalent [Redefinition Implementation Data Type](#) in the ECU extract.

5.3.4.8 Pointer Implementation Data Type

[SWS_Rte_07148] [For each [Pointer Implementation Data Type](#), the *RTE Types Header File* shall include the corresponding type declaration as:

```
typedef <tqlA> <addtqlA> <type> * <tqlB> <addtqlB> <name>;
```

where <name> is the [Implementation Data Type](#) symbol of the [Pointer Implementation Data Type](#).]([SRS_Rte_00055](#), [SRS_Rte_00166](#))

[SWS_Rte_07149] [[<tqlA>](#) (type qualifier A) of a [Pointer Implementation Data Type](#) ([\[SWS_Rte_07148\]](#)) or *Pointer element specifications* ([\[SWS_Rte_07146\]](#)) shall be set to `const` if the `swImplPolicy` of the `swPointerTargetProps` is set to `const` and shall be omitted for all other values of `swImplPolicy`.]([SRS_Rte_00055](#), [SRS_Rte_00166](#))

[SWS_Rte_07166] [[<tqlB>](#) (type qualifier B) of a [Pointer Implementation Data Type](#) ([\[SWS_Rte_07148\]](#)) or *Pointer element specifications*

([SWS_Rte_07146]) shall be set to `const` if the `swImplPolicy` of the `SwDataDefProps` of the `ImplementationDataType` respectively `ImplementationDataTypeElement` is set to `const` and shall be omitted for all other values of `swImplPolicy`.] (SRS_Rte_00055, SRS_Rte_00166)

[SWS_Rte_07036] [`<addtqlA>` (additional type qualifier A) of a `Pointer Implementation Data Type` ([SWS_Rte_07148]) or *Pointer element specifications* ([SWS_Rte_07146]) shall be set to the content of the `additionalNativeTypeQualifier` attribute of the `swPointerTargetProps` if the attribute exists and shall be omitted if such `additionalNativeTypeQualifier` attribute dose not exist.] (SRS_Rte_00055, SRS_Rte_00166)

[SWS_Rte_07037] [`<addtqlB>` (additional type qualifier B) of a `Pointer Implementation Data Type` ([SWS_Rte_07148]) or *Pointer element specifications* ([SWS_Rte_07146]) shall be set to the content of the `additionalNativeTypeQualifier` attribute of the `SwDataDefProps` of the `ImplementationDataType` respectively `ImplementationDataTypeElement` and shall be omitted if such `additionalNativeTypeQualifier` attribute dose not exist.] (SRS_Rte_00055, SRS_Rte_00166)

[SWS_Rte_07162] [`<type>` shall be set to the `nativeDeclaration` attribute of the referred `BaseType` if the `targetCategory` of a `Pointer Implementation Data Type` ([SWS_Rte_07148]) or *Pointer element specifications* ([SWS_Rte_07146]) is set to `VALUE`] (SRS_Rte_00055, SRS_Rte_00166)

[SWS_Rte_07163] [`<type>` shall be the `Implementation Data Type` symbol of the referred `ImplementationDataType` if the `targetCategory` of a `Pointer Implementation Data Type` ([SWS_Rte_07148]) or *Pointer element specifications* ([SWS_Rte_07146]) is set to `TYPE_REFERENCE`] (SRS_Rte_00055, SRS_Rte_00166)

[SWS_Rte_07169] [If more than one `Pointer Implementation Data Types` with equal `shortNames` which are resulting in the same C pointer type declaration are defined, the *RTE Types Header File* shall include only once the corresponding type declaration according to [SWS_Rte_07148].] (SRS_Rte_00165)

Note: This avoids the redeclaration of C types due to the multiple descriptions of equivalent `Pointer Implementation Data Type` in the ECU extract.

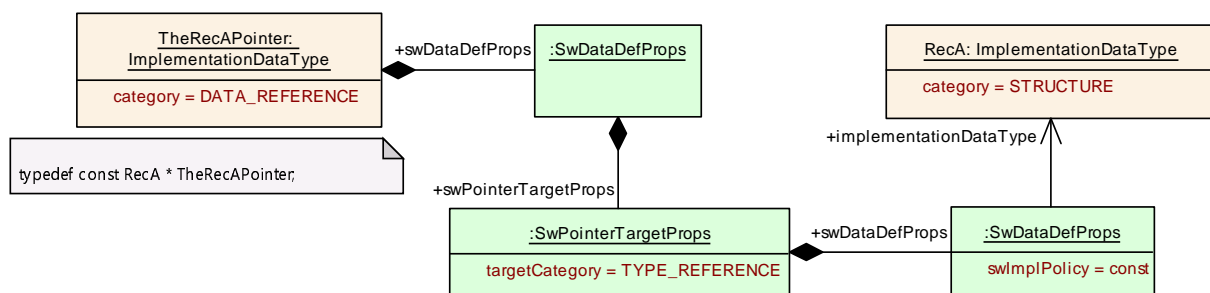


Figure 5.10: Example of a Pointer Implementation Data Type

5.3.4.9 ImplementationDataTypes with VariationPoints

[SWS_Rte_06539] [

The RTE Generator shall wrap each code related to `ImplementationDataType-Elements` which are subject to variability in `Structure Implementation Data Type` and `Union Implementation Data Type` (see 4.30 if the variability shall be implemented).

```
1  #if (<condition>)
2
3  <elements>
4
5  #endif
```

where `<condition>` are the *condition value macro(s)* of the `VariationPoints` according table 4.30 and

`<elements>` is the code according invariant `ImplementationDataType-Elements` (see also [SWS_Rte_07115], [SWS_Rte_07116], [SWS_Rte_07117], [SWS_Rte_07118], [SWS_Rte_07119], [SWS_Rte_07145], [SWS_Rte_07146])

](SRS_Rte_00201)

[SWS_Rte_06540] [The RTE Generator shall implement the `<size x>` of an `Array Implementation Data Type` for each `arraySize` which is subject to variability with the corresponding *attribute value macro* according table 4.30 if the variability shall be implemented.](SRS_Rte_00201)

5.3.4.10 Naming of data types

The `Implementation Data Type symbol` is defined as follows:

[SWS_Rte_06716] [The `Implementation Data Type symbol` shall be the `shortName` of the `ImplementationDataType` if no `symbol` attribute for this `ImplementationDataType` is defined.](SRS_Rte_00167)

Example 5.19

The `Primitive Implementation Data Type` in example 5.2 results in the type definition:

```
1  /* RTE Types Header File */
2  typedef unsigned char MyUint8;
```

[SWS_Rte_06717] [The `Implementation Data Type symbol` shall be the value of the `SymbolProps.symbol` attribute of the `ImplementationDataType` if the `symbol` attribute is defined.](SRS_Rte_00167)

[SWS_Rte_06718] [If the *RTE Types Header File* contains a generated C data type whose *Implementation Data Type symbol* differs from the *Implementation-DataType shortName*, the *Application Type Header Files* of each software component using the type shall contain a definition which redefines the *Implementation Data Type symbol* to the *shortName* of the *ImplementationDataType*.] (*SRS_Rte_00167*)

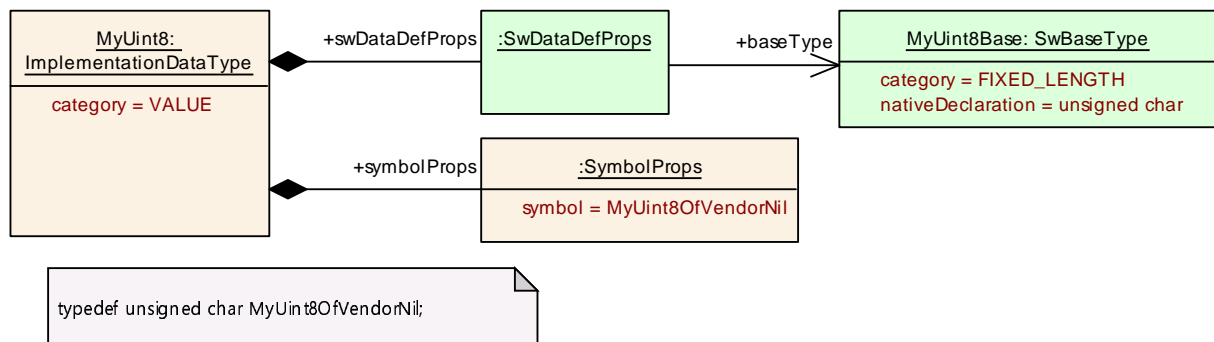


Figure 5.11: Primitive Implementation Data Type with *SymbolProps*

Example 5.20

If the input configuration contains a two *ImplementationDataTypes* with same name but different definition the *SymbolProps* can be used to avoid the name clash. The *Primitive Implementation Data Type* in example 5.11 results in following definition:

```

1 /* RTE Types Header File */
2 typedef unsigned char MyUint8OfVendorNil;

```

The *Application Types Header File* an using component contain the remapping to the original name:

```

1 /* Application Types Header File */
2 define MyUint8 MyUint8OfVendorNil;

```

[SWS_Rte_06719] [The RTE generator shall reject configurations where *ImplementationDataTypes* result in the same *Implementation Data Type symbol* but whose definition would not resulting in the same type declaration.] (*SRS_Rte_00018*)

Note: This would result in compiler errors due to incompatible redefinition of C types.

[SWS_Rte_06724] [The RTE generator shall reject configurations where the same software component uses *ImplementationDataTypes* with equal *shortNames* which would result in the mapping to different *Implementation Data Type symbols*.] (*SRS_Rte_00018*)

Note: This would result in compiler errors due to incompatible redefinition of the mapping from *ImplementationDataType.shortName* to *Implementation Data Type symbol*

5.3.4.11 C/C++

The following requirements apply to RTEs generated for C and C++.

[SWS_Rte_01161] [The name of the *RTE Types Header File* shall be `Rte_Type.h`.]
[\(SRS_BSW_00300\)](#)

[SWS_Rte_01162] [Within the *RTE Types Header File*, each data type shall be declared using `typedef`.]
[\(SRS_Rte_00126\)](#)

A `typedef` is used when declaring a new data type instead of a `#define` even though C only provides weak type checking since other static analysis tools can then be used to overlay strong type checking onto the C before it is compiled and thus detect type errors before the module is even compiled.

5.3.5 RTE Data Handle Types Header File

The *RTE Data Handle Types Header File* contains the Data Handle type declarations necessary for the component data structures (see Section 5.4.2). The *RTE Data Handle Types Header File* code is not allowed to create objects in memory.

[SWS_Rte_07920] [The RTE generator shall create the *RTE Data Handle Types Header File* including the type declarations of

`data element without status` ([SWS_Rte_01363], [SWS_Rte_01364],
[\[SWS_Rte_02607\]](#)),

`data element with status` ([SWS_Rte_01365], [SWS_Rte_01366],
[\[SWS_Rte_03734\]](#), [\[SWS_Rte_02666\]](#), [\[SWS_Rte_02589\]](#), [\[SWS_Rte_02590\]](#)),

and `data element with extended status` ([SWS_Rte_06817],
[\[SWS_Rte_06818\]](#), [\[SWS_Rte_06819\]](#), [\[SWS_Rte_06820\]](#), [\[SWS_Rte_06821\]](#),
[\[SWS_Rte_06822\]](#), [\[SWS_Rte_06823\]](#), [\[SWS_Rte_06824\]](#), [\[SWS_Rte_06825\]](#),
[\[SWS_Rte_06826\]](#)).]()

[SWS_Rte_07921] [The *RTE Data Handle Types Header File* shall not contain code that creates object in memory.]
[\(SRS_BSW_00308\)](#)

The *RTE Data Handle Types Header File* should be an output of the “RTE Contract” and “RTE Generation” phases.

5.3.5.1 File Name

[SWS_Rte_07922] [The name of the *RTE Data Handle Types Header File* shall be `Rte_DataHandleType.h`.]
[\(SRS_BSW_00300\)](#)

5.3.5.2 File Contents

The *RTE Data Handle Types Header File* contains the type declarations of [data element without status](#) and [data element with status](#) (see Section [5.4.2](#)).

[SWS_Rte_07923] [The *RTE Data Handle Types Header File* shall include the following mechanism to prevent multiple inclusions.

```

1  #ifndef RTE_DATA_HANDLE_TYPE_H
2  #define RTE_DATA_HANDLE_TYPE_H
3
4  /* File contents */
5
6  #endif /* RTE_DATA_HANDLE_TYPE_H */

```

]([SRS_Rte_00126](#))

5.3.6 Application Types Header File

The *Application Types Header File* provides a component local name space for enumeration literals and range values. The *Application Types Header File* is not allowed to create objects in memory.

The *Application Types Header File* file should be identical output for “RTE Contract” and “RTE Generation” phases.

[SWS_Rte_07120] [The RTE generator shall create an *Application Types Header File* for each software-component type (excluding [ParameterSwComponentTypes](#) and [NvBlockSwComponentTypes](#)) defined in the input.]([SRS_Rte_00024](#), [SRS_Rte_00140](#), [SRS_BSW_00447](#))

[SWS_Rte_07121] [The *Application Types Header File* shall not contain code that creates objects in memory.]([SRS_BSW_00308](#))

5.3.6.1 File Name

[SWS_Rte_07122] [The name of the *Application Types Header File* shall be formed by prefixing the AUTOSAR software-component type name with `Rte_[Byps_]` and appending the result with `_Type.h`. `[Byps_]` is an optionnal infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).]([SRS_BSW_00300](#), [SRS_Rte_00167](#))

Example 5.21

The following declaration in the input XML:

```

1  <APPLICATION-SW-COMPONENT-TYPE>
2    <SHORT-NAME>Source</SHORT-NAME>
3  </APPLICATION-SW-COMPONENT-TYPE>

```

should result in the *Application Types Header File* `Rte_Source_Type.h` being generated when the component wrapper method for bypass support is disabled.

5.3.6.2 Scope

[SWS_Rte_07124] [The *Application Types Header File* shall be valid for both C and C++ source.] ([SRS_Rte_00126](#), [SRS_Rte_00138](#))

Requirement [\[SWS_Rte_07124\]](#) is met by ensuring that all definitions within the *Application Types Header File* are defined using C linkage if a C++ compiler is used.

[SWS_Rte_07125] [All definitions within in the *Application Types Header File* shall be preceded by the following fragment;

```
1  #ifdef __cplusplus
2  extern "C" {
3  #endif /* __cplusplus */
```

] ([SRS_Rte_00126](#), [SRS_Rte_00138](#))

[SWS_Rte_07126] [All definitions within the application types header file shall be suffixed by the following fragment;

```
1  #ifdef __cplusplus
2  } /* extern "C" */
3  #endif /* __cplusplus */
```

] ([SRS_Rte_00126](#), [SRS_Rte_00138](#))

[SWS_Rte_07678] [The *Application Types Header File* shall be protected against multiple inclusions:

```
1  #ifndef RTE_<SWC>_TYPE_H
2  #define RTE_<SWC>_TYPE_H
3  ...
4  /*
5   * Contents of file
6   */
7  ...
8  #endif /* !RTE_<SWC>_TYPE_H */
```

Where `<SWC>` is the AUTOSAR software-component type name.³] ([SRS_Rte_00126](#))

5.3.6.3 File Contents

In contrast to the *Application Header File* the *Application Types Header File* supports that multiple *Application Types Header File*'s are included in the same module. This is necessary if for instance a BSW module uses several AUTOSAR Services.

³No additional capitalization is applied to the names.

[SWS_Rte_07127] [The *Application Types Header File* shall include the *RTE Types Header File*.] ([SRS_Rte_00087](#))

The name of the *RTE Types Header File* is defined in Section [5.3.4](#).

5.3.6.4 RTE Modes

The *Application Types Header File* shall contain identifiers for the [ModeDeclarations](#) and type definitions for [ModeDeclarationGroup](#)'s as defined in Chapter [5.5.3](#)

5.3.6.5 Enumeration Data Types

The *Application Types Header File* shall contain the enumeration constants as defined in Chapter [5.5.4](#)

5.3.6.6 Range Data Types

The *Application Types Header File* shall contain definitions of [Range](#) constants as defined in Chapter [5.5.5](#)

5.3.6.7 Implementation Data Type symbols

The *Application Types Header File* may contain definitions to redefine the [Implementation Data Type symbol](#) to the [shortName](#) of the [ImplementationDataType](#) in order to provide the expected type name to the software component implementation. See section [5.3.4.10](#).

5.3.6.8 Macros for accessing Availability Information in Structs for optional Members

AUTOSAR supports that elements of Structure Implementation Data Types are defined as optional. In the meta model, the attribute [isOptional](#) of those [ImplementationDataTypeElements](#) is set to True. These members may or may not exist at runtime.

Structure Implementation Data Types with optional members have to fulfill special structural requirements (see [\[2\]](#) for details). The availability information is stored in a special [ImplementationDataTypeElement](#) with the [shortName](#) [availabilityBitfield](#) which is a fixed-size array of `uint8`.

The software component needs support to evaluate and set the availability information for optional members.

[SWS_Rte_03617] [A macro to access the availability information shall be generated for each `ImplementationDataTypeElement` of an `ImplementationDataType` where the attribute `isOptional` is set true. The macro shall be generated in the *Application Types Header File* of each software component using this type as follows:

```
1 #define Rte_IsAvailable_<i>_<e>(data) (((data)->availabilityBitfield[<pos/8>]) & (1<<(<pos mod 8>)) != 0)
```

Where

- <i> is the `shortName` of the `ImplementationDataType`
- <e> is the `shortName` of the `ImplementationDataTypeElement`
- <pos> is the position of the optional `ImplementationDataTypeElement` among all optional `ImplementationDataTypeElements` within the `ImplementationDataType` starting with `pos = 0`.

]([SRS_Rte_00261](#))

[SWS_Rte_03618] [A macro to set the availability information shall be generated for each `ImplementationDataTypeElement` of an `ImplementationDataType` where the attribute `isOptional` is set true. The macro shall be generated in the *Application Types Header File* of each software component using this type as follows:

```
1 #define Rte_SetAvailable_<i>_<e>(data, available) \
2 ( \
3 (data)->availabilityBitfield[<pos/8>] = ((available) ? \
4 (data)->availabilityBitfield[<pos/8>] | (1<<(<pos mod 8>)) : \
5 (data)->availabilityBitfield[<pos/8>] & ~(1<<(<pos mod 8>)) ) \
6 )
```

Where

- <i> is the `shortName` of the `ImplementationDataType`
- <e> is the `shortName` of the `ImplementationDataTypeElement`
- <pos> is the position of the optional `ImplementationDataTypeElement` among all optional `ImplementationDataTypeElements` within the `ImplementationDataType` starting with `pos = 0`.

]([SRS_Rte_00261](#))

Note: Non-optional `ImplementationDataTypeElements` do not count since they do not need a bit in the `availabilityBitfield`. So the bit position within the `availabilityBitfield` is determined by the order of the optional `ImplementationDataTypeElements`.

Examples:

- 1st optional `ImplementationDataTypeElement` (`pos=0`): `(availabilityBitfield[0] & 0x01) != 0`

- 8th optional ImplementationDataTypeElement (pos=7): (availabilityBitfield[0] & 0x08) != 0
- 9th optional ImplementationDataTypeElement (pos=8): (availabilityBitfield[1] & 0x01) != 0

5.3.7 VFB Tracing Header File

The VFB Tracing Header File defines the configured VFB Trace events.

[SWS_Rte_01319] [The VFB Tracing Header File shall be created by the corresponding VFB Trace client for *RTE Generation Phase* or *Basic Software Scheduler Generation Phase* only.] ([SRS_Rte_00045](#))

The VFB Tracing Header Files are included by the generated RTE and may also be included by the corresponding VFB Trace client. The header file includes the declarations (in case of function implementation) or definitions (in case of inline or macro implementation) of the configured functions to ensure consistency between the invocation by the RTE and the definition by the user.

5.3.7.1 C/C++

The following requirements apply to RTEs generated for C and C++.

[SWS_Rte_01250] [The name of the VFB Tracing Header File shall be `Rte_Hook[_<client>].h`, where `<client>` is the [shortName](#) of the corresponding [RteVfbTraceClient](#) container. In case of the client without client prefix there is no corresponding [RteVfbTraceClient](#) container and the optional part of the file name will be omitted.] ([SRS_Rte_00045](#))

5.3.7.2 File Contents

[SWS_Rte_08901] [The VFB Tracing Header File shall be self-contained. I.e. it shall include all header files necessary to compile the defined or declared data, code and types.] ([SRS_Rte_00003](#), [SRS_Rte_00004](#), [SRS_Rte_00008](#), [SRS_Rte_00045](#))

Note that the requirement above might especially lead to inclusion of `Os.h`, the *RTE Types Header File* or the *RTE Configuration Header File*.

[SWS_Rte_01236] [For each trace event hook function defined in Section [5.11.5](#), the VFB Trace client shall define the implementation (in case of inline function or macro) or declare the trace event hook function (in case of C function) in the VFB Tracing Header

File. For empty macro implementations it shall use a mapping to `((void) (0))` to enable usage in comma separated lists.] ([SRS_Rte_00008](#))

Example 5.22

Consider an API call `Rte_Write_pl_a` for an instance of SW-C `c` writing primitive data of type `SwcCsType`. In case of a trace client `tcd` this will result in two trace event hook functions being created by the RTE generator, if enabled:

```
1 Rte_tcd_WriteHook_c_pl_a_Start
```

and

```
1 Rte_tcd_WriteHook_c_pl_a_Return
```

The trace client `tcd` would now have to provide declarations or definitions for those hook functions. It might emit in `Rte_Hook_tcd.h`:

```
1 extern void Rte_tcd_WriteHook_c_pl_a_Start(SwcCsType data); // tcd
   chose a function implementation of this hook
2 #define Rte_tcd_WriteHook_c_pl_a_Return(data) ((void) (0)) // tcd chose
   not being interested in this hook
```

5.3.8 RTE Configuration Header File

The *RTE Configuration Header File* contains user definitions that affect the behavior of the generated RTE.

The *RTE Configuration Header File* is generated by the RTE generator.

5.3.8.1 C/C++

The following requirements apply to RTEs generated for C and C++.

[SWS_Rte_01321] [The name of the *RTE Configuration Header File* shall be `Rte_Cfg.h`.] ([SRS_Rte_00008](#), [SRS_Rte_00045](#))

5.3.8.2 File Contents

[SWS_Rte_07641] [The *RTE Configuration Header File* shall include the file `Std_Types.h`.] ([SRS_Rte_00149](#), [SRS_Rte_00150](#), [SRS_BSW_00353](#))

5.3.8.2.1 Condition Value Macros

The *Condition Value Macros* are generated in the *PreBuild Data Set Contract Phase* and *PreBuild Data Set Generation Phase*. To do this a particular variant out of the *pre-build variability* of the input configuration has to be chosen by the means described in by [SWS_Rte_06500].

[SWS_Rte_06514] [If evaluated *BooleanValueVariationPoints* or *ConditionByFormulas* are resulting to true the *<value>* for *Condition Value Macros* shall be coded as `TRUE` and if these are resulting to false the value shall be coded as `FALSE`.] (*SRS_Rte_00201*, *SRS_Rte_00203*)

[SWS_Rte_06513] [For each *VariationPointProxy* which *bindingTime* = *Pre-CompileTime* the *RTE Configuration Header File* shall contain a definition of a *Condition Value Macro* in the *RTE PreBuild Data Set Contract Phase* and *RTE PreBuild Data Set Generation Phase*

```
#define Rte_SysCon_<cts>_<name> <value><suffix>
```

Where *<cts>* is the *component type symbol* of the *AtomicSwComponentType*,
<name> is the *shortName* of the *VariationPointProxy*,

<value> is the evaluated value of the *AttributeValueVariationPoint* or *ConditionByFormula*

and *<suffix>* shall be set according to [SWS_Rte_03619].

] (*SRS_Rte_00203*, *SRS_Rte_00167*)

This requirements makes the *SwSystemconst* values available to resolve the *pre-build variability* in the software components via the Preprocessor. This might be used to

- read the actual value of the value assigned to a *SwSystemconst*
- read the setting of an attribute (e.g. array size) dependent from a *SwSystemconst*
- check the existence of a conditional existent object, e.g. an code fragment implementing a particular functionality

Please note the *Rte_SysCon* macro holds the internal value of the evaluated *AttributeValueVariationPoint* or *ConditionByFormula*. Therefore the RTE does not perform value conversions for *SwSystemconst* using a *compuMethod*. See [TPS_GST_00262].

[SWS_Rte_03854] [For each *VariationPointProxy* which *bindingTime* = *Pre-CompileTime* the *RTE Application Header File* shall contain a definition

```
#define Rte_SysCon_<name> Rte_SysCon_<cts>_<name>
```

where `<cts>` is the [component type symbol](#) of the [AtomicSwComponentType](#) and

`<name>` is the [shortName](#) of the [VariationPointProxy](#).] ([SRS_Rte_00203](#), [SRS_Rte_00167](#))

[SWS_Rte_06515] [For each RTE API which is subject to variability and following the form *component port* or *entity port* in table 4.23 the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define Rte_VPCon_<cts>_<re>[_<resl>]_<p>_<o>[_<psl>] <value>
```

where `<cts>` is the [component type symbol](#) of the [AtomicSwComponentType](#),

`<re>` is the short name of the [RunnableEntity](#),

`<resl>` is the [shortLabel](#) of the [RunnableEntity](#)'s [VariationPoint](#) containing the reference element (e.g. a [VariableAccess](#)) to the [PortInterface](#) element,

`<p>` is the name of the [PortPrototype](#),

`<o>` is the short name of the [PortInterface](#) element and

`<psl>` is the [shortLabel](#) of the [PortPrototype](#)'s [VariationPoint](#) which is referred by the [VariableAccess](#)

If there is no [VariationPoint](#) at the [RunnableEntity](#) owning the [VariableAccess](#) the `<resl>` with leading underscore is omitted (`[_<resl>]`).

If there is no [VariationPoint](#) at the [PortPrototype](#) referred by the [VariableAccess](#) the `<psl>` with leading underscore is omitted (`[_<psl>]`).

`<value>` is the evaluated value of the [ConditionByFormula](#) of the [VariationPoint](#) vary the existence of the RTE API in table 4.23.] ([SRS_Rte_00201](#), [SRS_Rte_00167](#))

[SWS_Rte_08789] [For each [VariationPointProxy](#) which `bindingTime = Pre-CompileTime` the *RTE Configuration Header File* shall contain a definition of a *Condition Value Macro* in the *RTE PreBuild Data Set Contract Phase* and *RTE PreBuild Data Set Generation Phase*

```
#define SchM_SysCon_<bsnp>[_<vi>_<ai>]_<ki>_<name> <value>
```

Where

`<bsnp>` is the *BSW Scheduler Name Prefix* according [[SWS_Rte_07593](#)] and [[SWS_Rte_07594](#)],

`<vi>` is the [vendorId](#) of the BSW module,

`<ai>` is the [vendorApiInfix](#) of the BSW module,

`<ki>` is the *kind infix* according table 4.34,

<name> is the short name of the element which is subject to variability in table 4.34 defining the *Basic Software Scheduler* API name infix and

<value> is the evaluated value of the [AttributeValueVariationPoint](#) or [ConditionByFormula](#).

The sub part in squared brackets [[_<vi>_<ai>](#)] is omitted if no [vendorApiInfix](#) is defined for the *Basic Software Module*. See [[SWS_Rte_07528](#)]. ([SRS_Rte_00229](#), [SRS_BSW_00347](#))

This requirement makes the [SwSystemconst](#) value available to resolve the [pre-build variability](#) in the BSW module via the Preprocessor. This might be used to

- read the actual value of the value assigned to a [SwSystemconst](#)
- read the setting of an attribute (e.g. array size) dependent from a [SwSystemconst](#)
- check the existence of a conditional existent object, e.g. a code fragment implementing a particular functionality

[SWS_Rte_06518] [For each RTE API which is subject to variability and following the form *component internal* in table 4.23 the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define Rte_VPCon_<cts>_<ki>_<name>_<sl> <value>
```

where <cts> is the [component type symbol](#) of the [AtomicSwComponentType](#),

<ki> is the *kind infix* according table 4.23,

<name> is the short name of the element which is subject to variability in table 4.23 and is defining the API name infix,

<sl> is the [shortLabel](#) of the elements' [VariationPoint](#) defining the API name infix.

<value> is the evaluated value of the [ConditionByFormula](#) of the [VariationPoint](#) defining the variant existence of the RTE API in table 4.23. ([SRS_Rte_00201](#), [SRS_Rte_00167](#))

[SWS_Rte_06519] [For each RTE API which is subject to variability and which variability shall be implemented and which is following the form *entity internal* in table 4.23 the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define Rte_VPCon_<cts>_<re>[_<resl>]_<ki>_<name>_<sl> <value>
```

where <cts> is the [component type symbol](#) of the [AtomicSwComponentType](#),

<re> is the short name of the [RunnableEntity](#),

<resl> is the [shortLabel](#) of the [RunnableEntity](#)'s [VariationPoint](#) containing the reference element (e.g. a [VariableAccess](#)) to the [PortInterface](#) element,

<ki> is the *kind infix* according table 4.23 and

<name> is the short name of the element which is subject to variability in table 4.23 and is defining the API name infix.

<sl> is the *shortLabel* of the elements' *VariationPoint* defining the API name infix.

If there is no *VariationPoint* at the *RunnableEntity* owning the reference element (e.g. a *VariableAccess*) to the *PortInterface* element the <resl> with leading underscore is omitted ([_<resl>]).

<value> is the evaluated value of the *ConditionByFormula* of the *VariationPoint* defining the variant existence of the RTE API in table 4.23.](*SRS_Rte_00201*, *SRS_Rte_00167*)

[SWS_Rte_06520] [For each *PortPrototype* which is subject to variability and which variability shall be implemented the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define Rte_VPCon_<cts>_<p>_<psl> <value>
```

where <cts> is the *component type symbol* of the *AtomicSwComponentType*,

<p> is the short name of the *PortPrototype* and

<psl> is the *shortLabel* of the *PortPrototype*'s *VariationPoint* and

<value> is the evaluated value of the *ConditionByFormula* of the *VariationPoint* defining the variant existence of the *PortPrototype* in table 4.23.](*SRS_Rte_00201*, *SRS_Rte_00167*)

[SWS_Rte_06530] [For each *RunnableEntity* which is subject to variability and which variability shall be implemented the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define Rte_VPCon_<cts>_<re>[_<resl>]_<sl> <value>
```

where <cts> is the *component type symbol* of the *AtomicSwComponentType*,

<re> is the short name of the *RunnableEntity*

<resl> is the *shortLabel* of the *RunnableEntity*'s *VariationPoint* containing the reference element (e.g. a *VariableAccess*) to the *PortInterface* element,

<sl> is the *shortLabel* of the *RTEEvent*'s *VariationPoint* referencing the *RunnableEntity*,

<value> is the evaluated value of the *ConditionByFormula* of the *VariationPoint* defining the variant existence of the *RunnableEntity* in table 4.26.](*SRS_Rte_00201*, *SRS_Rte_00167*)

[SWS_Rte_06541] [For each *arraySize* which subject to variability the *RTE Configuration Header File* shall contain one definition of a *Attribute Value*

```
#define Rte_VPVal_<t>_<e 1>[_<e 2> ... _<e n>] <value>
```

where <t> is the [shortName](#) of the [ImplementationDataType](#),

[<e x>] are the [shortNames](#) of the Array's [ImplementationDataTypeElements](#) with a leading underscore ordered from the root to the Array's [ImplementationDataTypeElement](#) with the [arraySize](#) being subject to variability and

<value> is the evaluated value of the [AttributeValueVariationPoint](#) of the [arraySize](#)] ([SRS_Rte_00201](#), [SRS_Rte_00167](#))

[SWS_Rte_06542] [For each Array's [ImplementationDataTypeElement](#) which subject to variability the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define Rte_VPCon_<t>_<e 1>[_<e 2> ... _<e n>] <value>
```

where <t> is the [shortName](#) of the [ImplementationDataType](#),

[<e x>] are the [shortNames](#) of the Array's [ImplementationDataTypeElements](#) with a leading underscore ordered from the root to the Array's [ImplementationDataTypeElement](#) being subject to variability and

<value> is the evaluated value of the [ConditionByFormula](#) of the [VariationPoint](#) defining the conditional existence of the Array's [ImplementationDataTypeElement](#)] ([SRS_Rte_00201](#), [SRS_Rte_00167](#))

[SWS_Rte_06551] [For each [DataConstr](#) referenced by a [ApplicationPrimitiveDataType](#) where the [upperLimit](#) is subject to [PreCompileTime variability](#) the *RTE Configuration Header File* shall contain one definition of a *Attribute Value Macro*

```
#define Rte_VPVal_<cts>_<prefix><t>_UpperLimit <upperValue><suffix>
```

where <cts> is the [component type symbol](#) of the [AtomicSwComponentType](#),

<t> is the [shortName](#) of the [ApplicationPrimitiveDataType](#),

<prefix> is the optional [literalPrefix](#) attribute defined by the [IncludedDataTypeSet](#) referring the [AutosarDataType](#) to which the [DataConstr](#) belongs,

<upperValue> are the [upperLimit](#) value of the [dataConstr](#) referenced by the [ApplicationPrimitiveDataType](#) onto which the corresponding [CompuMethod](#) has been applied (see [\[SWS_Rte_07038\]](#)). The value in the macro definitions shall always reflect the closed interval, regardless of the interval type specified by the [DataConstr](#).

<suffix> shall be set according to [\[SWS_Rte_03619\]](#).] ([SRS_Rte_00201](#), [SRS_Rte_00167](#))

[SWS_Rte_06552] [For each *DataConstr* referenced by a *ApplicationPrimitiveDataType* where the *lowerLimit* is subject to *PreCompileTime variability* the *RTE Configuration Header File* shall contain one definition of a *Attribute Value Macro*

```
#define Rte_VPVal_<cts>_<prefix><t>_LowerLimit <lowerValue><suffix>
```

where <cts> is the *component type symbol* of the *AtomicSwComponentType*,

<t> is the *shortName* of the *ApplicationPrimitiveDataType*,

<prefix> is the optional *literalPrefix* attribute defined by the *IncludedDataTypeSet* referring the *AutosarDataType* to which the *DataConstr* belongs,

<lowerValue> are the *lowerLimit* value of the *dataConstr* referenced by the *ApplicationPrimitiveDataType* onto which the corresponding *CompuMethod* has been applied (see [SWS_Rte_07038]). The value in the macro definitions shall always reflect the closed interval, regardless of the interval type specified by the *DataConstr*.

<suffix> shall be set according to [SWS_Rte_03619].] (SRS_Rte_00201, SRS_Rte_00167)

[SWS_Rte_06535] [For each *Basic Software Scheduler API* which is subject to variability and following the form *module internal* in table 4.34 the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define SchM_VPCon_<bsnp>[_<vi>_<ai>]_<ki>_<name>_<sl> <value>
```

where here

<bsnp> is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594],

<vi> is the *vendorId* of the BSW module,

<ai> is the *vendorApiInfix* of the BSW module,

<ki> is the *kind infix* according table 4.34,

<name> is the short name of the element which is subject to variability in table 4.34 defining the *Basic Software Scheduler API* name infix and

<sl> is the *shortLabel* of the elements' *VariationPoint* defining the API name infix.

<value> is the evaluated value of the *ConditionByFormula* of the *VariationPoint* defining the variant existence of the *Basic Software Scheduler API* in table 4.34.

The sub part in squared brackets [_<vi>_<ai>] is omitted if no *vendorApiInfix* is defined for the *Basic Software Module*. See [SWS_Rte_07528].] (SRS_Rte_00229, SRS_BSW_00347)

[SWS_Rte_06536] [For each *Basic Software Scheduler* API which is subject to variability and which variability shall be implemented and which is following the form *module external* and *entity internal* in table 4.34 the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define SchM_VPCon_<bsnp>[_<vi>_<ai>]_<ki>_
                        <entity>[_<esl>]_<name>[_<sl>] <value>
```

where here

<bsnp> is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594],

<vi> is the *vendorId* of the BSW module,

<ai> is the *vendorApiInfix* of the BSW module,

<ki> is the *kind infix* according table 4.34,

entity is the *shortName* of the *BswModuleEntity*

<esl> is the *shortLabel* of the *BswModuleEntity*'s *VariationPoint* containing the subject to variability,

<name> is the *shortName* of the element/referenced element which is subject to variability in table 4.34 defining the *Basic Software Scheduler* API name infix and

<sl> is the *shortLabel* of the elements's *VariationPoint* defining the API name infix.

<value> is the evaluated value of the *ConditionByFormula* of the *VariationPoint* defining the variant existence of the *Basic Software Scheduler* API in table 4.34.

The sub part in squared brackets [_<vi>_<ai>] is omitted if no *vendorApiInfix* is defined for the *Basic Software Module*. See [SWS_Rte_07528].

If there is no *VariationPoint* at the *BswModuleEntity* referring to the subject to variability in table 4.34 the <esl> with leading underscore is omitted ([_<esl>]).

If there is no *VariationPoint* at the elements defining the *Basic Software Scheduler* API name infix 4.34 the <sl> with leading underscore is omitted ([_<sl>]).] (SRS_Rte_00229, SRS_BSW_00347)

[SWS_Rte_06532] [For each *BswSchedulableEntity* which is subject to variability and which variability shall be implemented the *RTE Configuration Header File* shall contain one definition of a *Condition Value*

```
#define SchM_VPCon_<bsnp>[_<vi>_<ai>]_<entry>_<esl> <value>
```

where here

<bsnp> is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594],

<vi> is the `vendorId` of the BSW module,

<ai> is the `vendorApiInfix` of the BSW module,

<entry> is the `shortName` of the implemented (`implementedEntry`) entry point and

<esl> is the `shortLabel` of the `BswModuleEntity`'s `VariationPoint`

<value> is the evaluated value of the `ConditionByFormula` of the `VariationPoint` defining the variant existence of the `BswSchedulableEntity` in table 4.36.

The sub part in squared brackets [`_<vi>_<ai>`] is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See [SWS_Rte_07528].] (SRS_Rte_00229, SRS_BSW_00347)

An example about the usage of condition value macros is shown in 5.6.

5.3.9 Generated RTE

Figure 5.1 defines the relationship between generated and standardized header files. It is **not** necessary to standardize the relationship between the C module, `Rte.c`, and the header files since when the RTE is generated the application header files are created anew along with the RTE. This means that details of which header files are included by `Rte.c` can be left as an implementation detail.

5.3.9.1 Header File Usage

[SWS_Rte_01257] [In compatibility mode, the Generated RTE module shall include `Os.h`.] (SRS_Rte_00145)

[SWS_Rte_03794] [In compatibility mode, the generated RTE module shall include `Com.h`.] (SRS_Rte_00145)

[SWS_Rte_01279] [In compatibility mode, the Generated RTE module shall include `Rte.h`.] (SRS_Rte_00145)

[SWS_Rte_01326] [In compatibility mode, the Generated RTE module shall include the *VFB Tracing Header Files*.] (SRS_Rte_00045, SRS_Rte_00145)

[SWS_Rte_03788] [Except for the declaration of entry points for components (see [SWS_Rte_07194]), the RTE shall map its memory objects in files in the RTE's own namespace using the AUTOSAR memory mapping mechanism (see [28]).] (SRS_Rte_00148)

[SWS_Rte_07692] [The Generated RTE module shall perform Inter Module Checks to avoid integration of incompatible files. The imported included files shall be checked by preprocessing directives.

The following version numbers shall be verified:

- <MODULENAME>_AR_RELEASE_MAJOR_VERSION
- <MODULENAME>_AR_RELEASE_MINOR_VERSION

Where <MODULENAME> is the module short name of the other (external) modules which provide header files included by the Generated RTE module.

If the values are not identical to the expected values, an error shall be reported.] ([SRS - BSW_00004](#))

Figure 5.12 provides an example of how the RTE header and generated header files could be used by a generated RTE.

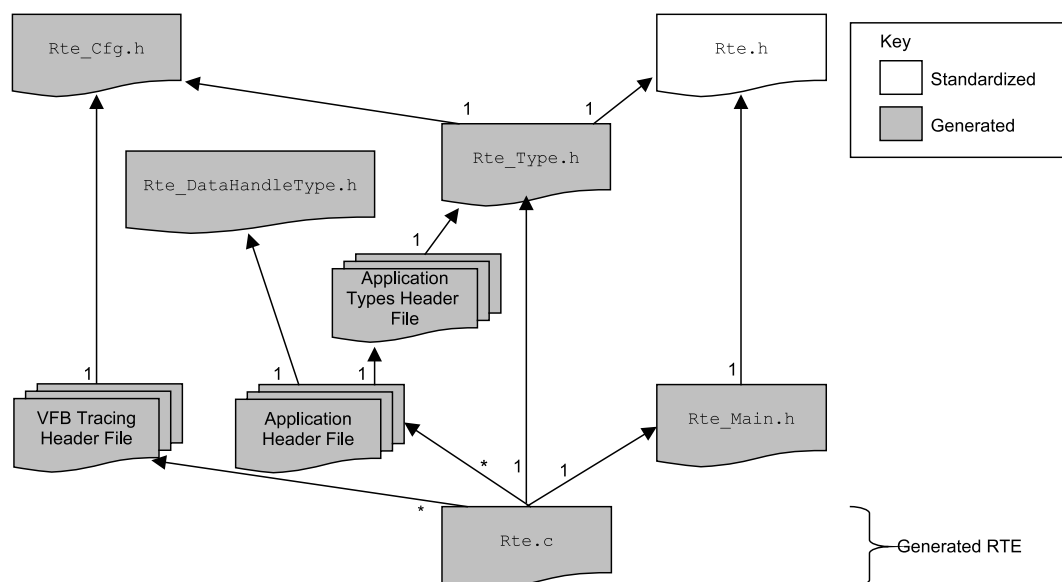


Figure 5.12: Example of header file use by the generated RTE.

In the example in Figure 5.12, the generated RTE C module requires access to the data structures created for each AUTOSAR software-component and therefore includes each application header file⁴. In the example, the generated RTE also includes the RTE header file and the lifecycle header file in order to obtain access to RTE and lifecycle related definitions.

Note: Inclusion of *Application Header Files* of different software components into the RTE C module needs support in the *Application Header Files* in order to avoid that some local definitions of software components are producing name clashes. If the RTE C module does not include any *Application Header File*, some type definitions (e.g. component data structure) might have to be generated twice.

⁴The requirement that a software module include at most one application header file applies only to modules that actually implement a software-component and therefore does not apply to the generated RTE.

5.3.9.2 C/C++

The following requirements apply to RTEs generated for C and C++.

Note: The `<PartitionName>`s referred to in requirements [SWS_Rte_02712], [SWS_Rte_02713] and [SWS_Rte_02740] are implementation-specific identifiers for the modules. They need not be the same as the `CoreId` identifiers configured for the multi core OS. Refer to section 4.3.4 for a discussion of the allocation of ECU execution logic to partitions and the allocation of partitions to cores.

[SWS_Rte_01169] [The name of the C module containing the generated RTE code that is shared by all cores of an ECU shall be `Rte.c`.] (SRS_BSW_00300, SRS_Rte_00126)

[SWS_Rte_02711] [On a multi core ECU, RTE shall only use global and static variables in the `Rte.c` module, if it is used in a single image system that supports shared memory. In this case, RTE shall guarantee consistency of this memory, e.g. by using OS mechanisms.] ()

[SWS_Rte_02712] [On a multi partition ECU, there shall be additional code and header files named `Rte_Partition_<PartitionName>` for the core specific code parts of RTE where `<PartitionName>` is the `shortName` of the container `Ecuc-Partition`.] ()

[SWS_Rte_02713] [There shall not be symbol redefinitions between different `Rte_Partition_<PartitionName>` files.] ()

These requirements makes sure, that all `Rte` modules can be linked in one image. On a multi core ECU, the RTE may be linked in one image or distributed over separate images, one per core.

An RTE that includes configured code from an object-code or source-code library may use additional modules. Further on due to the encapsulation of a component local name space [SRS_Rte_00167], it might be required to encapsulate part of the generated RTE code in component specific files as well to avoid name clashes in the RTE's implementation.

[SWS_Rte_07140] [The RTE generator is allowed to partition the generated RTE module in several files additionally to `Rte.c` and `Rte_Partition_<PartitionName>`.] (SRS_Rte_00167)

5.3.9.3 File Contents

By its very nature the contents of the generated RTE is largely vendor specific. It is therefore only possible to define those common aspects that are visible to the "outside world" such as the names of generated APIs and the definition of component data structures that apply any operating mode.

5.3.9.3.1 Component Data Structures

The *Component Data Structure* (Section 5.4.2) is a per-component data type used to define instance specific information required by the generated RTE.

[SWS_Rte_03711] [The generated RTE shall contain an instance of the relevant Component Data Structure for each software-component instance on the ECU for which the RTE is generated.] ([SRS_Rte_00011](#))

[SWS_Rte_03712] [The name of a Component Data Structure instantiated by the RTE generator shall be `Rte_Instance_<name>` where `<name>` is an automatically generated name, created in some manner such that all instance data structure names are unique. The name of a Component Data Structure instantiated by the RTE generator shall be `Rte_Instance_<name>` where `<name>` is an automatically generated name, created in some manner such that all instance data structure names are unique.] ([SRS_BSW_00307](#))

The software component instance name referred to in [\[SWS_Rte_03712\]](#) is never made visible to the users of the generated RTE. There is therefore no need to specify the precise form that the unique name takes. The `Rte_Instance_` prefix is mandated in order to ensure that no name clashes occur and also to ensure that the structures are readily identifiable in map files, debuggers, etc.

The `Rte_Instance_` prefix does NOT mean that the Component Data Structure instance is identical to the instance handle type `Rte_Instance` described in section 5.5.2; the prefix is mandated in order to ensure that no name clashes occur and also to ensure that the structures are readily identifiable in map files, debuggers, etc.

5.3.9.3.2 Generated API

[SWS_Rte_01266] [The RTE module shall define the generated functions that will be invoked when an AUTOSAR software-component makes an RTE API call.] ([SRS_Rte_00051](#))

The semantics of the generated functions are not defined (since these will obviously vary depending on the RTE API call that it is implementing) nor are the implementation details (which are vendor specific). However, the names of the generated functions defined in Section 5.2.6.1.

The signature of a generated function is the same as the signature of the relevant RTE API call (see Section 5.6) with the exception that the instance handle can be omitted since the generated function is applicable to a specific software-component instance.

5.3.9.3.3 Callbacks

In addition to the generated functions for the RTE API, the RTE module includes callbacks invoked by COM when signal events (receptions, transmission acknowledgment, etc.) occur.

[SWS_Rte_01264] [The RTE module shall define COM callbacks for relevant signals.] ([SRS_Rte_00019](#))

The required callbacks are defined in Section [5.9](#).

[SWS_Rte_03795] [The RTE generator shall generate a separate header file containing the prototypes of callback functions.] ([SRS_Rte_00019](#))

[SWS_Rte_03796] [The name of the header file containing the callback prototypes shall be `Rte_Cbk.h` in a C/C++ environment.] ([SRS_Rte_00019](#))

[\[SWS_Rte_03796\]](#) refers to the callbacks defined in section [5.9](#).

5.3.9.3.4 Task bodies

The RTE module define task bodies for tasks created by the RTE generator only in compatibility mode.

[SWS_Rte_01277] [In compatibility mode [\[SWS_Rte_01257\]](#), the RTE module shall define all task bodies created by the RTE generator.] ([SRS_Rte_00145](#))

Note that in vendor mode it is assumed that greater knowledge of the OS is available and therefore the above requirement does *not* apply so that specific optimizations, such as creating each task in a separate module, can be applied.

5.3.9.3.5 Lifecycle API

[SWS_Rte_01197] [The RTE module shall define the RTE lifecycle API.] ([SRS_Rte_00051](#))

The RTE lifecycle API is defined in Section [5.8](#).

5.3.9.4 Reentrancy

All code invoked by generated RTE code that can be subject to concurrent execution must be reentrant. This requirement for reentrancy can be overridden if the generated code is not subject to concurrent execution, for example, if protected by a data consistency mechanism to ensure that access to critical regions is call serialized.

5.3.10 RTE Post Build Variant Sets

[SWS_Rte_06620] [The RTE generator shall generate in the *Rte_PBcfg.h* file the `SchM_ConfigType` type declaration of the predefined post build variants data structure. This header file must be used by other RTE modules to resolve their runtime variabilities.] ([SRS_Rte_00201](#))

[SWS_Rte_06638] [The RTE generator must generate a *Rte_PBcfg.c* file containing the declarations and initializations of one or more RTE post build variants. Only one of these variants can be active at runtime.] ([SRS_Rte_00201](#), [SRS_BSW_00346](#))

Within an RTE with post build variants, one active `RtePostBuildVariantConfiguration` will exist. It is a pointer to this structure that shall be passed to `SchM_Init`. Also note that the container `PredefinedVariant` is only a Meta Model construct to allow the designer to create a validated collection of values assigned to a criterion. It is up to the implementer of the RTE generator to optimize variant configurations either for size and/or performance by using different levels of indirection to the `PostBuildVariantCriterionValues`. For the least amount of indirection for example one can have the criterion values at the level of the `Sch_ConfigType`. If you use post build loadable then you may want to reduce memory storage by reusing variant sets if they remain unchanged across two or more predefined variants.

The following subsections provide examples for the `SchM_ConfigType` declaration and instantiation only for demonstration purposes. No requirement what so ever is implied.

5.3.10.1 Example 1: File Contents *Rte_PBcfg.h*

An example of a flat data structure to represent the criterion values defined in the *Rte_PBcfg.h* file containing the `SchM_ConfigType` type which can contain the list of unique `PostBuildVariantCriterion` members. This approach immediately enforces that only one single criterion assignment can exist. The member names can, for example, follow the template defined below where `<sn>` is the `PostBuildVariantCriterion` `shortName`.

```

1  struct SchM_ConfigType {
2      /* The PostBuildVariantCriterion shortname */
3      int VarCri_<sn>;
4      .
5      .
6      .
7  };

```

5.3.10.2 Example 2: File Contents Rte_PBcfg.h

An example showing an additional level of indirection and as such allows for reuse of variant sets to optimize memory storage across for example several predefined variants is shown below. The RTE generator in this case can reuse some `PostBuildVariantCriterionValueSets` to reduce the memory resource consumption of an ECU. The RTE generator can declare in the `Rte_PBcfg.h` file a structure type for each **distinct unique** collection of `PostBuildVariantCriterionValueSets` containing the `PostBuildVariantCriteria`s as members. This implies that if two `PredefinedVariants` are defined each referring to a named `PostBuildVariantCriterionValueSet` and the list of `PostBuildVariantCriteria`s in each of these `PostBuildVariantCriterionValueSets` is identical that only one type is defined for these two named `PostBuildVariantCriterionValueSets`. The name of the type can, for example, follow the pattern below where the `<id>` is a unique identifier for that type (e.g. a counter).

```

1 struct Rte_VarSet_<id>_t {
2     /* The PostBuildVariantCriterion shortname */
3     int VarCri_<sn>;
4     .
5     .
6     .
7 };

```

Now the `SchM_ConfigType` type can be declared with pointers to these variant sets. The member names of this struct can, for example, follow the template below where `<id>` is a unique identifier.

```

1 struct SchM_ConfigType {
2     /* The PostBuildVariantCriterion shortname */
3     Rte_VarSet_<id>_t* VarSet_<id>_Ptr;
4     .
5     .
6     .
7 };

```

5.3.10.3 Examples: File Contents Rte_PBcfg.c

In correlation with example 1 of the header file the RTE generator can declare and optionally initialize a default variant configuration named `Rte_VarCfg` in the `Rte_PBcfg.c` file of the `SchM_ConfigType` type.

For example (the initializers are the criterion values):

```

1 const struct SchM_ConfigType Rte_VarCfg = {1,2,3,4,5};

```

And likewise for the example 2 header file the RTE generator can declare and initialize in the `Rte_PBcfg.c` file all possible `PostBuildVariantCriterionValueSets` and the `RtePostBuildVariantConfiguration` using references to these variant sets.

For example:

```

1  const struct Rte_VarSet_1_t Rte_VarSet_1a = {1,2,3};
2  const struct Rte_VarSet_1_t Rte_VarSet_1b = {1,4,1};
3  const struct Rte_VarSet_2_t Rte_VarSet_2 = {2,5,7,3,2};
4  .
5  .
6  .

1  const struct SchM_ConfigType Rte_VarCfg_1 =
2      {&Rte_VarSet_1a,&Rte_VarSet_2};
3  const struct SchM_ConfigType Rte_VarCfg_2 =
4      {&Rte_VarSet_1b,&Rte_VarSet_2};
5  .
6  .
7  .

```

When `SchM_Init` is called, a pointer to the active `SchM_ConfigType` will be passed along which shall be assigned to the named `Rte_VarCfgPtr` which is of type `SchM_ConfigType*`. This pointer shall be used to determine the values for actual used `PostBuildVariantCriteria`s and for variant validation when the DET is enabled.

Example 1 pseudo code evaluating the criteria

```

1  switch(Rte_VarCfg->VarCri_1)
2  {
3      case 1:
4          /* DO SOMETHING */
5          break;
6      case 2:
7          /* DO SOMETHING ELSE */
8  }

```

Example 2 pseudo code evaluating the criteria

```

1  switch(Rte_VarCfgPtr->VarSet_1_Ptr->VarCri_1)
2  {
3      case 1:
4          /* DO SOMETHING */
5          break;
6      case 2:
7          /* DO SOMETHING ELSE */
8  }

```

Another type of optimization strategy (besides flattening) that can be applied is double buffering for frequently used variant criterion values. The additional buffer can then be used in the conditions to optimize the performance of the RTE, e.g.

```

1  BufferedVarCri_1 = Rte_VarCfgPtr->VarSet_1->VarCri_1;
.

```

5.4 RTE Data Structures

Object-code software components are compiled against an application header file created during the “RTE Contract” phase but are linked against an RTE (and application header file) created during the “RTE Generation” phase. When generated in compatibility mode, an RTE has to work for object-code components compiled against an application header file created in compatibility mode, even if the application header file was created by a different RTE generator. It is thus necessary to define the data structures and naming conventions for the compatibility mode to ensure that the object-code is compatible with the generated RTE. An RTE generated in vendor mode only has to work for those object-code components that were compiled against application header files created in vendor mode by a compatible RTE generator (which in general would mean an RTE generator supplied by the same vendor).

The use of standardized data structures imposes tight constraints on the RTE implementation and therefore restricts the freedom of RTE vendors to optimize the solution of object-code components but has the advantage that RTE generators from different vendors can be used to compile an object-code software-component and to generate the RTE. No such restrictions apply for the vendor mode. If an RTE generator operating in vendor mode is used for an object-code component in both phases, vendor-specific optimizations can be used.

Note that with the exception of data structures required for support object-code software components in compatibility mode, the data structures used for “RTE Generation” phase are not defined. This permits vendor specific API mappings and data structures to be used for a generated RTE without loss of portability.

The following definitions only apply to RTE generators operating in compatibility mode – in this mode the instance handle and the component data structure have to be defined even for those (object-code) software components for which multiple instantiation is forbidden to ensure compatibility.

5.4.1 Instance Handle

The RTE is required to support object-code components as well as multiple instances of the same AUTOSAR software-component mapped to an ECU [[SRS_Rte_00011](#)]. To minimise memory overhead all instances of a component on an ECU share code [[SRS_Rte_00012](#)] and therefore both the RTE and the component instances require a means to distinguish different instances.

Support for both object-code components and multiple instances requires a level of indirection so that the correct generated RTE custom function is invoked in response to a component action. The indirection is supplied by the instance handle in combination with the API mapping defined in [Section 5.2.6](#).

[SWS_Rte_01012] [The component instance handle shall identify particular instances of a component.] ([SRS_BSW_00312](#), [SRS_Rte_00011](#))

The instance handle is passed to each runnable entity in a component when it is activated by the RTE as the first parameter of the function implementing the runnable entity [SWS_Rte_01016]. The instance handle is then passed back by the runnable entity to the RTE, as the first parameter of each direct RTE API call, so that the RTE can identify the correct component instance making the call. This scheme permits multiple instances of a component on the same ECU to share code.

The instance handle indirection permits the name of the RTE API call that is used within the component to be unique within the scope of a component as well as independent of the component's instance name. It thus enables object-code AUTOSAR software-components to be compiled before the final "RTE Generation" phase when the instance name is fixed.

[SWS_Rte_01013] [For the RTE C/C++ API, any call that can operate on different instances of a component that supports multiple instantiation [supportsMultipleInstantiation](#) shall have an instance handle as the first formal parameter.]([SRS_Rte_00011](#))

[SWS_Rte_03806] [If a component does not support multiple instantiation, the instance handle parameter shall be omitted in the RTE C/C++ API and in the signature of the RTE Hook functions.]([SRS_Rte_00011](#))

If the component does not support multiple instantiation, the instance handle is not passed to the API calls and runnable entities as parameters. In order to support access to the component data structure the name of the CDS is specified.

[SWS_Rte_03793] [If a software component does not support multiple instantiation, the name of the component data instance shall be `Rte_Inst_<cts>`, where `<cts>` is the [component type symbol](#) of the [AtomicSwComponentType](#).]([SRS_Rte_00011](#))

The data type of the instance handle is defined in Section [5.5.2](#).

Example 5.23

```

1  // -----
2  // Application header file
3  // -----
4
5  // ComponentDataStructure declaration
6  // [SWS_Rte_02310],[SWS_Rte_03733]
7  struct Rte_CDS_c
8  {
9      Rte_DE_uint8* rel_p_a;
10     Rte_DES_uint8* re2_p_a;
11     ...
12 };
13
14 // [SWS_Rte_02311]
15 typedef struct Rte_CDS_c Rte_CDS_c;
16
17 // Instance handle type
18 // [SWS_Rte_01007], [SWS_Rte_01148],[SWS_Rte_01150],[SWS_Rte_06810]
```

```

19 typedef CONSTP2CONST(Rte_CDS_c, AUTOMATIC, RTE_CONST) Rte_Instance;
20
21 // Instance handle declaration for swc without multiple instantiation
22 // [SWS_Rte_03793]
23 #define RTE_START_SEC_CONST_UNSPECIFIED
24 #include "Rte_MemMap.h"
25 extern CONSTP2CONST(Rte_CDS_c, RTE_CONST, RTE_CONST) Rte_Inst_c;
26 #define RTE_STOP_SEC_CONST_UNSPECIFIED
27 #include "Rte_MemMap.h"
28
29 //Api
30 #define Rte_IWrite_rel_p_a(v) ((Rte_Inst_c)->rel_p_a->value = (v))
31 #define Rte_IRead_re2_p_a() ((Rte_Inst_c)->re2_p_a->value)
32 #define Rte_IStatus_re2_p_a() ((Rte_Inst_c)->re2_p_a->status)
33
34 // -----
35 // Rte.c file
36 // -----
37
38 // ComponentDataStructure definition
39 // [SWS_Rte_03711],[SWS_Rte_03712],[SWS_Rte_03715]
40 const Rte_CDS_c Rte_Instance_c1 =
41 {
42     ...
43 };
44
45 // Instance handle definition for swc without multiple instantiation
46 // [SWS_Rte_03793]
47 #define RTE_START_SEC_CONST_UNSPECIFIED
48 #include "Rte_MemMap.h"
49 CONSTP2CONST(Rte_CDS_c, RTE_CONST, RTE_CONST) Rte_Inst_c = &
    Rte_Instance_c1;
50 #define RTE_STOP_SEC_CONST_UNSPECIFIED
51 #include "Rte_MemMap.h"

```

5.4.2 Component Data Structure

Different component instances share many common features - not least of which is support for shared code. However, each instance is required to invoke different RTE API functions and therefore the instance handle is used to access the component data structure that defines all instance specific data.

It is necessary to define the component data structure to ensure compatibility between the two RTE phases when operating in compatibility mode – for example, a “clever” compiler and linker may encode type information into a pointer type to ensure type-safety. In addition, the structure definition cannot be empty since this is an error in ANSI C.

[SWS_Rte_02310] [The *Application Header* File shall include a structure declaration for the component data structure as follows:

```
1 struct Rte_[Byps_]CDS_<cts> { <component data sections> };
```

where <cts> is the [component type symbol](#) of the [AtomicSwComponentType](#). [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software componenttype (See chapter 4.9.2).] ([SRS_BSW_00305](#), [SRS_Rte_00011](#), [SRS_Rte_00167](#))

[SWS_Rte_02311] [The *Application Header File* shall include a type declaration for the component data structure type as follows:

```
1 typedef struct Rte_[Byps_]CDS_<cts> Rte_[Byps_]CDS_<cts>;
```

where <cts> is the [component type symbol](#) of the [AtomicSwComponentType](#). [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software componenttype (See chapter 4.9.2).] ([SRS_BSW_00305](#), [SRS_Rte_00011](#), [SRS_Rte_00167](#))

The members of the component data structure include function pointers. It is important that such members are not subject to run-time modification and therefore the component data structure is required to be placed in read-only memory.

[SWS_Rte_03715] [All instances of the component data structure shall be defined as “const” (i.e. placed in read-only memory).] ([SRS_BSW_00007](#))

The elements of the component data structure are sorted into sections, each of which defines a logically related section. The sections defined within the component data structure are:

- **[SWS_Rte_03718]** [Data Handles section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#))
- **[SWS_Rte_03719]** [Per-instance Memory Handles section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#))
- **[SWS_Rte_01349]** [Inter-runnable Variable Handles section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#))
- **[SWS_Rte_03720]** [Calibration Parameter Handles section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#))
- **[SWS_Rte_03721]** [Exclusive-area API section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#))
- **[SWS_Rte_03716]** [Port API section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#))
- **[SWS_Rte_03717]** [Inter Runnable Variable API section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#))
- **[SWS_Rte_07225]** [Inter Runnable Triggering API section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#))
- **[SWS_Rte_07837]** [Instance Id section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#), [SRS_Rte_00244](#))

- **[SWS_Rte_08091]** [RAM Block Data Updated Handles section.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#), [SRS_Rte_00245](#))
- **[SWS_Rte_03722]** [Vendor specific section.] ([SRS_Rte_00011](#))

The order of elements within each section of the component data structure is defined as follows;

[SWS_Rte_03723] [Section entries shall be sorted alphabetically (ASCII / ISO 8859-1 code in ascending order) unless stated otherwise.] ([SRS_Rte_00051](#))

The sorting of entries is applied to each section in turn.

Note that there is *no* prefix associated with the name of each entry within a section; the component data structure as a whole has the prefix and therefore there is no need for each member to have the same prefix.

ANSI C does not permit empty structure definitions yet an instance handle is required for the RTE to function. Therefore if there are no API calls then a single dummy entry is defined for the RTE.

[SWS_Rte_03724] [If all sections of the Component Data Structure are empty the Component Data Structure shall contain a `uint8` with name `Rte_Dummy`.] ([SRS_Rte_00126](#))

[SWS_Rte_08900] [All data handles (i.e. the Data Handles themselves, the Per-instance Memory Handles, Inter Runnable Variable Handles and RAM Block Data Updated Handles) of the component data structure shall be defined as `P2VAR`.] ([SRS_BSW_00007](#))

Rationale: Many data handles are used for write access and have to be `P2VAR` anyway. But also data handles used for read accesses might contain a status in which case they have to be `P2VAR` as well. The logic to determine when to use `P2CONST` and when not is complex while the risk of a misuse (i.e. write access to a read handle) is low as it were the RTE to misuse its own data structure, which is unlikely to happen.

5.4.2.1 Data Handles Section

The data handles section is required to support the [Rte_IRead](#) and [Rte_IWrite](#) calls (see Section [5.2.4](#)).

[SWS_Rte_03733] [Data Handles shall be named `<re>_<p>_<o>` where `<re>` is the runnable entity name that reads (or writes) the data item, `<p>` the port name, `<o>` the data element.] ([SRS_BSW_00305](#), [SRS_Rte_00051](#))

A [RunnableEntity](#) can read and write to the same port/data element in case of a [PRPortPrototypes](#) where as [PPortPrototypes](#) and [RPortPrototypes](#) are inherently uni-directional (a provide port can only be written, a require port can only be

read). Please note that for read and write access of a runnable to data in a `PRPortPrototype` only one data handle exist.

[SWS_Rte_06827] [The Data Handle shall be a pointer to a `data element with extended status` if and only if the runnable has write access via a `PRPortPrototype` and acknowledgement is enabled for this data element.]([SRS_Rte_00051](#), [SRS_Rte_00185](#))

[SWS_Rte_02608] [The Data Handle shall be a pointer to a `data element with status` if and only if either

- the runnable has read access (via a `RPortPrototype` or `PRPortPrototype`) and either
 - `data element outdated` notification or
 - `data element invalidation` or
 - `data element never received status` or
 - `data element range check` or
 - `handleDataStatus`

is activated for this `data element`, or

- the runnable has write access via a `PPortPrototype` and acknowledgement is enabled for this `data element`.

]([SRS_Rte_00051](#), [SRS_Rte_00185](#))

[SWS_Rte_02588] [Otherwise, the data type for a Data Handle shall be a pointer to a `data element without status`.]([SRS_Rte_00051](#))

See below for the definitions of these terms.

[SWS_Rte_06529] [The RTE Generator shall wrap each entry of *Data Handles Section* in the component data structure of a variant existent `Rte_IRead` or `Rte_IWrite` API if the variability shall be implemented.

```

1  #if (<condition>)
2
3  <Data Handles Section Entry>
4
5  #endif

```

where `condition` is the condition value macro of the `VariationPoint` relevant for the variant existence of the `Rte_IRead` or `Rte_IWrite` API (see [\[SWS_Rte_06515\]](#)), `Data Handles Section Entry` is the code according an invariant *Data Handles Section Entry* (see also [\[SWS_Rte_03733\]](#), [\[SWS_Rte_02608\]](#), [\[SWS_Rte_02588\]](#))]([SRS_Rte_00201](#))

[SWS_Rte_08777] [In compatibility mode, if the software component does not support multiple instantiation the data handles section shall be empty.]([SRS_Rte_00051](#))

5.4.2.1.1 Data Element without Status

[SWS_Rte_01363] [The data type for a “data element without status” shall be named `Rte_DE_<dt>` where `<dt>` is the data element’s [ImplementationDataType](#) name.]([SRS_Rte_00051](#))

[SWS_Rte_01364] [A [data element without status](#) shall be a structure containing a single member named `value`.]([SRS_Rte_00051](#))

[SWS_Rte_02607] [The `value` member of a [data element without status](#) shall have the same data type as the corresponding data element.]([SRS_Rte_00051](#), [SRS_Rte_00147](#), [SRS_Rte_00078](#))

Note that requirements [\[SWS_Rte_01364\]](#) and [\[SWS_Rte_02607\]](#) together imply that creating a variable of data type `Rte_DE_<dt>` allocates enough memory to store the data copy.

5.4.2.1.2 Data Element with Status

[SWS_Rte_01365] [The data type for a “data element with status” shall be named `Rte_DES_<dt>` where `<dt>` is the data element’s [ImplementationDataType](#) name.]([SRS_Rte_00051](#))

[SWS_Rte_01366] [A [data element with status](#) shall be a structure containing exactly two members.]([SRS_Rte_00051](#))

[SWS_Rte_03734] [The first member of each [data element with status](#) shall be named ‘`value`’]([SRS_Rte_00051](#))

[SWS_Rte_02666] [The `value` member of a [data element with status](#) shall have the type of the corresponding data element.]([SRS_Rte_00051](#), [SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00185](#))

[SWS_Rte_02589] [The second member of each [data element with status](#) shall be named ‘`status`’].([SRS_Rte_00051](#), [SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00185](#))

[SWS_Rte_02590] [The `status` member of a [data element with status](#) shall be of the `Std_ReturnType` type.]([SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00185](#))

[SWS_Rte_02609] [In case of read access, the `status` member of a [data element with status](#) shall contain the error status corresponding to the `value` member.]([SRS_Rte_00147](#), [SRS_Rte_00078](#))

[SWS_Rte_03836] [In case of write access, the `status` member of a [data element with status](#) shall contain the transmission status corresponding to the `value` member.]([SRS_Rte_00185](#))

5.4.2.1.3 Data Element with Extended Status

[SWS_Rte_06817] [The data type for a `data element with extended status` (applies only for `PRPortPrototypes`) shall be named `Rte_DEX_<dt>` where `<dt>` is the data element's `ImplementationDataType` name.]([SRS_Rte_00051](#))

[SWS_Rte_06818] [A `data element with extended status` shall be a structure containing exactly three members.]([SRS_Rte_00051](#))

[SWS_Rte_06819] [The first member of each `data element with extended status` shall be named 'value'.]([SRS_Rte_00051](#))

[SWS_Rte_06820] [The value member of a `data element with extended status` shall have the type of the corresponding data element.]([SRS_Rte_00051](#), [SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00185](#))

[SWS_Rte_06821] [The second member of each `data element with extended status` shall be named 'status'.]([SRS_Rte_00051](#), [SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00185](#))

[SWS_Rte_06822] [The status member of a `data element with extended status` shall be of the `Std_ReturnType` type.]([SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00185](#))

[SWS_Rte_06823] [The third member of each `data element with extended status` shall be named 'feedback'.]([SRS_Rte_00051](#), [SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00185](#))

[SWS_Rte_06824] [The feedback member of a `data element with extended status` shall be of the `Std_ReturnType` type.]([SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00185](#))

[SWS_Rte_06825] [In case of read access, the status member of a `data element with extended status` shall contain the error status corresponding to the value member.]([SRS_Rte_00147](#), [SRS_Rte_00078](#))

[SWS_Rte_06826] [In case of write access, the feedback member of a `data element with extended status` shall contain the transmission status corresponding to the value member.]([SRS_Rte_00185](#))

5.4.2.1.4 Usage

A definition for every required `data element with status`, every `data element without status`, and every `data element with extended status` is emitted in the *RTE Data Handle Types Header File* (see Section [5.3.5](#)).

Example 5.24

Consider a `uint8` data element, `a`, of port `p` which is accessed using a `VariableAccess` in the `dataWriteAccess` role by runnables `re1` and `re2` and a `VariableAccess` in the `dataReadAccess` role by runnable `re2` within component `c`. `data element outdated` is defined for this `dataElement`.

The required data types within the *RTE Data Handle Types Header File* would be:

```
1 typedef struct {
2     uint8 value;
3 } Rte_DE_uint8;
4
5 typedef struct {
6     uint8 value;
7     Std_ReturnType status;
8 } Rte_DES_uint8;
```

Considering additionally a `uint16` data element `d`, of a port being a `PRPortPrototype` `pr` which is accessed using a `VariableAccess` in the `dataWriteAccess` role and a `dataReadAccess` role by runnable `re3` within component `c`. `data element outdated` is defined for this `dataElement` and additionally acknowledgement (`transmissionAcknowledge`) is requested.

The required data type within the *RTE Data Handle Types Header File* would be:

```
1 typedef struct {
2     uint16 value;
3     Std_ReturnType status;
4     Std_ReturnType feedback;
5 } Rte_DEX_uint16;
```

The component data structure for `c` would also include:

```
1 Rte_DE_uint8* re1_p_a;
2 Rte_DES_uint8* re2_p_a;
3 Rte_DEX_uint16* re3_pr_d;
```

A software-component that is supplied as object-code or is multiple instantiated requires “general purpose” definitions of `Rte_IRead`, `Rte_IWrite`, `Rte_IStatus` and `Rte_IFeedback` that use the data handles to access the data copies created within the generated RTE. For example:

```
1 #define Rte_IWrite_re1_p_a(instance,v) ((instance)->re1_p_a->value = (v))
2 #define Rte_IWrite_re2_p_a(instance,v) ((instance)->re2_p_a->value = (v))
3 #define Rte_IRead_re2_p_a(instance,v) ((instance)->re2_p_a->value)
4 #define Rte_IStatus_re2_p_a(instance) ((instance)->re2_p_a->status)
5 #define Rte_IWrite_re3_pr_d(instance,v) ((instance)->re3_pr_d->value = (v))
6 #define Rte_IRead_re3_pr_d(instance) ((instance)->re3_pr_d->value)
7 #define Rte_IStatus_re3_pr_d(instance) ((instance)->re3_pr_d->status)
8 #define Rte_IFeedback_re3_pr_d(instance) ((instance)->re3_pr_d->feedback)
```

The definitions of `Rte_IRead`, `Rte_IWrite`, `Rte_IStatus`, and `Rte_IFeedback` are type-safe since an attempt to assign an incorrect type will be detected by the compiler.

For source code component that does **not** use multiple instantiation the definitions of `Rte_IRead`, `Rte_IWrite`, `Rte_IStatus`, and `Rte_IFeedback` can remain as above or vendor specific optimizations can be applied without loss of portability.

The values assigned to data handles within *instances* of the component data structure created within the generated RTE depend on the mapping of tasks and runnables – See Section 5.2.4.

5.4.2.2 Per-instance Memory Handles Section

The Per-instance Memory Section Handles section enables to access instance specific memory (sections).

[SWS_Rte_02301] [The CDS shall contain a handle for each Per-instance Memory. This handle member shall be named `Pim_<name>` where `<name>` is the per-instance memory name.]([SRS_BSW_00305](#), [SRS_Rte_00051](#), [SRS_Rte_00013](#))

The Per-instance Memory Handles are typed; **[SWS_Rte_02302]** [The data type of each Per-instance Memory Handle shall be a pointer to the type of the per instance memory that is defined in the *Application Header* file.]([SRS_Rte_00051](#), [SRS_Rte_00013](#))

The RTE supports the access to the per-instance memories by the `Rte_Pim` API.

[SWS_Rte_06527] [The RTE Generator shall wrap each entry of *Per-instance Memory Handles Section* in the component data structure of a variant existent `PerInstanceMemory` or `arTypedPerInstanceMemory` if the variability shall be implemented.

```

1  #if (<condition>)
2
3  <Per-instance Memory Handles Section Entry>
4
5  #endif

```

where `condition` is the condition value macro of the `VariationPoint` relevant for the variant existence of the `Rte_Pim` API (see [\[SWS_Rte_06518\]](#)), `Per-instance Memory Handles Section Entry` is the code according an invariant *Per-instance Memory Handles Section Entry* (see also [\[SWS_Rte_02301\]](#), [\[SWS_Rte_02302\]](#))] ([SRS_Rte_00201](#))

Example 5.25

Referring to the specification items [\[SWS_Rte_02301\]](#), [\[SWS_Rte_02302\]](#), and [\[SWS_Rte_07133\]](#) Example 5.4 can be extended –

with respect to the software-component header:

```

1  struct Rte_CDS_c {
2      ...
3      /* per-instance memory handle section */
4      Rte_PimType_c_MyMemType *Pim_mem;
5
6      ...
7  };
8
9  typedef struct Rte_CDS_c Rte_CDS_c;
10
11 #define Rte_Pim_mem(instance) ((instance)->Pim_mem)

```

and in Rte.c:

```

1  Rte_PimType_c_MyMemType mem1;
2
3  const Rte_CDS_c Rte_Instance_c1 = {
4      ...
5      /* per-instance memory handle section */
6      /* Rte_PimType_c_MyMemType Pim_mem */
7      &mem1
8      ...
9  };

```

[SWS_Rte_08778] [If the software component does not support multiple instantiation nor requires compatibility mode, the per-instance memory handles section shall be empty.]([SRS_Rte_00051](#))

5.4.2.3 Inter Runnable Variable Handles Section

Each runnable may require separate handling for the inter runnable variables that it accesses. The indirection required for explicit access to inter runnable variables is described in section 5.4.2.7. The inter runnable variable handles section within the component data structure contains pointers to the (shadow) memory of inter runnable variables that can be directly accessed with the implicit API macros. The [inter runnable variable handles section](#) does not contain pointers for memory to handle inter runnable variables that are accessed with explicit API only.

[SWS_Rte_02636] [For each runnable and each inter runnable variable that is accessed implicitly by the runnable, there shall be exactly one inter runnable handle member within the component data structure and this inter runnable variable handle shall point to the (shadow) memory of the inter runnable variable for the runnable.]([SRS_Rte_00142](#))

[SWS_Rte_01350] [The name of each inter runnable variable handle member within the component data structure shall be `Irv_<re>_<o>` where `<o>` is the Inter-Runnable Variable short name and `<re>` is short name of the runnable name.]([SRS_Rte_00142](#))

[SWS_Rte_01351] [The data type of each inter runnable variable handle member shall be a pointer to the type of the inter runnable variable.] ([SRS_Rte_00142](#))

[SWS_Rte_06528] [The RTE Generator shall wrap each entry of *Inter Runnable Variable Handles Section* in the component data structure of a variant existent [Rte_IrvRead](#) or [Rte_IrvWrite](#) if the variability shall be implemented.

```

1  #if (<condition> [|| <condition>])
2
3  <Inter Runnable Variable Handles Section Entry>
4
5  #endif

```

where `condition` are the condition value macro(s) of the [VariationPoint](#) relevant for the variant existence of the [Rte_IrvRead](#) or [Rte_IrvWrite](#) API accessing the same *Inter Runnable Variable* (see [\[SWS_Rte_06519\]](#)), *Inter Runnable Variable Handles Section Entry* is the code according an invariant *Inter Runnable Variable Handles Section Entry* (see also [\[SWS_Rte_02636\]](#), [\[SWS_Rte_01350\]](#), [\[SWS_Rte_01351\]](#)) ([SRS_Rte_00201](#))

[SWS_Rte_08779] [If the software component does not support multiple instantiation nor requires compatibility mode, the inter runnable variable handles section shall be empty.] ([SRS_Rte_00051](#))

5.4.2.4 Exclusive-area API Section

The exclusive-area API section includes exclusive areas that are accessed explicitly, using the RTE API, by the SW-C. Each entry in the section is a function pointer to the relevant RTE API function generated for the SW-C instance.

[SWS_Rte_03739] [If the according [SwcExclusiveAreaPolicy.apiPrinciple](#) of the [ExclusiveArea](#) is set to "common", the name of each Exclusive-area API section entry shall be `<root>_<name>` where `<root>` is either `Entry` or `Exit` and `<name>` is the `shortName` of the [ExclusiveArea](#).] ([SRS_Rte_00051](#), [SRS_Rte_00032](#))

[SWS_Rte_04545] [If the according [SwcExclusiveAreaPolicy.apiPrinciple](#) of the [ExclusiveArea](#) is set to "perExecutable", the name of each Exclusive-area API section entry shall be `<root>_<re>_<name>` where `<root>` is either `Entry` or `Exit`, `<re>` is the `shortName` of the [RunnableEntity](#) with the `canEnterExclusiveArea` association, and `<name>` is the `shortName` of the [ExclusiveArea](#).] ([SRS_Rte_00051](#), [SRS_Rte_00032](#))

[SWS_Rte_03740] [The data type of each Exclusive-area API section entry shall be a function pointer that points to the generated RTE API function.] ([SRS_Rte_00051](#), [SRS_Rte_00032](#))

[SWS_Rte_06521] [The RTE Generator shall wrap each definition of a variant existent [Rte_Enter](#) and [Rte_Exit](#) in the Exclusive-area API section according table 4.23 if the variability shall be implemented.

```

1  #if (<condition>)
2
3  <Exclusive-area API section entry>
4
5  #endif

```

where `condition` is the condition value macro of the `VariationPoint` relevant for the variant existence of the `Rte_Enter` and `Rte_Exit` API (see [SWS_Rte_06518]), `Exclusive-area API section entry` is the code according an invariant `Exclusive-area` section entry (see also [SWS_Rte_03739], [SWS_Rte_03740]) (SRS_Rte_00201)

[SWS_Rte_03812] [Entries in the `Exclusive-area API` section shall be sorted alphabetically (ASCII / ISO 8859-1 code in ascending order).] (SRS_Rte_00051, SRS_Rte_00032)

Note that two function pointers will be required for each accessed exclusive area; one for the Entry function and one for the Exit function.

[SWS_Rte_08780] [If the software component does not support multiple instantiation nor requires compatibility mode, the exclusive-area API section shall be empty.] (SRS_Rte_00051)

5.4.2.5 Port API Section

Port API section comprises zero or more *function references* within the component data structure type that defines all API functions that access a port and can be invoked by the software-component (instance).

[SWS_Rte_02616] [The function table entries for port access shall be grouped by the port names into port data structures.] (SRS_Rte_00051)

Each entry in the port API section of the component data structure is a “port data structure”.

[SWS_Rte_02617] [The name of each *port data structure* in the component data structure shall be `<p>` where `<p>` is the port short-name.] (SRS_Rte_00051)

[SWS_Rte_03799] [The component data structure shall contain a port data structure for port `p` only if at least one API from table 5.2 is present and either the component supports multiple instantiation, or the component requires compatibility mode, or if the `indirectAPI` attribute for `p` is set to ‘true’.] (SRS_Rte_00051)

[SWS_Rte_06522] [The RTE Generator shall wrap each *port data structure* of a variant existent `PortPrototype` if the variability shall be implemented.

```

1  #if (<condition>)
2
3  <port data structure>
4
5  #endif

```

where `condition` is the condition value macro of the `VariationPoint` relevant for the variant existence of the `PortPrototype` (see [SWS_Rte_06520], `port data structure` is the code according an invariant *port data structures* (see also [SWS_Rte_02617], [SWS_Rte_03799])) (SRS_Rte_00201)

[SWS_Rte_03731] [The data type name for a port data structure shall be `struct Rte_PDS_<cts>_<i>_<P/R/PR>`

where `<cts>` is the `component type symbol` of the `AtomicSwComponentType`, `<i>` is the port interface name and

'P', 'R' or 'PR' are literals to indicate provide, require or provide-require ports respectively.] (SRS_BSW_00305, SRS_Rte_00051)

[SWS_Rte_CONSTR_09080] The *shortNames* of *PortInterfaces* shall be unique within a software component if it supports multiple instantiation or `indirectAPI` attribute is set to 'true' [The *shortNames* of *PortInterfaces* shall be unique within a software component for each set of `PPortPrototypes` or `RPortPrototypes` if the software component supports multiple instantiation or if the `indirectAPI` attribute is set to 'true' for at least one require or provide port.

This is required to generate distinguishable Port Data Structure data types.]()

[SWS_Rte_08312] [The RTE generator shall reject a configuration violating the [SWS_Rte_CONSTR_09080].] (SRS_Rte_00051)

[SWS_Rte_07137] [The port data structure type(s) shall be defined in the *Application Header* file.] (SRS_Rte_00051)

A port data structure type is defined for each port interface that types a port. Thus different ports typed by the same port interface structure share the same port data structure type.

[SWS_Rte_07138] [The *Application Header* file shall contain a definition of a port data structure type for interface `i` and port type `R`, `P`, `PR` only if the component supports multiple instantiation or at least one require, provide or provide-require port exists that has the `indirectAPI` attribute set to 'true'.] (SRS_Rte_00051)

[SWS_Rte_06523] [The RTE Generator shall wrap each *port data structure type* related to variant existent `PortPrototypes` if the variability shall be implemented and if all require `PortPrototypes` or all provide `PortPrototypes` are variant.

```

1  #if (<condition> [|| <condition>])
2
3  <port data structure type>
4
5  #endif

```

where `condition` are the condition value macro(s) of the `VariationPoints` relevant for the variant existence of the `PortPrototypes` requiring the *port data structure type* (see [SWS_Rte_06520]), `port data structure type` is the code according

an invariant *port data structure type* (see also [SWS_Rte_03731], [SWS_Rte_07138], [SWS_Rte_03730] [SWS_Rte_02620])) (SRS_Rte_00201)

Note: If any invariant `PortPrototype` requires the *port data structure type* it shall be defined unconditional.

[SWS_Rte_07677] [The RTE shall support an indirect API for the port access functions listed in table 5.2.] (SRS_Rte_00051)

[SWS_Rte_03730] [A port data structure shall contain a function table entry for each API function associated with the port as referenced in table 5.2. Pure API macros, like `Rte_IRead` and other implicit API functions, do not have a function table entry.] (SRS_Rte_00051)

API function	reference
<code>Rte_Send_<p>_<o></code>	5.6.5
<code>Rte_Write_<p>_<o></code>	5.6.5
<code>Rte_Switch_<p>_<o></code>	5.6.6
<code>Rte_Invalidate_<p>_<o></code>	5.6.7
<code>Rte_Feedback_<p>_<o></code>	5.6.8
<code>Rte_SwitchAck_<p>_<o></code>	5.6.9
<code>Rte_Read_<p>_<o></code>	5.6.10
<code>Rte_DRead_<p>_<o></code>	5.6.10
<code>Rte_Receive_<p>_<o></code>	5.6.12
<code>Rte_Call_<p>_<o></code>	5.6.13
<code>Rte_Result_<p>_<o></code>	5.6.14
<code>Rte_Prm_<p>_<o></code>	5.6.17
<code>Rte_Mode_<p>_<o></code>	5.6.32
<code>Rte_Trigger_<p>_<o></code>	5.6.34
<code>Rte_IsUpdated_<p>_<o></code>	5.6.37

Table 5.2: Table of API functions that are referenced in the port API section.

[SWS_Rte_02620] [An API function shall only be included in a port data structure, if it is required at least by one port.] (SRS_Rte_00051)

[SWS_Rte_02621] [If a function table entry is available in a port data structure, the corresponding function shall be implemented for all ports that use this port data structure type. API functions related to ports that are not required by the AUTOSAR configuration shall behave like those for an unconnected port.] (SRS_Rte_00051)

APIs may be required only for some ports of a software component instance due to differences in for example the need for transmission acknowledgement. [SWS_Rte_02621] is necessary for the concept of the indirect API. It allows iteration over ports.

[SWS_Rte_01055] [The name of each function table entry in a port data structure shall be `<name>_<o>` where `<name>` is the API root (e.g. Call, Write) and `<o>` the data element or operation name.] (SRS_BSW_00305, SRS_Rte_00051)

Requirement [SWS_Rte_01055] does *not* include the port name in the function table entry name since the port is implicit when using a port handle.

[SWS_Rte_03726] [The data type of each function table entry in a port data structure shall be a function pointer that points to the generated RTE function.] ([SRS_Rte_00051](#))

The signature of a generated function, and hence the definition of the function pointer type, is the same as the signature of the relevant RTE API call (see Section 5.6) with the exception that the instance handle is omitted.

Example 5.26

This example shows a port data structure for the provide ports of the interface type `i2` in an AUTOSAR SW-C `c`.

`i2` is a [SenderReceiverInterface](#) which contains a data element prototype of type `uint8` with [data semantics](#).

If one of the provide ports of `c` for the interface `i2` has a transmission acknowledgement defined and `i2` is not used with [data element invalidation](#), the *Application Header* file would include a port data structure type like this:

```
1 struct Rte_PDS_c_i2_P {
2     Std_ReturnType (*Feedback_a)(uint8);
3     Std_ReturnType (*Write_a)(uint8);
4 }
```

If the provide port `p1` of the AUTOSAR SW-C `c` is of interface `i2`, the generated *Application Header* file would include the following macros to provide the direct API functions [Rte_Feedback_p1_a](#) and [Rte_Write_p1_a](#):

```
1 /*direct API*/
2 #define Rte_Feedback_p1_a(inst,data)
3     ((inst)->p1.Feedback_a)(data)
4 #define Rte_Write_p1_a(inst,data) ((inst)->p1.Write_a)(data)
```

[SWS_Rte_02618] [The port data structures within a component data structure shall first be sorted on the port data structure type name and then on the short name of the port.] ([SRS_Rte_00051](#))

The requirements [SWS_Rte_03731] and [SWS_Rte_02618] guarantee, that all port data structures within the component data structure are grouped by their interface type and require/provide-direction.

Example 5.27

This example shows the grouping of port data structures within the component data structure.

The *Application Header* file for an AUTOSAR SW-C `c` with three provide ports `p1`, `p2`, and `p3` of interface `i2` would include a block of port data structures like this:

```

1  struct Rte_CDS_c {
2      ...
3      struct Rte_PDS_c_i1_R z;
4
5      /* port data structures          */
6      * for provide ports of interface i2 */
7      struct Rte_PDS_c_i2_P p1;
8      struct Rte_PDS_c_i2_P p2;
9      struct Rte_PDS_c_i2_P p3;
10
11     /* further port data structures */
12     struct Rte_PDS_c_i2_R c;
13     ...
14 }
15
16 typedef struct Rte_CDS_c Rte_CDS_c;

```

If `inst` is a pointer to a component data structure, and `ph` is defined by

```
1  struct Rte_PDS_c_i2_P *ph = &(inst->p1);
```

`ph` points to the port data structure `p1` of the instance handle `inst`. Since the three provide port data structures `p1`, `p2`, and `p3` of interface `i2` are ordered sequentially in the component data structure, `ph` can also be interpreted as an array of port data structures. E.g., `ph[2]` is equal to `inst->p3`.

In the following, `ph` will be called a port handle.

[SWS_Rte_01343] [RTE shall create *port handle types* for each port data structure using `typedef` to a pointer to the appropriate port data structure.] ([SRS_Rte_00051](#))

[SWS_Rte_01342] [The *port handle type* name shall be `Rte_PortHandle_<i>_<P/R/PR>` where `<i>` is the port interface name and 'P', 'R' or 'PR' are literals to indicate provide, require or provide-require ports respectively.] ([SRS_Rte_00051](#))

[SWS_Rte_06524] [The RTE Generator shall wrap each *port handle type* related to variant existent [PortPrototypes](#) if the variability shall be implemented and if all require [PortPrototypes](#) or all provide [PortPrototypes](#) are variant.

```

1  #if (<condition> [|| <condition>])
2
3  <port handle type>
4
5  #endif

```

where `condition` are the condition value macro(s) of the [VariationPoints](#) relevant for the variant existence of the [PortPrototypes](#) requiring the *port data structure type* (see [\[SWS_Rte_06520\]](#)), port data structure type is the code according an invariant *port data structure type* (see also [\[SWS_Rte_01343\]](#), [\[SWS_Rte_01342\]](#)) ([SRS_Rte_00201](#))

[SWS_Rte_01053] [The port handle types shall be written to the application header file.] ([SRS_Rte_00051](#))

RTE provides port handles for access to the arrays of port data structures of the same interface type and provide/receive direction by the macro `Rte_Ports`, see section 5.6.1, and to the number of similar ports by the macro `Rte_NPorts`, see 5.6.1.

Example 5.28

For the provide port `i2` of AUTOSAR SW-C `c` from example 5.26, the following port handle type will be defined in the *Application Header* file:

```
1 typedef struct Rte_PDS_c_i2_P *Rte_PortHandle_i2_P;
```

The macros to access the port handles for the indirect API might look like this in the generated *Application Header* file:

```
1 /*indirect (port oriented) API*/
2 #define Rte_Ports_i2_P(inst) &((inst)->p1)
3 #define Rte_NPorts_i2_P(inst) 3
```

So, the port handle `ph` of the previous example 5.27 could be defined by a user as:

```
1 Rte_PortHandle_i2_P ph = Rte_Ports_i2_P(inst);
```

To write '49' on all ports `p1` to `p3`, the indirect API can be used within the software component as follows:

```
1 uint8 p;
2 Rte_PortHandle_i2_P ph = Rte_Ports_i2_P(inst);
3 for(p=0;p<Rte_NPorts_i_P(inst);p++) {
4     ph[p].Write_a(49);
5 }
```

Software components may also want to set up their own port handle arrays to iterate over a smaller sub group than all ports with the same interface and direction.

`Rte_Port` can be used to pick the port handle for one specific port, see 5.6.3.

5.4.2.6 Calibration Parameter Handles Section

The RTE is required to support access to calibration parameters derived by *per-instance* `ParameterDataPrototypes` (see 4.2.9.3) using the `Rte_CData` (see section 5.6.16).

[SWS_Rte_03835] [The name of each Calibration parameter handle shall be `CData_<name>` where `<name>` is the `ParameterDataPrototype` name.] ([SRS_Rte_00051](#), [SRS_Rte_00154](#), [SRS_Rte_00155](#))

[SWS_Rte_03949] [The type of each calibration parameter handle shall be a function pointer that points to the generated RTE function.] ([SRS_Rte_00051](#), [SRS_Rte_00154](#), [SRS_Rte_00155](#))

Note that accesses to `ParameterDataPrototypes` within `ParameterSwComponentTypes` do not result in any handles within this section since the generated `Rte_Prm` (see section 5.6.17) API is accessed either directly (single instantiation) or through handles in the port API section (multiple instantiation). Likewise, access to `shared ParameterDataPrototypes` does not result in any handle in the Calibration Parameter Handles Section since, by definition, no per-instance data is present.

[SWS_Rte_08782] [If the software component does not support multiple instantiation nor requires compatibility mode, the calibration parameter handles section shall be empty.] ([SRS_Rte_00051](#))

5.4.2.7 Inter Runnable Variable API Section

The Inter Runnable Variable API section comprises zero or more *function table entries* within the component data structure type that defines all explicit API functions to access an inter runnable variable by the software-component (instance). The API for implicit access of inter runnable variables does not have any *function table entries*, since the implicit API uses macro's to access the inter runnable variables or their shadow memory directly, see section 5.4.2.3.

Since the entries of this section are only required to access the explicit InterRunnable-Variable API if a software component supports multiple instantiation, it shall be omitted for software components which do not support multiple instantiation.

[SWS_Rte_03725] [If the component supports multiple instantiation, the member name of each function table entry within the component data structure shall be `<name>_<re>_<o>` where `<name>` is the API root (e.g. `IrvRead`), `<re>` the runnable name, and `<o>` the inter runnable variable name.] ([SRS_Rte_00051](#))

[SWS_Rte_03752] [The data type of each function table entry shall be a function pointer that points to the generated RTE function.] ([SRS_Rte_00051](#))

The signature of a generated function, and hence the definition of the function pointer type, is the same as the signature of the relevant RTE API call (see Section 5.6) with the exception that the instance handle is omitted.

[SWS_Rte_02623] [If the component supports multiple instantiation or requires compatibility mode, the *Inter Runnable Variable API Section* shall contain pointers to API functions as listed in table 5.3.] ([SRS_Rte_00051](#))

API function	reference
Rte_IrvRead_<re>_<o>	5.6.28
Rte_IrvWrite_<re>_<o>	5.6.29

Table 5.3: Table of API functions that are referenced in the inter runnable variable API section

[SWS_Rte_06525] [The RTE Generator shall wrap each entry of *Inter Runnable Variable API Section* in the component data structure of a variant existent [Rte_IrvRead](#) or [Rte_IrvWrite](#) API if the variability shall be implemented.

```

1  #if (<condition>)
2
3  <Inter Runnable Variable API Section Entry>
4
5  #endif

```

where `condition` is the condition value macro of the [VariationPoint](#) relevant for the variant existence of the [Rte_IrvRead](#) or [Rte_IrvWrite](#) API (see [\[SWS_Rte_06519\]](#)), *Inter Runnable Variable API Section Entry* is the code according an invariant *Inter Runnable Variable API Section Entry* (see also [\[SWS_Rte_03725\]](#), [\[SWS_Rte_03752\]](#), [\[SWS_Rte_02623\]](#))] ([SRS_Rte_00201](#))

[SWS_Rte_08783] [If the software component does not support multiple instantiation nor requires compatibility mode, the inter runnable variable API section shall be empty.] ([SRS_Rte_00051](#))

5.4.2.8 Inter Runnable Triggering API Section

The Inter Runnable Triggering API Section includes the Inter Runnable Triggering API handles. Each entry in the section is a function pointer to the relevant RTE API function generated for the SW-C instance.

[SWS_Rte_07226] [The name of each *Inter Runnable Triggering handle* shall be `Rte_IrTrigger_<re>_<name>` where `<re>` is the name of the runnable entity the API might be used and `<name>` is the name of the [InternalTriggeringPoint](#).] ([SRS_Rte_00051](#), [SRS_Rte_00163](#))

[SWS_Rte_07227] [The data type of each *Inter Runnable Triggering handle* entry shall be a function pointer that points to the generated RTE API function defined in [5.6.35](#).] ([SRS_Rte_00051](#), [SRS_Rte_00163](#))

[SWS_Rte_06526] [The RTE Generator shall wrap each entry of *Inter Runnable Triggering handle* in the component data structure of a variant existent [Rte_IrTrigger](#) API if the variability shall be implemented.

```

1  #if (<condition>)
2
3  <Inter Runnable Variable API Section Entry>
4
5  #endif

```

where `condition` is the condition value macro of the [VariationPoint](#) relevant for the variant existence of the [Rte_IrTrigger](#) API (see [\[SWS_Rte_06519\]](#), *Inter Runnable Variable API Section Entry* is the code according an invariant *Inter Runnable Variable API Section Entry* (see also [\[SWS_Rte_03725\]](#), [\[SWS_Rte_03752\]](#), [\[SWS_Rte_02623\]](#))] ([SRS_Rte_00201](#))

[SWS_Rte_07228] [Entries in the Inter Runnable Triggering handles section shall be sorted alphabetically (ASCII / ISO 8859-1 code in ascending order).] ([SRS_Rte_00051](#), [SRS_Rte_00163](#))

[SWS_Rte_08784] [If the software component does not support multiple instantiation nor requires compatibility mode, the inter runnable triggering API section shall be empty.] ([SRS_Rte_00051](#))

5.4.2.9 Instance Id Section

[SWS_Rte_07838] [If a software component type supports multiple instantiation, the RTE generator shall add in the Component Data Structure Instance Id Section an element named Instance_Id of type uint8.] ([SRS_Rte_00011](#), [SRS_Rte_00051](#), [SRS_Rte_00244](#))

[SWS_Rte_07839] [For each prototype of a software component type that supports multiple instantiation, the RTE generator shall set the value of the element Instance_Id from 0 to N-1 according to the number (N) of software component prototypes and according to the names of the software component prototypes sorted alphabetically (ASCII / ISO 8859-1 code in ascending order).] ([SRS_Rte_00011](#), [SRS_Rte_00051](#), [SRS_Rte_00244](#))

Example: Two prototypes (instances) named A and B of a software component type exist:

- Instance_Id for instance A takes the value 0.
- Instance_Id for instance B takes the value 1.

Note: The Instance_Id should not be used by the runnable implementation. The Instance_Id has been created to support implementation of bypass on software component that supports multiple instantiation.

[SWS_Rte_08785] [If the software component does not support multiple instantiation, the instance id section shall be empty.] ([SRS_Rte_00051](#))

5.4.2.10 RAM Block Data Updated Handles Section

The RAM Block Data Updated Handles section is required to express an update of implicit written NV data in case the [NvBlockSwComponentType](#) is used (see section [4.2.10.2](#)). For that purpose each RAM Block Updated Handle accesses a separate "dirty flag".

[SWS_Rte_08092] [The CDS shall contain a handle for each [SwcServiceDependency](#) defining a [RoleBasedPortAssignment](#) in the role [NvDataPort](#). This handle member shall be named DF_<name> where <name> is the [SwcServiceDependency](#) name.] ([SRS_Rte_00051](#), [SRS_Rte_00245](#))

In addition to a "dirty flag" on port level the RTE also supports "dirty flags" on data element level.

[SWS_Rte_03879] [The CDS shall contain a handle for each [SwcServiceDependency](#) defining a [RoleBasedDataAssignment](#) in the role `NvDataElement`. This handle member shall be named `DF_<name>` where `<name>` is the [SwcServiceDependency](#) name.]([SRS_Rte_00051](#), [SRS_Rte_00245](#))

[SWS_Rte_08093] [The data type of each RAM Block Data Updated Handle shall be a pointer to `boolean`.]([SRS_Rte_00051](#), [SRS_Rte_00245](#))

The RTE supports the access to dirty flags for implicit communication by invoking the [Rte_IWrite](#) and [Rte_IWriteRef](#) APIs.

[SWS_Rte_08094] [The invocation of any [Rte_IWrite](#) or [Rte_IWriteRef](#) API of a data belonging to a [PPortPrototype](#) / [PRPortPrototype](#) referenced in the role `NvDataPort` by a [SwcServiceDependency](#) shall set the related dirty flag addressed by the RAM Block Updated Handle to `TRUE`.]([SRS_Rte_00051](#), [SRS_Rte_00245](#))

[SWS_Rte_03880] [The invocation of any [Rte_IWrite](#) or [Rte_IWriteRef](#) API of a data belonging to a [RoleBasedDataAssignment](#) referenced in the role `NvDataElement` by a [SwcServiceDependency](#) shall set the related dirty flag addressed by the RAM Block Updated Handle to `TRUE`.]([SRS_Rte_00051](#), [SRS_Rte_00245](#))

[SWS_Rte_07416] [For a [VariableDataPrototype](#) belonging to a [PPortPrototype](#) / [PRPortPrototype](#) referenced in the role `NvDataPort` by a [SwcServiceDependency](#) the RTE shall, after the NvM has been informed, set the related dirty flag addressed by the RAM Block Updated Handle to `FALSE`.]([SRS_Rte_00051](#), [SRS_Rte_00245](#))

[SWS_Rte_03881] [For a [VariableDataPrototype](#) belonging to a [RoleBasedDataAssignment](#) referenced in the role `NvDataElement` by a [SwcServiceDependency](#) the RTE shall, after the NvM has been informed, set the related dirty flag addressed by the RAM Block Updated Handle to `FALSE`.]([SRS_Rte_00051](#), [SRS_Rte_00245](#))

The NvM is informed of the status change through either the invocation of `NvM_SetRamBlockStatus` [[SWS_Rte_08081](#)] or directly through `NvM_WriteBlock` [[SWS_Rte_08085](#)]. The invocation of either is guarded by a check on the dirty flag.

[SWS_Rte_03882] [The RTE Generator shall wrap each entry of *RAM Block Data Updated Handles Section* related to variant existent [PPortPrototypes](#) / [PRPortPrototypes](#) referenced in the role `NvDataPort` by a [SwcServiceDependency](#) if the variability shall be implemented.

The RTE Generator shall wrap each entry of *RAM Block Data Updated Handles Section* related to variant existent [VariableDataPrototypes](#) referred by a [RoleBasedDataAssignment](#) referenced in the role `NvDataElement` by a [SwcServiceDependency](#) if the variability shall be implemented.

```
1 #if (<condition>)
```

```

2
3 <RAM Block Data Updated Handles Section Entry>
4
5 #endif

```

where `condition` are the condition value macros of the `VariationPoints` relevant for the variant existence of the `Rte_IWrite` and `Rte_IWriteRef` APIs (see [SWS_Rte_06518]); the single condition value macros are concatenated with logical `or` (`||`) operators to ensure the availability of the handle if any relevant API is existent, `RAM Block Data Updated Handles Section Entry` is the code according an invariant *RAM Block Data Updated Handles Section Entry* where `condition` are the condition value macros of the `VariationPoints` concatenated with logical `or` (`||`) operators (see also [SWS_Rte_08092], [SWS_Rte_08093]).] (*SRS_Rte_00201*)

[SWS_Rte_03872] [If the software component does not support multiple instantiation nor requires compatibility mode, the *RAM Block Data Updated Handles Section* shall be empty.] (*SRS_Rte_00051*)

5.4.2.11 Vendor Specific Section

The vendor specific section is used to contain any vendor specific data required to be supported for each instances. By definition the contents of this section are outside the scope of this chapter and only available for use by the RTE generator responsible for the “RTE Generation” phase.

[SWS_Rte_08786] [If the software component does not support multiple instantiation nor requires compatibility mode, the vendor specific section shall be empty.] (*SRS_Rte_00051*)

5.5 API Data Types

Besides the API functions for accessing RTE services, the API also contains RTE-specific data types.

5.5.1 Std_ReturnType

The specification in [31] specifies a standard API return type `Std_ReturnType`. The `Std_ReturnType` defines the “status” and “error values” returned by API functions. It is defined as a `uint8` type. The value “0” is reserved for “No error occurred”.

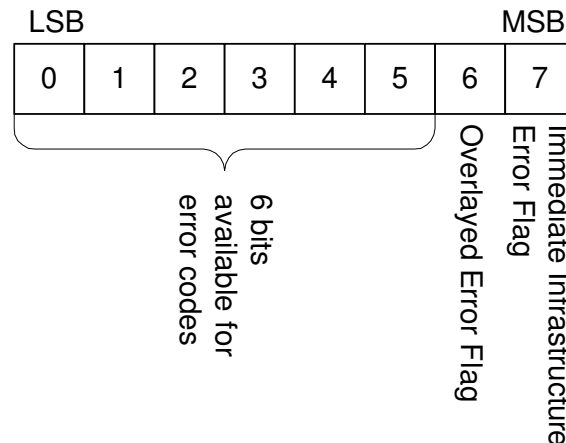


Figure 5.13: Bit-Layout of the Std_ReturnType

Figure 5.13 shows the general layout of Std_ReturnType.

The two most significant bits of the Std_ReturnType are reserved flags:

- The most significant bit 7 of Std_ReturnType is the “Immediate Infrastructure Error Flag” with the following values
 - “1” the error code indicates an immediate infrastructure error.
 - “0” the error code indicates no immediate infrastructure error.
- The second most significant bit 6 of Std_ReturnType is the Overlaid Error Flag. The use of this flag depends on the context and will be explained in table 5.5.

In order to avoid explicit access to bit numbers in the code, the RTE provides the three following macros that enables an application to check the return value of an API:

- **[SWS_Rte_07404]** [For infrastructure errors, this macro is a boolean expression that is true if the corresponding bit is set:

```
1  #define Rte_IsInfrastructureError(status) ((status & 128U) != 0)

|()

```

- **[SWS_Rte_07405]** [For overlaid errors, this macro is a boolean expression that is true if the corresponding bit is set:

```
1  #define Rte_HasOverlaidError(status) ((status & 64U) != 0)

|()

```

- **[SWS_Rte_07406]** [For reading only the application error code without the eventual overlaid error, the following macro returns the lower 6 bits of the error code:

```
1  #define Rte_ApplicationError(status) (status & 63U)

|()

```

5.5.1.1 Infrastructure Errors

Infrastructure errors are split into two groups:

- “Immediate Infrastructure Errors” can be associated with the currently available data set. These [Immediate Infrastructure Errors](#) are mutually exclusive. Only one of these errors can be notified to a SW-C with one API call.

[SWS_Rte_02593] [[Immediate Infrastructure Errors](#) shall override any application level error.]([SRS_Rte_00084](#), [SRS_Rte_00123](#))

[Immediate Infrastructure Error](#) codes are used on the receiver side for errors that result in no reception of application data and application errors.

An [Immediate Infrastructure Error](#) is indicated in the `Std_ReturnType` by the [Immediate Infrastructure Error Flag](#) being set.

- “Overlaid Errors” are associated with communication events that happened after the reception of the currently available data set, e.g., [data element outdated](#) notification, or loss of data elements due to queue overflow.

[SWS_Rte_01318] [[Overlaid Error Flags](#) shall be reported using the unique bit of the [Overlaid Error Flag](#) within the `Std_ReturnType` type.]([SRS_Rte_00084](#), [SRS_Rte_00094](#))

An [Overlaid Error](#) can be combined with any other application or infrastructure error code.

5.5.1.2 Application Errors

[SWS_Rte_02573] [RTE shall support application errors with the following format definition: Application errors are coded in the least significant 6 bits of `Std_ReturnType` with the [Immediate Infrastructure Error Flag](#) set to “0”. The application error code does not use the [Overlaid Error Flag](#).]([SRS_Rte_00124](#))

This results in the following value range for application errors:

range	minimum value	maximum value
application errors	1	63

Table 5.4: application error value range

In client server communication, the server may return any value within the application error range. The client will then receive one of the following:

- An [Immediate Infrastructure Error](#) to indicate that the communication was not successful, or

- The server return code, or
- The server return code might be overlayed by the [Overlayed Error Flag](#) in a future release of RTE. In this release, there is no overlayed error defined for client server communication.

The client can filter the return value, e.g., by using the following code:

```
Std_ReturnType status;
status = Rte_Call_<p>_<o>(<instance>, <parameters>);
if (Rte_HasOverlayedError(status)) {
    /* handle overlayed error flag */
    * in this release of the RTE, the flag is reserved *
    * but not used for client server communication */
}

if(Rte_IsInfrastructureError(status)) {
    /* handle infrastructure error */
}
else {
    /* handle application error with error code status */
    status = Rte_ApplicationError(status);
}
```

5.5.1.3 Predefined Error Codes

For client server communication, application error values are defined per client server interface and shall be passed to the RTE with the interface configuration.

The following standard error and status identifiers are defined:

Symbolic name	Value	Comments
RTE_E_OK	0	[SWS_Rte_01058]

Standard Application Error Values:		
RTE_E_INVALID	1	[SWS_Rte_02594]
To be defined by the corresponding AUTOSAR Service	1	Returned by AUTOSAR Services to indicate a generic application error.

Immediate Infrastructure Error codes		
RTE_E_COM_STOPPED	128	[SWS_Rte_01060]
RTE_E_TIMEOUT	129	[SWS_Rte_01064]
RTE_E_LIMIT	130	[SWS_Rte_01317]
RTE_E_NO_DATA	131	[SWS_Rte_01061]
RTE_E_TRANSMIT_ACK	132	[SWS_Rte_01065]
RTE_E_NEVER_RECEIVED	133	[SWS_Rte_07384]
RTE_E_UNCONNECTED	134	[SWS_Rte_07655]
RTE_E_IN_EXCLUSIVE_AREA	135	[SWS_Rte_02739]
RTE_E_SEG_FAULT	136	[SWS_Rte_02757]
RTE_E_OUT_OF_RANGE	137	[SWS_Rte_08065]

Symbolic name	Value	Comments
RTE_E_SERIALIZATION_ERROR, RTE_E_HARD_TRANSFORMER_ERROR	138	[SWS_Rte_08725]
RTE_E_SERIALIZATION_LIMIT, RTE_E_TRANSFORMER_LIMIT	139	[SWS_Rte_08726]
RTE_E_SOFT_TRANSFORMER_ERROR	140	[SWS_Rte_08551]
RTE_E_COM_BUSY	141	[SWS_Rte_01389]
RTE_E_RAM_UNCHANGED	142	[SWS_Rte_04582]

Overlaid Errors

These errors do not refer to the data returned with the API. They can be overlaid with other Application- or Immediate Infrastructure Errors.

RTE_E_LOST_DATA	64	[SWS_Rte_02571]
RTE_E_MAX_AGE_EXCEEDED	64	[SWS_Rte_02702]

Table 5.5: RTE Error and Status values

The underlying type for `Std_ReturnType` is defined as a `uint8` for reasons of compatibility – it avoids RTEs from different vendors assuming a different size if an `enum` was the underlying type. Consequently, `#define` is used to declare the error values:

```
1 typedef uint8 Std_ReturnType;
2
3 #define RTE_E_OK 0U
```

[SWS_Rte_01269] [The standard errors as defined in table 5.5 including `RTE_E_OK` shall be defined in the RTE Header File.] (*SRS_Rte_00051*)

[SWS_Rte_02575] [Application Error Identifiers with exception of `RTE_E_INVALID` shall be defined in the Application Header File.] (*SRS_Rte_00124*, *SRS_Rte_00167*)

[SWS_Rte_02576] [The application errors shall have a symbolic name defined as follows:

```
1 #define RTE_E_<interface>_<error> <error value>U
```

where `<interface>` `PortInterface` and `<error>` `ApplicationError` are the interface and error names from the configuration.⁵] (*SRS_Rte_00123*)

An `Std_ReturnType` value can be directly compared (for equality) with the above pre-defined error identifiers.

[SWS_Rte_07143] [The RTE generator shall generate symbolic name for application errors with equal `<interface>` name, `<error>` name and `<error value>` only once.] (*SRS_Rte_00165*)

⁵No additional capitalization is applied to the names.

5.5.1.3.1 No Error

5.5.1.3.1.1 RTE_E_OK

[SWS_Rte_01058] [
Symbolic name: RTE_E_OK
Value: 0
Comments: No error occurred.]([SRS_BSW_00327](#))

5.5.1.3.2 Standard Application Error Values

5.5.1.3.2.1 RTE_E_INVALID

[SWS_Rte_02594] [
Symbolic name: RTE_E_INVALID
Value: 1
Comments: Generic application error indicated by signal invalidation in sender receiver communication with [data semantics](#) on the receiver side.]([SRS_BSW_00327](#), [SRS_Rte_00078](#))

5.5.1.3.2.2 RTE_E_RAM_UNCHANGED

[SWS_Rte_04582] [
Symbolic name: RTE_E_RAM_UNCHANGED
Value: 142
Comments: Indication that the NVM RAM block was not changed (This is no error).]([SRS_BSW_00327](#))

5.5.1.3.3 Immediate Infrastructure Error Codes

5.5.1.3.3.1 RTE_E_COM_STOPPED

[SWS_Rte_01060] [
Symbolic name: RTE_E_COM_STOPPED
Value: 128
Comments: An IPDU group was disabled while the application was waiting for the transmission acknowledgment. No value is available. This is not considered a fault, since the IPDU group is switched off on purpose.

This semantics are as follows:

- the OUT buffers of a client are not modified,
- the explicit read APIs read the last known value (or init value),

- no runnable with startOnEvent on a DataReceivedEvent for this, VariableDataPrototype is triggered,
- the buffers for implicit read access will keep the previous value.

]([SRS_BSW_00327](#))

5.5.1.3.3.2 RTE_E_TIMEOUT

[SWS_Rte_01064] [

Symbolic name: RTE_E_TIMEOUT

Value: 129

Comments: A blocking API call returned due to expiry of a local timeout rather than the intended result. OUT buffers are not modified. The interpretation of this being an error depends on the application.]([SRS_BSW_00327](#), [SRS_Rte_00069](#))

5.5.1.3.3.3 RTE_E_LIMIT

[SWS_Rte_01317] [

Symbolic name: RTE_E_LIMIT

Value: 130

Comments: An internal RTE limit has been exceeded. Request could not be handled. OUT buffers are not modified.]([SRS_BSW_00327](#))

5.5.1.3.3.4 RTE_E_NO_DATA

[SWS_Rte_01061] [

Symbolic name: RTE_E_NO_DATA

Value: 131

Comments: An explicit read API call returned no data. (This is no error.)]([SRS_BSW_00327](#))

5.5.1.3.3.5 RTE_E_TRANSMIT_ACK

[SWS_Rte_01065] [

Symbolic name: RTE_E_TRANSMIT_ACK

Value: 132

Comments: Transmission acknowledgement received.]([SRS_BSW_00327](#))

5.5.1.3.3.6 RTE_E_NEVER_RECEIVED

[SWS_Rte_07384] [

Symbolic name: RTE_E_NEVER_RECEIVED

Value: 133

Comments: No data received for the corresponding unqueued data element since system start or partition restart.]([SRS_BSW_00327](#), [SRS_Rte_00184](#))

5.5.1.3.3.7 RTE_E_UNCONNECTED

[SWS_Rte_07655] [

Symbolic name: RTE_E_UNCONNECTED

Value: 134

Comments: The port used for communication is not connected.]([SRS_BSW_00327](#), [SRS_Rte_00139](#), [SRS_Rte_00200](#))

5.5.1.3.3.8 RTE_E_IN_EXCLUSIVE_AREA

[SWS_Rte_02739] [

Symbolic name: RTE_E_IN_EXCLUSIVE_AREA

Value: 135

Comments: The error is returned by a blocking API and indicates that the runnable could not enter a wait state. This could be for example because one [ExecutableEntity](#) of the current task's call stack has entered an [ExclusiveArea](#).]([SRS_BSW_00327](#))

5.5.1.3.3.9 RTE_E_SEG_FAULT

[SWS_Rte_02757] [

Symbolic name: RTE_E_SEG_FAULT

Value: 136

Comments: The error can be returned by an RTE API, if the parameters contain a direct or indirect reference to memory that is not accessible from the callers partition.]([SRS_BSW_00327](#))

5.5.1.3.3.10 RTE_E_OUT_OF_RANGE

[SWS_Rte_08065] [

Symbolic name: RTE_E_OUT_OF_RANGE

Value: 137

Comments: The received data is out of range.]([SRS_BSW_00327](#), [SRS_Rte_00180](#))

5.5.1.3.3.11 RTE_E_SERIALIZATION_ERROR, RTE_E_HARD_TRANSFORMER_ERROR

[SWS_Rte_08725] [

Symbolic name: RTE_E_SERIALIZATION_ERROR,
RTE_E_HARD_TRANSFORMER_ERROR

Value: 138

Comments: An error during transformation occurred.]([SRS_Rte_00091](#), [SRS_BSW_00327](#))

5.5.1.3.3.12 RTE_E_SERIALIZATION_LIMIT, RTE_E_TRANSFORMER_LIMIT

[SWS_Rte_08726] [

Symbolic name: RTE_E_SERIALIZATION_LIMIT, RTE_E_TRANSFORMER_LIMIT

Value: 139

Comments: Buffer for transformation operation could not be created.]([SRS_Rte_00091](#), [SRS_BSW_00327](#))

5.5.1.3.3.13 RTE_E_SOFT_TRANSFORMER_ERROR

[SWS_Rte_08551] [

Symbolic name: RTE_E_SOFT_TRANSFORMER_ERROR

Value: 140

Comments: An error during transformation occurred which shall be notified to the SWC but still produces valid data as output (comparable to a warning).]([SRS_Rte_00091](#), [SRS_BSW_00327](#))

5.5.1.3.3.14 RTE_E_COM_BUSY

[SWS_Rte_01389] [

Symbolic name: RTE_E_COM_BUSY

Value: 141

Comments: The transmission/reception could not be performed due to another transmission/reception currently ongoing for the same signal.]([SRS_Rte_00246](#))

5.5.1.3.4 Overlayed Error

These errors do not refer to the data returned with the API. They can be overlayed with other Application- or Immediate Infrastructure Errors.

5.5.1.3.4.1 RTE_E_LOST_DATA

[SWS_Rte_02571] [

Symbolic name: RTE_E_LOST_DATA

Value: 64

Comments: An API call for reading received data with *event semantics* indicates that some incoming data has been lost due to an overflow of the receive queue or due to an error of the underlying communication stack.]([SRS_BSW_00327](#), [SRS_Rte_00107](#), [SRS_Rte_00110](#), [SRS_Rte_00094](#))

5.5.1.3.4.2 RTE_E_MAX_AGE_EXCEEDED

[SWS_Rte_02702] [

Symbolic name: RTE_E_MAX_AGE_EXCEEDED

Value: 64

Comments: An API call for reading received data with *data semantics* indicates that the available data has exceeded the aliveTimeout limit. A COM signal outdated callback will result in this error.]([SRS_BSW_00327](#), [SRS_Rte_00078](#))

5.5.2 Rte_Instance

The `Rte_Instance` data type defines the handle used to access instance specific information from the component data structure.

[SWS_Rte_01148] [The underlying data type for an instance handle shall be a pointer to a *Component Data Structure*.]([SRS_Rte_00011](#), [SRS_Rte_00051](#))

The component data structure (see Section 5.4.2) is uniquely defined for a component type and therefore the data type for the instance handle is automatically unique for each component type.

The instance handle type is defined in the application header file [[SWS_Rte_01007](#)].

To avoid long and complex type names within SW-C code the following requirement imposes a fixed name on the instance handle data type.

[SWS_Rte_01150] [The name of the instance handle type shall be defined, using typedef as `Rte_[Byps_] Instance`. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).]([SRS_BSW_00305](#))

[SWS_Rte_06810] [The instance handle typedef shall use the `CONSTP2CONST` macro with `memclass AUTOMATIC` and `ptrclass RTE_CONST`.]([SRS_BSW_00007](#))

Requirement [[SWS_Rte_06810](#)] uses `memclass AUTOMATIC` rather than `memclass TYPEDEF` because the instance handle is used as a function parameter and hence automatic. This means the typedef is guaranteed to be compatible when the RTE

implementation must use a pointer to the component data structure rather than the instance handle typedef.

The example [5.23](#) illustrates the definition of the instance handle typedef.

5.5.3 RTE Modes

[SWS_Rte_02659] [For each [ModeDeclarationGroup](#) of category "ALPHABETIC_ORDER", used in the SW-C's ports, the *Application Types Header File* shall contain a definition

```
1 #ifndef RTE_TRANSITION_<prefix><ModeDeclarationGroup>
2 #define RTE_TRANSITION_<prefix><ModeDeclarationGroup> <n>U
3 #endif
```

where `<ModeDeclarationGroup>` is the *shortName* of the [ModeDeclarationGroup](#),

`<prefix>` is the optional [prefix](#) attribute defined by the [IncludedModeDeclarationGroupSet](#) referring the [ModeDeclarationGroup](#) and

`<n>` is the number of modes declared within the group.⁶ ([SRS_Rte_00144](#))

[SWS_Rte_03858] [For each [ModeDeclarationGroup](#) of category "EXPLICIT_ORDER", used in the SW-C's ports, the *Application Types Header File* shall contain a definition

```
1 #ifndef RTE_TRANSITION_<prefix><ModeDeclarationGroup>
2 #define RTE_TRANSITION_<prefix><ModeDeclarationGroup> \
3     <onTransitionValue>U
4 #endif
```

where `<ModeDeclarationGroup>` is the *shortName* of the [ModeDeclarationGroup](#),

`<prefix>` is the optional [prefix](#) attribute defined by the [IncludedModeDeclarationGroupSet](#) referring the [ModeDeclarationGroup](#) and

`<onTransitionValue>` is the [onTransitionValue](#) of the *ModeDeclarationGroup*. ([SRS_Rte_00144](#))

[SWS_Rte_07640] [The RTE Generator shall reject configurations where two [ModeDeclarationGroups](#), used in the SW-C's ports, with the same name but different [ModeDeclarations](#) exists.] ([SRS_Rte_00144](#), [SRS_Rte_00018](#))

The rational for [\[SWS_Rte_07640\]](#) is to protect against conditions which would lead to [\[SWS_Rte_02659\]](#) to generate conflicting types or macro definitions.

[SWS_Rte_02568] [For each mode of a [ModeDeclarationGroup](#) of category "ALPHABETIC_ORDER", used in the SW-C's ports, the *Application Types Header File* shall contain a definition

⁶No additional capitalization is applied to the names.

```

1  #ifndef RTE_MODE_<prefix><ModeDeclarationGroup>_<ModeDeclaration>
2  #define RTE_MODE_<prefix><ModeDeclarationGroup>_<ModeDeclaration> \
3      <index>U
4  #endif

```

where `<ModeDeclarationGroup>` is the short name of the [ModeDeclarationGroup](#),

`<prefix>` is the optional [prefix](#) attribute defined by the [IncludedModeDeclarationGroupSet](#) referring the [ModeDeclarationGroup](#)

`<ModeDeclaration>` is the *shortName* of a [ModeDeclaration](#), and `<index>` is the index of the [ModeDeclarations](#) in alphabetic ordering (ASCII / ISO 8859-1 code in ascending order) of the *shortNames* within the [ModeDeclarationGroup](#)⁷.

The lowest index shall be '0' and therefore the range of assigned values is 0..<n-1> where <n> is the number of modes declared within the group.]([SRS_Rte_00144](#))

[SWS_Rte_03859] [For each mode of a [ModeDeclarationGroup](#) of category "EXPLICIT_ORDER", used in the SW-C's ports, the *Application Types Header File* shall contain a definition

```

1  #ifndef RTE_MODE_<prefix><ModeDeclarationGroup>_<ModeDeclaration>
2  #define RTE_MODE_<prefix><ModeDeclarationGroup>_<ModeDeclaration> \
3      <value>U
4  #endif

```

where `<ModeDeclarationGroup>` is the short name of the [ModeDeclarationGroup](#),

`<prefix>` is the optional [prefix](#) attribute defined by the [IncludedModeDeclarationGroupSet](#) referring the [ModeDeclarationGroup](#)

`<ModeDeclaration>` is the *shortName* of a [ModeDeclaration](#), and `<value>` is the *value* specified at the [ModeDeclaration](#).]([SRS_Rte_00144](#))

5.5.4 Enumeration Data Types

Enumeration is not a plain primitive [ImplementationDataType](#). Rather a range of integers can be used as a structural description. The mapping of integers on "labels" in the enumeration is actually modeled in the SwC-T with the semantics class [CompuMethod](#) of a [SwDataDefProps](#) [2]. Enumeration data types are modeled as [ImplementationDataTypes](#) having a [SwDataDefProps](#) referencing a [CompuMethod](#) that contains only [CompuScales](#) with point ranges (i. e. lower and upper limit of a [CompuScale](#) are identical).

[SWS_Rte_03809] [The *Application Types Header File* shall include the definitions of all constants of [ImplementationDataTypes](#) and [ApplicationDataTypes](#) for each [ImplementationDataType/ApplicationDataTypes](#) used

⁷No additional capitalization is applied to the names.

(See [SWS_Rte_08802] for the meaning of the term "used") by this software component.

This includes constants for `CompuMethods` referenced by `ImplementationDataTypeElements` of `ImplementationDataTypes` directly referenced by the software component and constants for `CompuMethods` of `ImplementationDataTypes` which are referenced indirectly via `ImplementationDataTypes` / `ImplementationDataTypeElements` of category `TYPE_REFERENCE`.] (*SRS_Rte_00167*)

[SWS_Rte_03809] is applicable regardless if the `AutosarDataType` is referenced by an `DataPrototypes` in `PortInterfaces` used for `SwComponentTypes` Ports, `DataPrototypes` defined in the `InternalBehavior` of the `SwComponentType` or `AutosarDataTypes` which are only referenced by the `IncludedDataTypeSet`.

This requirement ensures the availability of `AutosarDataType` constants for the internal use in AUTOSAR software components, for example enumeration constants.

The name of those constants bases on the `CompuScale` symbolic name as defined in [TPS_SWCT_01569].

[SWS_Rte_03810] [For each `CompuScale` which has a point range and is located in the `compuInternalToPhys` container of a `CompuMethod` referenced by an `ImplementationDataType` or `ApplicationPrimitiveDataType` according [SWS_Rte_03809] with *category* "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or `BITFIELD_TEXTTABLE`, the *Application Types Header File* file shall contain a definition

```
1 #ifndef <prefix><EnumLiteral>
2 #define <prefix><EnumLiteral> <value><suffix>
3 #endif /* <prefix><EnumLiteral> */
```

where the name of the enumeration literal `<EnumLiteral>` is derived according to the following rule:

```
if (attribute symbol of CompuScale is available and not empty) {
    <EnumLiteral> := C identifier specified in symbol attribute of CompuScale
} else {
    if (string specified in the VT element of the CompuConst of the CompuScale
        is a valid C identifier) {
        <EnumLiteral> :=
            string specified in the VT element of the CompuConst of the CompuScale
    } else {
        if (attribute shortLabel of CompuScale is available and not empty) {
            <EnumLiteral> :=
                string specified in shortLabel attribute of CompuScale
        }
    }
}
```

`<prefix>` is the optional `literalPrefix` attribute defined by the `IncludedDataTypeSet` referring the `AutosarDataType` using the `CompuMethod`.

<value> is the value representing the [CompuScale](#)'s point range.
 <suffix> shall be set according to [\[SWS_Rte_03619\]](#).|([SRS_Rte_00167](#))

Please note that the [IncludedDataTypeSet.literalPrefix](#) applies only to the [AutosarDataType\(s\)](#) explicitly referenced by the [IncludedDataTypeSet](#) and does not automatically propagate to other [AutosarDataType\(s\)](#) associated via [DataTypeMaps](#). Both [ApplicationDataType](#) and mapped [ImplementationDataType](#) must be explicitly referenced if all associated labels are to have the prefix.

[\[SWS_Rte_03810\]](#) implies that the RTE does add prefix to the names of the enumeration constants on explicit demand only. This is necessary in order to handle enumeration constants supplied by Basic Software modules which all use their own prefix convention. Such Enumeration constant names have to be unique in the whole AUTOSAR system.

[SWS_Rte_08401] [In the case that the same [ImplementationDataType](#) or [ApplicationPrimitiveDataType](#) is referenced via different [IncludedDataTypeSets](#) with different [literalPrefix](#) attributes, the definition according to [\[SWS_Rte_03810\]](#) has to be provided once for each different [literalPrefix](#).|([SRS_Rte_00167](#))

[SWS_Rte_03851] [If the input of the RTE generator contains a [CompuMethod](#) with category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or BITFIELD_TEXTTABLE that contains a [CompuScale](#) with a point range, and

- neither the attribute [symbol](#) of the [CompuScale](#) is available and not empty,
- nor the string specified in the VT element of the [CompuConst](#) of the [CompuScale](#) is a valid C identifier,
- nor the attribute [shortLabel](#) of [CompuScale](#) is available and not empty,

the RTE generator shall reject this input as an invalid configuration. |([SRS_Rte_00018](#))

[SWS_Rte_03813] [The RTE shall reject configurations where the same software component type uses [ImplementationDataTypes](#) and [ApplicationPrimitiveDataTypes](#) referencing two or more [CompuMethods](#) with category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or BITFIELD_TEXTTABLE that both contain a [CompuScale](#) with a different point range and an identical [CompuScale symbolic names](#) as an invalid configuration. The only exception is that the usage of the [ImplementationDataTypes](#) and [ApplicationPrimitiveDataTypes](#) are defined with non identical <literalPrefix>es. |([SRS_Rte_00018](#))

[SWS_Rte_07175] [The RTE generator shall reject configurations violating the [constr_1434]. |([SRS_Rte_00018](#))

This rejects configurations where an [ImplementationDataType](#) or an [ApplicationPrimitiveDataType](#) references a [CompuMethod](#) which is of category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE",

"SCALE_RATIONAL_AND_TEXTTABLE", or BITFIELD_TEXTTABLE and has [CompuScales](#) with identical CompuScale Value symbolic names.

Note that there might exist additional [CompuScales](#) with non-point ranges inside a [CompuMethod](#) of category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or BITFIELD_TEXTTABLE, but for those no enumeration literals are generated by the RTE generator.

The RTE generator does not support the use of C enums for [DataPrototypes](#) used in application software.

[SWS_Rte_03862] [The RTE generator shall reject configurations violating the [constr_1244], so where a [DataPrototype](#) that is used in an [AtomicSwComponentType](#) has set the [swDataDefProps.additionalNativeTypeQualifier](#) attribute set to `enum.`] ([SRS_Rte_00018](#))

[SWS_Rte_08802] The meaning of the term "used" with respect to [Autosar-DataTypes](#) [An [AutosarDataType](#) is used if it meets any one of the following conditions:

- it is referenced by a [DataPrototype](#) in the [SwcInternalBehavior](#), or
- it is referenced by a [VariationPointProxy](#) in the [SwcInternalBehavior](#), or
- it is referenced by a [DataPrototype](#) in a [PortInterface](#) referenced by a [PortPrototype](#), or
- it is referenced by an [IncludedDataTypeSet](#) in the [SwcInternalBehavior](#), or
- it is the [ImplementationDataType](#) mapped to an [ApplicationDataType](#) (i.e. via the [DataTypeMappingSet](#)) that is used in one of the above ways, or
- it is an [ImplementationDataTypeElement](#) of a complex [Implementation-DataType](#) that is used in one of the above ways, or
- it is referenced as the target type of an [ImplementationDataType](#) or [ImplementationDataTypeElement](#) of category TYPE_REFERENCE that is used in one of the above ways, or
- it is an [ApplicationDataType](#) referenced as the type of a sub-element of a complex [ApplicationDataType](#) that is used in one of the above ways.

]()

5.5.5 Range Data Types

For the [ApplicationPrimitiveDataType](#) a Range might be specified by referencing a data constraint ([dataConstr](#)) giving the `lowerLimit` and the `upperLimit`. To

allow a Software Component the access to these values two definitions for these values shall be generated.

[SWS_Rte_05051] [The *Application Types Header File* shall include the definitions of all `lowerLimit` and `upperLimit` constants of each `ApplicationPrimitiveDataType` used by this software component once per `ApplicationPrimitiveDataType` if the `ApplicationPrimitiveDataType` is not referenced via different `IncludedDataTypeSets`.] (*SRS_Rte_00167*)

[SWS_Rte_08402] [The *Application Types Header File* shall include the definitions of all `lowerLimit` and `upperLimit` constants of each `ApplicationPrimitiveDataType` used by this software component for each combination of different `literalPrefix` and `ApplicationPrimitiveDataType` when the same `ImplementationDataType` or `ApplicationPrimitiveDataType` is referenced via different `IncludedDataTypeSets`.] (*SRS_Rte_00167*)

[SWS_Rte_05052] [The `lowerLimit` and `upperLimit` constants for *ApplicationPrimitiveDataType* referencing a `DataConstr` shall be generated by RTE generator in the *Application Type Header File* as:

```
1 #define <prefix><DataType>_LowerLimit <lowerValue><suffix>
2 #define <prefix><DataType>_UpperLimit <upperValue><suffix>
```

where `<DataType>` is the name of the `ApplicationPrimitiveDataType` used by the software component.

`<prefix>` is the optional `literalPrefix` attribute defined by the `IncludedDataTypeSet` referring the `AutosarDataType` to which the `DataConstr` belongs.

`<lowerValue>` and `<upperValue>` are the values `lowerLimit` and `upperLimit` of the `dataConstr` referenced by the *ApplicationPrimitiveDataType* onto which the corresponding `CompuMethod` has been applied (see [SWS_Rte_07038]). The values in the macro definitions shall always reflect the closed interval, regardless of the interval type specified by the `dataConstr`.

`<suffix>` shall be set according to [SWS_Rte_03619].] (*SRS_Rte_00167*)

Please note that [SWS_Rte_07196] is not applicable for [SWS_Rte_05052]. Further on it's possible that a `DataPrototype` using an *ApplicationPrimitiveDataType* might reference additional `dataConstr` (see [SWS_Rte_07196]). In this case the `upperLimit` and `lowerLimit` definitions according [SWS_Rte_05052] do not reflect the real applicable range of the `DataPrototype`. No macros are generated for *DataPrototype* specific data constraints.

Please note that the `prefix` can either be defined that the `IncludedDataTypeSet` with a `literalPrefix` attribute references the `ApplicationDataType` or it references the `ImplementationDataType`.

Rationale: `ApplicationPrimitiveDataType` is taken as the basis for the generation of limits (as opposed to take the corresponding `ImplementationDataType`) because the limits defined on the `ImplementationDataType` may be wider than

the limits of the [ApplicationPrimitiveDataType](#) ((see subsection "Data Types for Single Values" in the AUTOSAR SW-C Template [2]).

[SWS_Rte_08403] [For AUTOSAR data types which have an [invalidValue](#) specified, the Application Types header file shall contain the definition

```
1 #define InvalidValue_<prefix><DataType> <invalidValue><suffix>
```

where

<prefix> is the optional literalPrefix attribute defined by the Included-DataTypeSet referring the AutosarDataType

<DataType> is the short name of the data type.

<invalidValue> is the value defined as [invalidValue](#) for the data type.

<suffix> shall be set according to [\[SWS_Rte_03619\]](#).|()

[SWS_Rte_08416] [The Application Types Header File shall include the definitions of all [invalidValue](#) constants used by this software component for each combination of different [literalPrefix](#) and [ApplicationPrimitiveDataType](#) when the same [ImplementationDataType](#) or [ApplicationPrimitiveDataType](#) is referenced via different [IncludedDataTypeSets](#).] ([SRS_Rte_00167](#))

5.5.6 Data Types with bitfield conversions

[AutosarDataTypes](#) associated with a [CompuMethod](#) of category BIT-FIELD_TEXTTABLE support the concatenation of a value set inside a single scalar variable. Thereby single bits may get an individual (boolean) meaning or a set of bits is used carry an enumeration. Please note that those data types are not mapped to C bit fields rather than to scalars (e.g. uint8). Thereby the RTE Generator provides a set of definitions for the "Bit Mask", "Bit Start Position" and the "Number of Bits" in order to support the usage of the AUTOSAR Bit Handling Routines [\[32\]](#) for those kind of data types. For some operations on a set of bits (the set may contain only 1 bit) the AUTOSAR bitfield library requires a single contiguous bit field which means that all bits set to 1 in the [CompuScale.mask](#) attribute value are adjoining, e.g. 0b00010000 or 0b00111100.

[SWS_Rte_07410] [For each unique [CompuScale.shortLabel](#) / [CompuScale.mask](#) value pair for a [CompuScale](#) which is located in the [compuInternalToPhys](#) container of a [CompuMethod](#) referenced by an [ImplementationDataType](#) or [ApplicationPrimitiveDataType](#) according [\[SWS_Rte_03809\]](#) with category BIT-FIELD_TEXTTABLE the *Application Types Header File* shall contain a definition for the bit field mask

```
1 #ifndef <prefix><BflMaskLabel>_BflMask
2 #define <prefix><BflMaskLabel>_BflMask <mask>U
3 #endif /* <prefix><BflMaskLabel>_BflMask */
```


where

<BflMaskLabel> is the value of the attribute `CompuScale.shortLabel`

<mask> is the value of the attribute `mask`

<prefix> is the optional `literalPrefix` attribute defined by the `IncludedDataTypeSet` referring the `AutosarDataType` using the `CompuMethod`.|(SRS_Rte_00167)

[SWS_Rte_07411] [For each unique `CompuScale.shortLabel` / `CompuScale.mask` value pair for a `CompuScale` with a single contiguous bit field which is located in the `compuInternalToPhys` container of a `CompuMethod` referenced by an `ImplementationDataType` or `ApplicationPrimitiveDataType` according [SWS_Rte_03809] with category `BITFIELD_TEXTTABLE` the *Application Types Header File* shall contain a definition for the bit start position

```
1 #ifndef <prefix><BflStartPnLabel>_BflPn
2 #define <prefix><BflStartPnLabel>_BflPn <BflStartPnNumber>U
3 #endif /* <prefix><BflStartPnLabel>_BflPn */
```

where

<BitStartPnLabel> is the value of the attribute `CompuScale.shortLabel`

<BflStartPnNumber> is the number of the first bit in the attribute value `CompuScale.mask` which is set to 1. Thereby the bit counting starts from 0 (LSB) to n (MSB).

<prefix> is the optional `literalPrefix` attribute defined by the `IncludedDataTypeSet` referring the `AutosarDataType` using the `CompuMethod`.|(SRS_Rte_00167)

[SWS_Rte_07412] [For each unique `CompuScale.shortLabel` / `CompuScale.mask` value pair for a `CompuScale` with a single contiguous bit field which is located in the `compuInternalToPhys` container of a `CompuMethod` referenced by an `ImplementationDataType` or `ApplicationPrimitiveDataType` according [SWS_Rte_03809] with category `BITFIELD_TEXTTABLE` the *Application Types Header File* shall contain a definition for the bit field length

```
1 #ifndef <prefix><BflLengthLabel>_BflLn
2 #define <prefix><BflLengthLabel>_BflLn <BflLength>U
3 #endif /* <prefix><BflLengthLabel>_BflLn */
```

where

<BflLengthLabel> is the value of the attribute `shortLabel` <BflLength> is the number of contiguous bits set to 1 in the attribute value `CompuScale.mask`.

<prefix> is the optional `literalPrefix` attribute defined by the `IncludedDataTypeSet` referring the `AutosarDataType` using the `CompuMethod`.|(SRS_Rte_00167)

Please note the example in section F.3.

[SWS_Rte_07414] [The requirements [SWS_Rte_07410], [SWS_Rte_07411], and [SWS_Rte_07412] are only applied to `CompuScales` where the attribute `shortLabel` is defined.](SRS_Rte_00167)

5.6 API Reference

The functions described in this section are organized by the RTE API mapping name used by C and C++ AUTOSAR software-components to access the API. The API mapping hides from the AUTOSAR software-component programmer any need to be aware of the steps taken by the RTE generator to ensure that the generated API functions have unique names.

The instance handle as the first parameter of the API calls is marked as an optional parameter in this section. If an AUTOSAR software-component supports multiple instantiation, the instance handle shall be passed [[SWS_Rte_01013](#)].

Note that [[SWS_Rte_03806](#)] requires that the instance handle parameter does not exist if the AUTOSAR software-component does not support multiple instantiation.

5.6.1 Rte_Ports

Purpose: Provide an array of the ports of a given interface type and a given provide / require usage that can be accessed by the indirect API.

Signature: [[SWS_Rte_02619](#)] [
Rte_PortHandle_<i>_<R/P/PR>
Rte_[Byp_]Ports_<i>_<R/P/PR>(
[IN Rte_Instance <instance>])

Where here <i> is the port interface name and 'P', 'R' or 'PR' are literals to indicate provide, require or provide-require ports respectively. [Byp_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_Rte_00051](#))

Existence: [[SWS_Rte_02613](#)] [An [Rte_Ports](#) API shall be created for each interface type and usage by a port in at least one PreCompileTime variant when the [indirectAPI](#) attribute of that port is set to true.] ([SRS_Rte_00051](#))

Please note that the usage of the [Rte_Ports](#) API is not restricted to particular runnables of the software component. Nevertheless the constraints with respect to RTE API usage by specific runnables are applicable for the according elements in the port data structure.

Description: The [Rte_Ports](#) API provides access to an array of ports for the port oriented API.

[[SWS_Rte_03602](#)] [[Rte_Ports](#) API shall return an array of ports which contains only those ports for which the indirect API was generated or it shall return a NULL_PTR if the port data structure for this port interface does not exist.] ([SRS_Rte_00051](#))

Return Value: Array of port data structures of the corresponding interface type and usage.

Notes: The existence condition for the port data structure is specified in [\[SWS_Rte_03799\]](#).

5.6.2 Rte_NPorts

Purpose: Provide the number of ports of a given interface type and provide / require usage that can be accessed through the indirect API.

Signature: [\[SWS_Rte_02614\]](#) `[`
`uint8`
`Rte_[Byps_]NPorts_<i>_<R/P/PR> (`
`[IN Rte_Instance <instance>])`

Where here <i> is the port interface name and 'P', 'R' or 'PR' are literals to indicate provide, require or provide-require ports respectively. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_Rte_00051](#))

Existence: [\[SWS_Rte_02615\]](#) [An [Rte_NPorts](#) API shall be created for each interface type and usage by a port in at least one `PreCompileTime` variant when the `indirectAPI` attribute of the port is set to true.] ([SRS_Rte_00051](#))

Description: The [Rte_NPorts](#) API supports access to an array of ports for the port oriented API.

[\[SWS_Rte_03603\]](#) [The [Rte_NPorts](#) shall return the number of ports of a given interface and provide / require usage for which the indirect API was generated or 0 if the port port data structure for this port interface does not exist.] ([SRS_Rte_00051](#))

Return Value: Number of port data structures of the corresponding interface type and usage.

Notes: The existence condition for the port data structure is specified in [\[SWS_Rte_03799\]](#).

5.6.3 Rte_Port

Purpose: Provide access to the port data structure for a single port of a particular software component instance. This allows a software component to extract a sub-group of ports characterized by the same interface in order to iterate over this sub-group.

- Signature:** **[SWS_Rte_01354]** [
Rte_PortHandle_<i>_<R/P/PR>
Rte_[Byps_]Port_<p>([IN Rte_Instance <instance>])

where <i> is the port interface name and <p> is the name of the port.
[Byps_] is an optional infix used when component wrapper method
for bypass support is enabled for the related software component
type (See chapter 4.9.2).]([SRS_Rte_00051](#))
- Existence:** **[SWS_Rte_01355]** [An [Rte_Port](#) API shall be created for each port
of an AUTOSAR SW-C, for which the [indirectAPI](#) attribute is set
to true.]([SRS_Rte_00051](#))

Please note that the usage of the [Rte_Port](#) API is not restricted
to particular runnables of the software component. Nevertheless the
constraints with respect to RTE API usage by specific runnables are
applicable for the according elements in the port data structure.
- Description:** The [Rte_Port](#) API provides a pointer to a single port data structure,
in order to support the indirect API.
- Return Value:** Pointer to port data structure for the appropriate port.
- Notes:** None.

5.6.4 Rte_Write

- Purpose:** Initiate an “explicit” sender-receiver transmission of data elements
with “data” semantic ([swImplPolicy](#) different from [queued](#)).
- Signature:** **[SWS_Rte_01071]** [
If [returnValueProvision](#) of the related [dataSendPoint](#)(s) is
not set to [noReturnValueProvided](#):

Std_ReturnType
Rte_[Byps_]Write_<p>_<o>([IN Rte_Instance <instance>],
IN <data>,
[IN Std_TransformerForward forwardedStatus],
[IN uint8* metaDataPtr],
[OUT Std_TransformerError transformerError])

If [returnValueProvision](#) of the related [dataSendPoint](#)(s) is
set to [noReturnValueProvided](#):

void
Rte_[Byps_]Write_<p>_<o>([IN Rte_Instance <instance>],
IN <data>,
[IN Std_TransformerForward forwardedStatus],
[IN uint8* metaDataPtr],
[OUT Std_TransformerError transformerError])

Where `<p>` is the port name and `<o>` the [VariableDataPrototype](#) within the sender-receiver interface categorizing the port. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] ([SRS_BSW_00310](#), [SRS_Rte_00098](#), [SRS_Rte_00028](#), [SRS_Rte_00131](#))

Existence: **[SWS_Rte_01280]** [The presence of a [VariableAccess](#) in the [dataSendPoint](#) role for a provided [VariableDataPrototype](#) with [data semantics](#) shall result in the generation of an [Rte_Write](#) API for the provided [VariableDataPrototype](#).] ([SRS_Rte_00051](#))

[SWS_Rte_CONSTR_09015] **[Rte_Write](#) API may only be used by the runnable that describe its usage** [The [Rte_Write](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in the [dataSendPoint](#) role] ()

[SWS_Rte_08574] [The optional OUT parameter `transformerError` of the API shall be generated if the [PortPrototype](#) of port `<p>` is referenced by a [PortAPIOption](#) which has the attribute `errorHandling` set to `transformerErrorHandling`.] ([SRS_Rte_00249](#))

[SWS_Rte_04573]{DRAFT} [The optional IN parameter `forwardedStatus` of the API shall be generated if the [PortPrototype](#) of port `<p>` is referenced by a [PortAPIOption](#) which has the attribute `transformerStatusForwarding` set to `transformerStatusForwarding`.] ([SRS_Rte_00249](#))

Description: The [Rte_Write](#) API call initiates a sender-receiver communication where the transmission occurs at the point the API call is made (cf. explicit transmission).

The [Rte_Write](#) API call includes the IN parameter `<data>` to pass the data element to write.

The IN parameter `<data>` is passed by value or reference according to the [ImplementationDataType](#) as described in the section 5.2.6.5.

If the IN parameter `<data>` is passed by reference, the pointer must remain valid until the API call returns.

The optional IN parameter `metaDataPtr` contains a pointer to the meta data byte array which is to be forwarded to COM or LdCom. See [\[SWS_Rte_03620\]](#).

The optional IN parameter `forwardedStatus` contains the transformer status which shall be reconstructed inside the transformer chain. See ASWS TransformerGeneral [\[26\]](#).

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter 4.10.5.

The RTE generator shall take into account the kind of connected require port which might not be just a variable but also a NV data. The table 4.13 gives an overview of compatibility rules.

Return Value: None in case `returnValueProvision` of the related `dataSend-Point(s)` is set to `noReturnValueProvided`. Otherwise, the return value is used to indicate errors detected by the RTE during execution of the `Rte_Write`.

- **[SWS_Rte_07820]** `[RTE_E_OK` – data passed to communication service successfully.]([SRS_Rte_00094](#))
 - **[SWS_Rte_07822]** `[RTE_E_COM_STOPPED` – the RTE could not perform the operation because the communication service is currently not available (inter ECU communication only). RTE shall return `RTE_E_COM_STOPPED` when:
 - in case of COM the corresponding service returns `COM_SERVICE_NOT_AVAILABLE`
 - in case of LdCom the corresponding `LdCom_Transmit` returns `E_NOT_OK`
]([SRS_Rte_00094](#))
 - **[SWS_Rte_02756]** `[RTE_E_SEG_FAULT` – a segmentation violation is detected in the handed over parameters to the RTE API as required in [\[SWS_Rte_02752\]](#) and [\[SWS_Rte_02753\]](#). No transmission is executed.]([SRS_Rte_00210](#))
 - **[SWS_Rte_01390]** `[RTE_E_COM_BUSY` – The transmission is rejected due to a currently ongoing transmission. The transmission is not executed.]([SRS_Rte_00246](#))
- Note: API call can be retried after the currently ongoing request has finished.
- **[SWS_Rte_08546]** `[RTE_E_HARD_TRANSFORMER_ERROR` – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
 - **[SWS_Rte_08557]** `[RTE_E_SOFT_TRANSFORMER_ERROR` – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

Notes: The `Rte_Write` call is used to transmit “data” (`swImplPolicy` not queued).

[SWS_Rte_07824] [In case of inter ECU communication, the `Rte_Write` shall cause an immediate transmission request.] (*SRS_Rte_00028*, *SRS_Rte_00131*)

Note that depending on the configuration a transmission request may not result in an actual transmission, for example transmission may be rate limited (time-based filtering) and thus dependent on other factors than API calls.

[SWS_Rte_07826] [In case of inter ECU communication, the `Rte_Write` API shall return when the signal has been passed to the communication service for transmission.] (*SRS_Rte_00028*, *SRS_Rte_00131*)

Depending on the communication server the transmission may or may not have been acknowledged by the receiver at the point the API call returns.

[SWS_Rte_02635] [In case of intra ECU communication, the `Rte_Write` API call shall return after copying the data to RTE local memory or using IOC buffers.] (*SRS_Rte_00028*, *SRS_Rte_00131*)

[SWS_Rte_01080] [If the transmission acknowledgement is enabled, the RTE shall notify component when the transmission is acknowledged or a transmission error occurs.] (*SRS_Rte_00122*)

[SWS_Rte_01082] [If a provide port typed by a sender-receiver interface has multiple require ports connected (i.e. it has multiple receivers), then the RTE shall ensure that writes to all receivers are independent.] (*SRS_Rte_00028*)

Requirement [\[SWS_Rte_01082\]](#) ensures that an error detected by the RTE when writing to one receiver, e.g. communication is stopped, does not prevent the transmission of this message to other components.

[SWS_Rte_08413] [If a provide port typed by a sender-receiver interface has multiple require ports connected (i.e. it has multiple receivers), then the RTE shall return `RTE_E_OK` only if no error at all occurred.] (*SRS_Rte_00028*)

[SWS_Rte_08414] [In case of multiple faults during a call of `Rte_Write` the resulting return value shall be derived according to the following priority rules (highest priority first):

1. `RTE_E_SEG_FAULT`
2. `RTE_E_HARD_TRANSFORMER_ERROR`

3. RTE_E_COM_STOPPED
 4. RTE_E_SOFT_TRANSFORMER_ERROR
-]([SRS_Rte_00028](#))

5.6.5 Rte_Send

Purpose: Initiate an “explicit” sender-receiver transmission of data elements with “event” semantic ([swImplPolicy](#) equal to [queued](#)).

Signature: **[SWS_Rte_01072]** [
If [returnValueProvision](#) of the related [dataSendPoint](#)(s) is not set to [noReturnValueProvided](#):

```
Std_ReturnType
Rte_[Byps_]Send_<p>_<o>([IN Rte_Instance <instance>],
    IN <data>,
    [IN Std_TransformerForward forwardedStatus],
    [IN uint8* metaDataPtr],
    [OUT Std_TransformerError transformerError])
```

If [returnValueProvision](#) of the related [dataSendPoint](#)(s) is set to [noReturnValueProvided](#):

```
void
Rte_[Byps_]Send_<p>_<o>([IN Rte_Instance <instance>],
    IN <data>,
    [IN Std_TransformerForward forwardedStatus],
    [IN uint8* metaDataPtr],
    [OUT Std_TransformerError transformerError])
```

Where <p> is the port name and <o> the [VariableDataPrototype](#) within the sender-receiver interface categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).]([SRS_BSW_00310](#), [SRS_Rte_00141](#), [SRS_Rte_00028](#), [SRS_Rte_00131](#))

Existence: **[SWS_Rte_01281]** [The presence of a [VariableAccess](#) in the [dataSendPoint](#) role for a provided [VariableDataPrototype](#) with [event semantics](#) shall result in the generation of an [Rte_Send](#) API for the provided [VariableDataPrototype](#).]([SRS_Rte_00051](#))

[SWS_Rte_CONSTR_09016] **Rte_Send API may only be used by the runnable that describes its usage** [The [Rte_Send](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in the [dataSendPoint](#) role]()

[SWS_Rte_08562] [The optional OUT parameter `transformerError` of the API shall be generated if the `PortPrototype` of port `<p>` is referenced by a `PortAPIOption` which has the attribute `errorHandling` set to `transformerErrorHandling`.] ([SRS_Rte_00249](#))

[SWS_Rte_04574]{DRAFT} [The optional IN parameter `forwardedStatus` of the API shall be generated if the `PortPrototype` of port `<p>` is referenced by a `PortAPIOption` which has the attribute `transformerStatusForwarding` set to `transformerStatusForwarding`.] ([SRS_Rte_00249](#))

Description: The `Rte_Send` API call initiates a sender-receiver communication where the transmission occurs at the point the API call is made (cf. explicit transmission).

The `Rte_Send` API call includes the IN parameter `<data>` to pass the data element to send.

The IN parameter `<data>` is passed by value or reference according to the `ImplementationDataType` as described in the section [5.2.6.5](#).

If the IN parameter `<data>` is passed by reference, the pointer must remain valid until the API call returns.

The optional IN parameter `metaDataPtr` contains a pointer to the meta data byte array which is to be forwarded to COM or LdCom. See [\[SWS_Rte_03620\]](#).

The optional IN parameter `forwardedStatus` contains the transformer status which shall be reconstructed inside the transformer chain. See ASWS TransformerGeneral [\[26\]](#).

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#).

The RTE generator has to take into account the kind of connected require port which might not be just a variable but also a NV data. The table [4.13](#) gives an overview of compatibility rules.

Return Value: None in case `returnValueProvision` of the related `dataSendPoint(s)` is set to `noReturnValueProvided`. Otherwise, the return value is used to indicate errors detected by the RTE during execution of the `Rte_Send`.

- **[SWS_Rte_07821]** [RTE_E_OK – data passed to communication service successfully.] ([SRS_Rte_00094](#))
- **[SWS_Rte_07823]** [RTE_E_COM_STOPPED – the RTE could not perform the operation because the communication service is

currently not available (inter ECU communication only). RTE shall return `RTE_E_COM_STOPPED` when:

- in case of COM the corresponding service returns `COM_SERVICE_NOT_AVAILABLE`
- in case of LdCom the corresponding `LdCom_Transmit` returns `E_NOT_OK`

]([SRS_Rte_00094](#))

- **[SWS_Rte_02634]** [`RTE_E_LIMIT` – an ‘event’ has been discarded due to a full queue by one of the ECU local receivers (intra ECU communication only).]([SRS_Rte_00143](#))
- **[SWS_Rte_02754]** [`RTE_E_SEG_FAULT` – a segmentation violation is detected in the handed over parameters to the RTE API as required in [[SWS_Rte_02752](#)] and [[SWS_Rte_02753](#)]. No transmission is executed.]([SRS_Rte_00210](#))
- **[SWS_Rte_08547]** [`RTE_E_HARD_TRANSFORMER_ERROR` – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08553]** [`RTE_E_SOFT_TRANSFORMER_ERROR` – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

Notes:

The `Rte_Send` call is used to transmit “events” (`swImplPolicy = queued`).

[SWS_Rte_07825] [In case of inter ECU communication, the `Rte_Send` shall cause an immediate transmission request.]([SRS_Rte_00028](#), [SRS_Rte_00131](#))

Note that depending on the configuration a transmission request may not result in an actual transmission, for example transmission may be rate limited (time-based filtering) and thus dependent on other factors than API calls.

[SWS_Rte_07827] [In case of inter ECU communication, the `Rte_Send` API shall return when the signal has been passed to the communication service for transmission.]([SRS_Rte_00028](#), [SRS_Rte_00131](#))

Depending on the communication server the transmission may or may not have been acknowledged by the receiver at the point the API call returns.

[SWS_Rte_02633] [In case of intra ECU communication, the [Rte_Send](#) API call shall return after attempting to enqueue the data in the IOC or RTE internal queues.] ([SRS_Rte_00028](#), [SRS_Rte_00131](#))

If the transmission acknowledgement is enabled, the RTE has to notify component when the transmission is acknowledged or a transmission error occurs. [[SWS_Rte_01080](#)]

If a provide port typed by a sender-receiver interface has multiple require ports connected (i.e. it has multiple receivers), then the RTE shall ensure that writes to all receivers are independent. [[SWS_Rte_01082](#)]

Requirement [[SWS_Rte_01082](#)] ensures that an error detected by the RTE when writing to one receiver, e.g. an overflow in one component's queue, does not prevent the transmission of this message to other components.

If a provide port typed by a sender-receiver interface has multiple require ports connected (i.e. it has multiple receivers), then the RTE shall return `RTE_E_OK` only if no error at all occurred. [[SWS_Rte_08413](#)]

[SWS_Rte_08415] [In case of multiple faults during a call of [Rte_Send](#) the resulting return value shall be derived according to the following priority rules (highest priority first):

1. `RTE_E_SEG_FAULT`
2. `RTE_E_LIMIT` (only in case of Intra-ECU communication)
3. `RTE_E_HARD_TRANSFORMER_ERROR`
4. `RTE_E_COM_STOPPED`
5. `RTE_E_SOFT_TRANSFORMER_ERROR`

] ([SRS_Rte_00028](#))

5.6.6 Rte_Switch

Purpose: Initiate a mode switch. The [Rte_Switch](#) API call is used for 'explicit' sending of a [mode switch notification](#).

Signature: **[SWS_Rte_02631]** [
If [returnValueProvision](#) of the related [ModeSwitchPoint](#)(s) is not set to [noReturnValueProvided](#):

```
Std_ReturnType
Rte_[BypS_]Switch_<p>_<o>([IN Rte_Instance <instance>],
                           IN <mode>)
```

If `returnValueProvision` of the related `ModeSwitchPoint`(s) is set to `noReturnValueProvided`:

```
void
Rte_[Byp_]Switch_<p>_<o>([IN Rte_Instance <instance>],
                        IN <mode>)
```

Where `<p>` is the port name and `<o>` the *ModeDeclarationGroup-Prototype* within the `ModeSwitchInterface` categorizing the port. `[Byp_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] (*SRS_BSW_00310*, *SRS_Rte_00143*, *SRS_Rte_00028*, *SRS_Rte_00131*)

Existence: [SWS_Rte_02632] [The existence of a *ModeSwitchPoint* shall result in the generation of a `Rte_Switch` API.] (*SRS_Rte_00051*)

[SWS_Rte_CONSTR_09017] **`Rte_Switch` API may only be used by the runnable that describes its usage** [The `Rte_Switch` API may only be used by the runnable that contains the corresponding *ModeSwitchPoint*] ()

Description: The `Rte_Switch` triggers a mode switch for all connected require *ModeDeclarationGroupPrototypes*.

The `Rte_Switch` API call includes exactly one IN parameter for the next mode `<mode>`. The IN parameter `<mode>` is passed by value according to the *ImplementationDataType* on which the *ModeDeclarationGroup* is mapped. The type name shall be equal to the `shortName` of the *ImplementationDataType*.

Return Value: None in case `returnValueProvision` of the related *ModeSwitchPoint*(s) is set to `noReturnValueProvided`. Otherwise, the return value is used to indicate errors detected by the RTE during execution of the `Rte_Switch` call.

- [SWS_Rte_02674] [RTE_E_OK – data passed to service successfully.] (*SRS_Rte_00094*)
- [SWS_Rte_02675] [RTE_E_LIMIT – a mode switch has been discarded by the receiving partition due to a full queue.] (*SRS_Rte_00143*)

Notes: `Rte_Switch` is restricted to ECU local communication.

If a mode instance is currently involved in a transition then the `Rte_Switch` API will attempt to queue the request and return [SWS_Rte_02667]. However if no transition is in progress for the mode instance, the mode disables and the activations of on-entry, on-transition, and on-exit ExecutableEntities for this

mode instance are executed before the `Rte_Switch` API returns [SWS_Rte_02665].

Note that the mode switch might be discarded when the queue is full and a mode transition is in progress, see [SWS_Rte_02675].

5.6.7 Rte_Invalidate

Purpose: Invalidate a data element for an “explicit” sender-receiver transmission.

Signature: [SWS_Rte_01206] [If `returnValueProvision` of the related `dataSendPoint`(s) is not set to `noReturnValueProvided`:

```
Std_ReturnType
Rte_[Byp_]Invalidate_<p>_<o>(
    [IN Rte_Instance <instance>],
    [OUT Std_TransformerError transformerError])
```

If `returnValueProvision` of the related `dataSendPoint`(s) is set to `noReturnValueProvided`:

```
void
Rte_[Byp_]Invalidate_<p>_<o>(
    [IN Rte_Instance <instance>],
    [OUT Std_TransformerError transformerError])
```

Where `<p>` is the port name and `<o>` the `VariableDataPrototype` within the sender-receiver interface categorizing the port. `[Byp_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] (SRS_BSW_00310, SRS_Rte_00078)

Existence: [SWS_Rte_01282] [An `Rte_Invalidate` API shall be created for any `VariableAccess` in the `dataSendPoint` role that references a provided `VariableDataPrototype` which associated `InvalidationPolicy` is set to `keep`, `replace` or `externalReplacement`.] (SRS_Rte_00051, SRS_Rte_00078)

[SWS_Rte_CONSTR_09018] `Rte_Invalidate` API may only be used by the runnable that describe its usage [The `Rte_Invalidate` API may only be used by the runnable that contains the corresponding `VariableAccess` in the `dataSendPoint` role] ()

[SWS_Rte_08582] [The optional OUT parameter `transformerError` of the API shall be generated if the `PortPrototype` of port

<p> is referenced by a `PortAPIOption` which has the attribute `errorHandling` set to `transformerErrorHandling`.]([SRS_Rte_00249](#))

Description: The `Rte_Invalidate` API takes the instance handle as input parameter. The return value is used to indicate the success, or otherwise, of the API call to the caller.

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#).

Return Value: None in case `returnValueProvision` of the related `dataSend-Point(s)` is set to `noReturnValueProvided`. Otherwise, the return value is used to indicate the “OK” status or errors detected by the RTE during execution of the `Rte_Invalidate` call.

- **[SWS_Rte_01207]** [RTE_E_OK – No error occurred.]([SRS_Rte_00094](#))
- **[SWS_Rte_01339]** [RTE_E_COM_STOPPED – the RTE could not perform the operation because the communication service is currently not available (inter ECU communication only). RTE shall return `RTE_E_COM_STOPPED` when:
 - in case of COM the corresponding service returns `COM_SERVICE_NOT_AVAILABLE`
 - in case of LdCom the corresponding `LdCom_Transmit` returns `E_NOT_OK`
]([SRS_Rte_00094](#))
- **[SWS_Rte_08576]** [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08577]** [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

[SWS_Rte_08583] [In case of multiple faults during a call of `Rte_Invalidate` the resulting return value shall be derived according to the following priority rules (highest priority first): (1) `RTE_E_HARD_TRANSFORMER_ERROR`, (2) `RTE_E_COM_STOPPED`, (3) `RTE_E_SOFT_TRANSFORMER_ERROR`.]([SRS_Rte_00122](#))

Notes: The API name includes an identifier <p><o> that is formed from the port and operation item names. See Section [5.2.6.4](#) for details on the naming convention.

The communication service configuration determines whether the signal receiver(s) receive an “invalid signal” notification or whether the invalidated signal is silently replaced by the signal’s initial value.

5.6.8 Rte_Feedback

Purpose: Provide access to acknowledgement notifications for explicit sender-receiver communication and to pass error notification to senders.

Signature: **[SWS_Rte_01083]** [
Std_ReturnType
Rte_[Byps_]Feedback_<p>_<o>(
[IN Rte_Instance <instance>])

Where <p> is the port name and <o> the [VariableDataPrototype](#) within the sender-receiver interface categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_BSW_00310](#), [SRS_Rte_00122](#))

Existence: **[SWS_Rte_01283]** [Acknowledgement is enabled for a provided [VariableDataPrototype](#) by the existence of a [TransmissionAcknowledgementRequest](#) in the [SenderComSpec](#).] ([SRS_Rte_00051](#), [SRS_Rte_00122](#))

[SWS_Rte_01284] [A blocking [Rte_Feedback](#) API shall be generated for a provided [VariableDataPrototype](#) if acknowledgement is enabled and a [WaitPoint](#) references a [DataSendCompletedEvent](#) that in turn references the [VariableAccess](#) which in turn references the [VariableDataPrototype](#).] ([SRS_Rte_00051](#), [SRS_Rte_00122](#))

[SWS_Rte_07850] [A blocking [Rte_Feedback](#) API shall block when a transmission of the related [VariableDataPrototype](#) is ongoing.] ([SRS_Rte_00051](#), [SRS_Rte_00122](#))

[SWS_Rte_07851] [A blocking [Rte_Feedback](#) API shall return:

- if the sender port is not connected or
- if the calling runnable runs in an exclusive area or
- if no transmission of the related [VariableDataPrototype](#) is ongoing or
- when the wait point timeout occurs or
- when the related [DataSendCompletedEvent](#) is triggered.

] ([SRS_Rte_00051](#), [SRS_Rte_00122](#))

[SWS_Rte_01285] [A non-blocking `Rte_Feedback` API shall be generated for a provided `VariableDataPrototype` if acknowledgement is enabled and a `VariableAccess` in the `dataSendPoint` role references the `VariableDataPrototype` but no `WaitPoint` references the `DataSendCompletedEvent` that references the `VariableAccess` which in turn references the `VariableDataPrototype`.] (*SRS_Rte_00051, SRS_Rte_00122*)

Please note that a non-blocking `Rte_Feedback` API does not require the existence of a `DataSendCompletedEvent`. If the `DataSendCompletedEvent` exists it can be used to trigger the execution of a `RunnableEntity` in which the non-blocking `Rte_Feedback` API function may be called.

[SWS_Rte_01286] [If acknowledgement is enabled for a provided `VariableDataPrototype` and a `DataSendCompletedEvent` references a runnable entity as well as the `VariableAccess` which in turn references the `VariableDataPrototype`, the runnable entity shall be activated when the transmission acknowledgement occurs or when a timeout was detected by the RTE. *[SWS_Rte_01137]*.] (*SRS_Rte_00051, SRS_Rte_00122*)

Requirement *[SWS_Rte_01286]* merely affects when the runnable is activated – an API call should still be created, according to requirement *[SWS_Rte_01285]* to actually read the data.

[SWS_Rte_01287] [A `DataSendCompletedEvent` that references a `RunnableEntity` and is referenced by a `WaitPoint` shall be an invalid configuration which is rejected by the RTE generator.] (*SRS_Rte_00051, SRS_Rte_00122, SRS_Rte_00018*)

[SWS_Rte_CONSTR_09019] **`Rte_Feedback` API may only be used by the runnable that describe its usage** [A blocking `Rte_Feedback` API may only be used by the runnable that contains the corresponding `WaitPoint`]()

[SWS_Rte_07634] [A call to `Rte_Feedback` shall not change the status returned by `Rte_Feedback`.] (*SRS_Rte_00122*)

The `Rte_Feedback` API return value is only changed when a new transmission is requested (`Rte_Send` or `Rte_Write`) or when the notification from COM is received.

[SWS_Rte_07635] [After a `Rte_Send` or `Rte_Write` transmission request, only the first notification from COM shall be taken into account for a given Signal or SignalGroup.] (*SRS_Rte_00122*)

[SWS_Rte_07635] is needed in case of cyclic transmission which could result in multiple transmissions with different status.

Description: The `Rte_Feedback` API takes no parameters other than the instance handle – the return value is used to indicate the acknowledgment status to the caller.

The `Rte_Feedback` API applies only to explicit sender-receiver communication.

Return Value: The return value is used to indicate the status of the transmission and errors detected by the RTE.

- **[SWS_Rte_01084]** [`RTE_E_NO_DATA` – No acknowledgments or error notifications were received from COM when the `Rte_Feedback` API was called (non-blocking call) or when the `WaitPoint` timeout expired (blocking call).] ([SRS_Rte_00094](#), [SRS_Rte_00122](#))
- `RTE_E_COM_STOPPED` – returned in one of these cases:
 - **[SWS_Rte_07636]** [(Inter-ECU communication only) The last transmission was rejected (when the `Rte_Send` or `Rte_Write` API was called), with an `RTE_E_COM_STOPPED` return code.] ([SRS_Rte_00094](#), [SRS_Rte_00122](#))
 - **[SWS_Rte_03774]** [(Inter-ECU communication only) An error notification from COM was received before any timeout notification.] ([SRS_Rte_00094](#), [SRS_Rte_00122](#))
- **[SWS_Rte_07637]** [`RTE_E_TIMEOUT` – (Inter-ECU and Inter-Partition only) A timeout notification was received from COM or IOC before any error notification.] ([SRS_Rte_00094](#), [SRS_Rte_00122](#))
- **[SWS_Rte_01086]** [`RTE_E_TRANSMIT_ACK` – In case of inter-ECU communication, a transmission acknowledgment was received from COM; or in case of intra-ECU communication, even if a queue overflow occurred.] ([SRS_Rte_00094](#), [SRS_Rte_00122](#))
- `RTE_E_UNCONNECTED` – Indicates that the sender port is not connected [[SWS_Rte_01344](#)].
- **[SWS_Rte_02740]** [`RTE_E_IN_EXCLUSIVE_AREA` – Used only for the blocking API. `RTE_E_IN_EXCLUSIVE_AREA` indicates that the runnable can not enter wait, as one of the `ExecutableEntity`s in the call stack of this task is currently in an exclusive area, see [[SWS_Rte_02739](#)]. - In a properly configured system, this error should not occur. The check can be disabled according to [[SWS_Rte_08318](#)].] ([SRS_Rte_00092](#), [SRS_Rte_00046](#), [SRS_Rte_00032](#))

- **[SWS_Rte_08578]** [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08579]** [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08318]** [If [RteInExclusiveAreaCheckEnabled](#) is set to *false* the RTE generator shall omit the check and return of [\[SWS_Rte_02740\]](#).]([SRS_Rte_00092](#), [SRS_Rte_00046](#), [SRS_Rte_00032](#))

The RTE_E_NO_DATA, RTE_E_TRANSMIT_ACK and RTE_E_UNCONNECTED return values are not considered to be an error but rather indicates correct operation of the API call.

[SWS_Rte_07652] [The initial return value of the [Rte_Feedback](#) API, before any attempt to write some data shall be RTE_E_TRANSMIT_ACK.]([SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00128](#), [SRS_Rte_00185](#))

[SWS_Rte_08075] [In case of multiple faults during a call of [Rte_Feedback](#) the resulting return value shall be derived according to the following priority rules (highest priority first): (1) RTE_E_UNCONNECTED, (2) RTE_E_IN_EXCLUSIVE_AREA, (3) RTE_E_TIMEOUT, (4) RTE_E_HARD_TRANSFORMER_ERROR, (5) RTE_E_COM_STOPPED, (6) RTE_E_NO_DATA, (7) RTE_E_SOFT_TRANSFORMER_ERROR, (8) RTE_E_TRANSMIT_ACK.]([SRS_Rte_00122](#))

Notes:

If multiple transmissions on the same port/element are outstanding it is not possible to determine which is acknowledged first. If this is important, transmissions should be call serialized with the next occurring only when the previous transmission has been acknowledged or has timed out.

A transmission acknowledgment (or error and timeout) notification is not always provided by COM (the bus or PDU Router may not support transmission acknowledgment for this PDU, or COM may not be configured to perform transmission deadline monitoring).

In case of a blocking [Rte_Feedback](#) the value of the [WaitPoint](#) timeout depends on the timeout defined at the COM level.

5.6.9 Rte_SwitchAck

Purpose: Provide access to mode switch completed acknowledgements and error notifications to [mode managers](#).

Signature: **[SWS_Rte_02725]** [
Std_ReturnType
Rte_[Byps_]SwitchAck_<p>_<o>(
[IN Rte_Instance <instance>])

Where <p> is the port name and <o> the [ModeDeclarationGroupPrototype](#) within the [ModeSwitchInterface](#) categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_BSW_00310](#), [SRS_Rte_00122](#))

Existence: **[SWS_Rte_02676]** [Acknowledgement is enabled for a provided [ModeDeclarationGroupPrototype](#) by the existence of a [ModeSwitchedAckRequest](#) in the [ModeSwitchSenderComSpec](#).] ([SRS_Rte_00051](#), [SRS_Rte_00122](#))

[SWS_Rte_02677] [A blocking [Rte_SwitchAck](#) API shall be generated for a provided [ModeDeclarationGroupPrototype](#) if acknowledgement is enabled and a [WaitPoint](#) references a [ModeSwitchedAckEvent](#) that in turn references the [ModeDeclarationGroupPrototype](#).] ([SRS_Rte_00051](#), [SRS_Rte_00122](#))

[SWS_Rte_07846] [A blocking [Rte_SwitchAck](#) API shall block when a mode switch in the related mode machine instance is ongoing.] ([SRS_Rte_00122](#), [SRS_Rte_00092](#))

[SWS_Rte_07847] [A blocking [Rte_SwitchAck](#) API shall return:

- if the mode machine instance behaves as unconnected or
- if the calling runnable runs in an exclusive area or
- if no mode switch in the related mode machine instance is ongoing or
- when the wait point timeout occurs or
- when the related [ModeSwitchedAckEvent](#) is triggered.

] ([SRS_Rte_00122](#), [SRS_Rte_00092](#), [SRS_Rte_00139](#))

[SWS_Rte_02678] [A non-blocking [Rte_SwitchAck](#) API shall be generated for a provided [ModeDeclarationGroupPrototype](#) if acknowledgement is enabled but no [WaitPoint](#) references a [ModeSwitchedAckEvent](#) that references the [ModeDeclarationGroupPrototype](#).

Please note that a non-blocking API does not require the existence of a [ModeSwitchedAckEvent](#). If the [ModeSwitchedAckEvent](#) exists it can be used to trigger the execution of a [RunnableEntity](#) in which the non-blocking API function may be called.]([SRS_Rte_00051](#), [SRS_Rte_00122](#))

[SWS_Rte_CONSTR_09020] The blocking [Rte_SwitchAck](#) API may only be used by the runnable that describes its usage. [A blocking [Rte_SwitchAck](#) API must only be used by the runnable that contains the corresponding [WaitPoint](#)]()

Description: The [Rte_SwitchAck](#) API takes no parameters other than the instance handle – the return value is used to indicate the acknowledgement status to the caller.

Return Value: The return value is used to indicate the status of a mode switch and errors detected by the RTE.

- **[SWS_Rte_02727]** [RTE_E_NO_DATA – (non-blocking read) The mode switch is still in progress.]([SRS_Rte_00094](#), [SRS_Rte_00122](#))
- **[SWS_Rte_02728]** [RTE_E_TIMEOUT – The configured timeout exceeds before the mode transition was completed.]([SRS_Rte_00094](#), [SRS_Rte_00210](#))
- **[SWS_Rte_03853]** [RTE_E_TIMEOUT – Any [mode users](#) partition is stopped or restarting or has been restarted while the mode switch was requested.]([SRS_Rte_00094](#), [SRS_Rte_00210](#))
- **[SWS_Rte_02729]** [RTE_E_TRANSMIT_ACK – The mode switch has been completed (see [[SWS_Rte_02587](#)]).]([SRS_Rte_00094](#), [SRS_Rte_00122](#))
- **[SWS_Rte_07659]** [RTE_E_UNCONNECTED – Indicates that the mode provider port is not connected.]([SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00139](#))
- **[SWS_Rte_02741]** [RTE_E_IN_EXCLUSIVE_AREA – Used only for the blocking API. RTE_E_IN_EXCLUSIVE_AREA indicates that the runnable can not enter wait, as one of the [ExecutableEntity](#)s in the call stack of this task is currently in an exclusive area, see [[SWS_Rte_02739](#)]. - In a properly configured system, this error should not occur. The check can be disabled according to [[SWS_Rte_08319](#)].]([SRS_Rte_00092](#), [SRS_Rte_00046](#), [SRS_Rte_00032](#))
- **[SWS_Rte_08319]** [If [RteInExclusiveAreaCheckEnabled](#) is set to *false* the RTE generator shall omit the check and return

of [SWS_Rte_02741].](SRS_Rte_00092, SRS_Rte_00046, SRS_Rte_00032)

The RTE_E_TRANSMIT_ACK return value is not considered to be an error but rather indicates correct operation of the API call.

When RTE_E_NO_DATA occurs, a component is free to re-invoke Rte_SwitchAck and thus repeat the attempt to read the status of the mode switch.

[SWS_Rte_07848] [The initial return value of the Rte_SwitchAck API before any attempt to switch a mode shall be RTE_E_TRANSMIT_ACK.](SRS_Rte_00094, SRS_Rte_00122)

[SWS_Rte_07849] [In case of multiple faults during a call of Rte_SwitchAck the resulting return value shall be derived according to the following priority rules (highest priority first): (1) RTE_E_UNCONNECTED, (2) RTE_E_IN_EXCLUSIVE_AREA, (3) RTE_E_TIMEOUT, (4) RTE_E_NO_DATA, (5) RTE_E_TRANSMIT_ACK.](SRS_Rte_00094, SRS_Rte_00122)

Notes: If multiple mode switches of the same mode machine instance are outstanding, it is not possible to determine which is acknowledged first. If this is important, switches should be serialized with the next switch occurring only when the previous switch has been acknowledged. The queue length should be 1.

5.6.10 Rte_Read

Purpose: Performs an “explicit” read on a sender-receiver communication data element with “data” semantics (swImplPolicy != queued). By compatibility, the port may also have a ParameterInterface or a NvDataInterface. The Rte_Read API is used for explicit read by argument.

Signature: **[SWS_Rte_01091]** [If returnValueProvision of the related dataReceivePointByArgument(s) is not set to noReturnValueProvided:

```
Std_ReturnType
Rte_[Byp_]Read_<p>_<o>(
    [IN Rte_Instance <instance>],
    OUT <data>,
    [OUT Std_TransformerError transformerError],
    [OUT uint8* metaDataPtr])
```

If returnValueProvision of the related dataReceivePointByArgument(s) is set to noReturnValueProvided:


```
void
Rte_[Byps_]Read_<p>_<o>(
    [IN Rte_Instance <instance>],
    OUT <data>,
    [OUT Std_TransformerError transformerError],
    [OUT uint8* metaDataPtr])
```

Where <p> is the port name and <o> the [VariableDataPrototype](#) within the sender-receiver interface categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).]([SRS_BSW_00310](#), [SRS_Rte_00141](#), [SRS_Rte_00028](#), [SRS_Rte_00131](#))

Existence: [SWS_Rte_01289] [A non-blocking [Rte_Read](#) API shall be generated if a [VariableAccess](#) in the [dataReceivePointByArgument](#) role references a required [VariableDataPrototype](#) with 'data' semantics.]([SRS_Rte_00051](#))

[SWS_Rte_07396] [The RTE shall ensure that direct explicit read accesses will not deliver undefined data item values. In case there may be an explicit read access before the first data reception an initial value shall be provided as the result of this explicit read access.]([SRS_Rte_00051](#), [SRS_Rte_00183](#))

A [WaitPoint](#) cannot reference a [DataReceivedEvent](#) that in turn references a required [VariableDataPrototype](#) with 'data' semantics shall be considered an invalid configuration (see [[SWS_Rte_03018](#)]). Hence there are no blocking [Rte_Read](#) API.

[SWS_Rte_CONSTR_09021] **[Rte_Read](#) API may only be used by the runnable that describe its usage** [The [Rte_Read](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in the [dataReceivePointByArgument](#) role]()

[SWS_Rte_01313] [A [DataReceivedEvent](#) that references a runnable entity and is referenced by a [WaitPoint](#) shall be an invalid configuration.]([SRS_Rte_00051](#), [SRS_Rte_00018](#))

The RTE generator shall take into account the kind of provide port which might not be just a variable but also a Parameter (fixed, const or standard), a standard sender (i.e. a variable) or a NV data. The table 4.13 gives an overview of compatibility rules.

[SWS_Rte_08563] [The optional OUT parameter `transformerError` of the API shall be generated if the [PortPrototype](#) of port <p> is referenced by a [PortAPIOption](#) which has the attribute `errorHandling` set to `transformerErrorHandling`.]([SRS_Rte_00249](#))

The optional OUT parameter `metaDataPtr` contains a pointer to the meta data byte array which is to be forwarded from COM or LdCom. See [SWS_Rte_03620].

Description: The `Rte_Read` API call includes the OUT parameter `<data>` to pass back the received data.

The pointer to the OUT parameter `<data>` must remain valid until the API call returns.

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter 4.10.5.

Return Value: None in case `returnValueProvision` of the related `dataReceivePointByArgument(s)` is set to `noReturnValueProvided`. Otherwise, the return value is used to indicate errors detected by the RTE during execution of the `Rte_Read` API call or errors detected by the communication system.

- [SWS_Rte_01093] [RTE_E_OK – data read successfully.] (SRS_Rte_00094)
- [SWS_Rte_02626] [RTE_E_INVALID – data element invalid.] (SRS_Rte_00078)
- [SWS_Rte_02703] [RTE_E_MAX_AGE_EXCEEDED – data element outdated. This Overlaid Error can be combined with any other error code.] (SRS_Rte_00147)
- [SWS_Rte_07643] [RTE_E_NEVER_RECEIVED – No data received since system start or partition restart.] (SRS_Rte_00184, SRS_Rte_00224)
- [SWS_Rte_01371] [RTE_E_OUT_OF_RANGE – data element out of range.] (SRS_Rte_00180)
- [SWS_Rte_01391] [RTE_E_COM_BUSY – The read request is rejected due to a currently ongoing reception. No received data can be provided.] (SRS_Rte_00246)

Note: API call can be retried after the currently ongoing request has finished.

- [SWS_Rte_06830] [RTE_E_COM_STOPPED – The RTE could not perform the operation because the COM service is currently not available (inter ECU communication only). RTE shall return `RTE_E_COM_STOPPED` when the corresponding COM service returns `COM_SERVICE_NOT_AVAILABLE`. In case of stopped I-PDUS the last known value (or init value) is given back as data.] (SRS_Rte_00094)

- RTE_E_UNCONNECTED – Indicates that the receiver port is not connected [[SWS_Rte_01330](#)].
- **[SWS_Rte_08548]** [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08554]** [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

[SWS_Rte_08592] [In case of multiple faults during a call of [Rte_Read](#) the resulting return value shall be derived according to the following priority rules (highest priority first):

1. RTE_E_UNCONNECTED
2. RTE_E_COM_STOPPED
3. RTE_E_NEVER_RECEIVED
4. RTE_E_COM_BUSY
5. RTE_E_HARD_TRANSFORMER_ERROR
6. RTE_E_INVALID
7. RTE_E_OUT_OF_RANGE
8. RTE_E_SOFT_TRANSFORMER_ERROR

]([SRS_Rte_00028](#))

Please note that RTE_E_MAX_AGE_EXCEEDED is an overlay error and could be combined with any other error. Nevertheless in case of RTE_E_UNCONNECTED or RTE_E_COM_STOPPED time out monitoring is NOT active which in turn excludes the coincidence of RTE_E_MAX_AGE_EXCEEDED.

Notes: The API name includes an identifier <p>_<o> that indicates the read access point name and is formed from the port and operation item names. See section [5.2.6.4](#) for details on the naming convention.

5.6.11 Rte_DRead

Purpose: Performs an “explicit” read on a sender-receiver communication data element with “data” semantics ([swImplPolicy](#) != [queued](#)). By compatibility, the port may also have a [ParameterInterface](#) or

a [NvDataInterface](#). The [Rte_DRead](#) API is used for explicit read by value.

Signature: **[SWS_Rte_07394]** [

```
<return>
Rte_[Byps_]DRead_<p>_<o>([IN Rte_Instance <instance>],
    [OUT Std_TransformerError transformerError],
    [OUT uint8* metaDataPtr])
```

Where [<p>](#) is the port name and [<o>](#) the [VariableDataPrototype](#) within the sender-receiver interface categorizing the port. [\[Byps_\]](#) is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_BSW_00310](#), [SRS_Rte_00141](#), [SRS_Rte_00028](#), [SRS_Rte_00131](#), [SRS_Rte_00183](#))

Existence:

[SWS_Rte_07395] [A non-blocking [Rte_DRead](#) API shall be generated if a [VariableAccess](#) in the [dataReceivePointByValue](#) role references a required [VariableDataPrototype](#) with 'data' semantics. This requirement is applicable only for primitive data types.] ([SRS_Rte_00051](#), [SRS_Rte_00183](#))

The RTE shall ensure that direct explicit read accesses will not deliver undefined data item values. In case there may be an explicit read access before the first data reception an initial value has to be provided as the result of this explicit read access. [[SWS_Rte_07396](#)]

A [WaitPoint](#) cannot reference a [DataReceivedEvent](#) that in turn references a required [VariableDataPrototype](#) with 'data' semantics. Such a configuration has to be considered as invalid (see [[SWS_Rte_03018](#)]). Hence there are no blocking [Rte_DRead](#) API.

[SWS_Rte_CONSTR_09022] **[Rte_DRead](#) API may only be used by the runnable that describe its usage** [The [Rte_DRead](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in the [dataReceivePointByValue](#) role]()

A [DataReceivedEvent](#) that references a runnable entity and is referenced by a [WaitPoint](#) shall be an invalid configuration. [[SWS_Rte_01313](#)]

The RTE generator shall take into account the kind of provide port which might not be just a variable but also a Parameter (fixed, const or standard), a standard sender (i.e. a variable) or a NV data. The table [4.13](#) gives an overview of compatibility rules.

[SWS_Rte_08565] [The optional OUT parameter `transformerError` of the API shall be generated if the [PortPrototype](#) of port

<p> is referenced by a [PortAPIOption](#) which has the attribute [errorHandling](#) set to `transformerErrorHandling`.] ([SRS_Rte_00249](#))

The optional OUT parameter `metaDataPtr` contains a pointer to the meta data byte array which is to be forwarded from COM or LdCom. See [[SWS_Rte_03620](#)].

Description: The [Rte_DRead](#) API returns the received data as a return value.

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#).

Return Value: The [Rte_DRead](#) return value provide access to the data value of the [VariableDataPrototype](#).

The return type of [Rte_DRead](#) is dependent on the [ImplementationDataType](#) of the [VariableDataPrototype](#). Thus the component does not need to use type casting to convert access to the [VariableDataPrototype](#) data.

For details of the <return> value definition see section [5.2.6.6](#).

Please note that the [Rte_DRead](#) API only supports [VariableDataPrototypes](#) typed by a [Primitive Implementation Data Type](#) or [Redefinition Implementation Data Type](#) redefining a [Primitive Implementation Data Type](#).

Notes: The API name includes an identifier <p>_<o> that indicates the read access point name and is formed from the port and operation item names. See section [5.2.6.4](#) for details on the naming convention.

5.6.12 Rte_Receive

Purpose: Performs an “explicit” read on a sender-receiver communication data element with “event” semantics (`swImplPolicy = queued`).

[[SWS_Rte_01092](#)] [

If [returnValueProvision](#) of the related [dataReceivePointByArgument\(s\)](#) is not set to `noReturnValueProvided`:

```
Std_ReturnType
Rte_[Byps_]Receive_<p>_<o>([IN Rte_Instance <instance>],
    OUT <data>,
    [OUT Std_TransformerError transformerError],
    [OUT uint8* metaDataPtr])
```

If [returnValueProvision](#) of the related [dataReceivePointByArgument\(s\)](#) is set to `noReturnValueProvided`:

```
void
Rte_[Byp_]Receive_<p>_<o>([IN Rte_Instance <instance>],
    OUT <data>,
    [OUT Std_TransformerError transformerError],
    [OUT uint8* metaDataPtr])
```

Where <p> is the port name and <o> the data element within the sender-receiver interface categorizing the port. [Byp_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).]([SRS_BSW_00310](#), [SRS_Rte_00141](#), [SRS_Rte_00028](#), [SRS_Rte_00131](#))

Existence: [SWS_Rte_01288] [A non-blocking [Rte_Receive](#) API shall be generated if a [VariableAccess](#) in the [dataReceivePointByArgument](#) role references a required [VariableDataPrototype](#) with 'event' semantics.]([SRS_Rte_00051](#))

[SWS_Rte_07638] [The RTE Generator shall reject configurations where a [VariableDataPrototype](#) with 'event' semantics is referenced by a [VariableAccess](#) in the [dataReceivePointByValue](#) role.]([SRS_Rte_00018](#))

[SWS_Rte_01290] [A blocking [Rte_Receive](#) API shall be generated if a [VariableAccess](#) in the [dataReceivePointByArgument](#) role references a required [VariableDataPrototype](#) with 'event' semantics that is, in turn, referenced by a [DataReceivedEvent](#) and the [DataReceivedEvent](#) is referenced by a [WaitPoint](#).]([SRS_Rte_00051](#))

[SWS_Rte_CONSTR_09023] **[Rte_Receive](#) API may only be used by the runnable that describe its usage** [The [Rte_Receive](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in the [dataReceivePointByArgument](#) role]()

A [DataReceivedEvent](#) that references a runnable entity and is referenced by a [WaitPoint](#) has to be treated as an invalid configuration. [[SWS_Rte_01313](#)]

[SWS_Rte_08564] [The optional OUT parameter `transformerError` of the API shall be generated if the [PortPrototype](#) of port <p> is referenced by a [PortAPIOption](#) which has the attribute `errorHandling` set to `transformerErrorHandling`.]([SRS_Rte_00249](#))

The optional OUT parameter `metaDataPtr` contains a pointer to the meta data byte array which is to be forwarded from COM or LdCom. See [[SWS_Rte_03620](#)].

Description: The `Rte_Receive` API call includes the OUT parameter `<data>` to pass back the received data element.

The pointers to the OUT parameters must remain valid until the API call returns.

[SWS_Rte_07673] [In case return value is `RTE_E_NO_DATA`, `RTE_E_TIMEOUT`, `RTE_E_UNCONNECTED` or `RTE_E_IN_EXCLUSIVE_AREA`, the OUT parameters shall remain unchanged.] ([SRS_Rte_00094](#), [SRS_Rte_00141](#))

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#).

Return Value: None in case `returnValueProvision` of the related `dataReceivePointByArgument(s)` is set to `noReturnValueProvided`. Otherwise, the return value is used to indicate errors detected by the RTE during execution of the `Rte_Receive` API call or errors detected by the communication system.

- **[SWS_Rte_02598]** [`RTE_E_OK` – data read successfully.] ([SRS_Rte_00094](#))
- **[SWS_Rte_01094]** [`RTE_E_NO_DATA` – (explicit non-blocking read) no events were received and no other error occurred when the read was attempted.] ([SRS_Rte_00094](#))
- **[SWS_Rte_01095]** [`RTE_E_TIMEOUT` – (explicit blocking read) no events were received and no other error occurred when the read was attempted.] ([SRS_Rte_00094](#), [SRS_Rte_00069](#))
- **[SWS_Rte_02572]** [`RTE_E_LOST_DATA` – Indicates that some incoming data has been lost due to an overflow of the receive queue or due to an error of the underlying communication layers. This is not an error of the data returned in the parameters. This [Overlaid Error](#) can be combined with any other error.] ([SRS_Rte_00107](#), [SRS_Rte_00110](#), [SRS_Rte_00094](#))
- `RTE_E_UNCONNECTED` – Indicates that the receiver port is not connected [[SWS_Rte_01331](#)].

Unlike `RTE_E_NO_DATA`, there is no need to retry receiving an event in this case.

- **[SWS_Rte_02743]** [`RTE_E_IN_EXCLUSIVE_AREA` – Used only for the blocking API. `RTE_E_IN_EXCLUSIVE_AREA` indicates that the runnable can not enter wait, as one of the [ExecutableEntities](#) in the call stack of this task is currently in an exclusive area, see [[SWS_Rte_02739](#)]. - In a properly configured system, this error should not occur. The check can

be disabled according to [SWS_Rte_08320].] (SRS_Rte_00092, SRS_Rte_00046, SRS_Rte_00032)

- [SWS_Rte_08320] [If `RteInExclusiveAreaCheckEnabled` is set to *false* the RTE generator shall omit the check and return of [SWS_Rte_02743].] (SRS_Rte_00092, SRS_Rte_00046, SRS_Rte_00032)
- [SWS_Rte_08549] [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain represented a hard transformer error.] (SRS_Rte_00094, SRS_Rte_00091)
- [SWS_Rte_08552] [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.] (SRS_Rte_00094, SRS_Rte_00091)

The `RTE_E_NO_DATA`, `RTE_E_TIMEOUT` and `RTE_E_UNCONNECTED` return values are not considered to be errors but rather indicate correct operation of the API call.

[SWS_Rte_08593] [In case of multiple faults during a call of `Rte_Receive` the resulting return value shall be derived according to the following priority rules (highest priority first):

1. `RTE_E_UNCONNECTED`
2. `RTE_E_IN_EXCLUSIVE_AREA`
3. `RTE_E_TIMEOUT`
4. `RTE_E_HARD_TRANSFORMER_ERROR`
5. `RTE_E_SOFT_TRANSFORMER_ERROR`
6. `RTE_E_NO_DATA`

] (SRS_Rte_00028)

Please note that `RTE_E_LOST_DATA` is an overlay error and could be combined with any other error. Nevertheless in case of `RTE_E_UNCONNECTED` its not possible to lose data which in turn excludes the coincidence of `RTE_E_LOST_DATA`.

Notes:

The API name includes an identifier `<p>_<o>` that indicates the read access point name and is formed from the port and operation item names. See Section 5.2.6.4 for details on the naming convention.

5.6.13 Rte_Call

Purpose: Initiate a client-server communication.

Signature: **[SWS_Rte_01102]** [
 If [returnValueProvision](#) of the related [ServerCallPoint](#)(s) is not set to [noReturnValueProvided](#):

```
Std_ReturnType
Rte_[Byp_]Call_<p>_<o>([IN Rte_Instance <instance>],
    [IN|IN/OUT|OUT] <data_1>...
    [IN|IN/OUT|OUT] <data_n>,
    [OUT Std_TransformerError transformerError])
```

If [returnValueProvision](#) of the related [ServerCallPoint](#)(s) is set to [noReturnValueProvided](#):

```
void
Rte_[Byp_]Call_<p>_<o>([IN Rte_Instance <instance>],
    [IN|IN/OUT|OUT] <data_1>...
    [IN|IN/OUT|OUT] <data_n>,
    [OUT Std_TransformerError transformerError])
```

Where <p> is the port name and <o> the operation within the client-server interface categorizing the port. [Byp_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2.) ([SRS_BSW_00310](#), [SRS_Rte_00029](#))

Existence: **[SWS_Rte_01293]** [A synchronous [Rte_Call](#) API shall be generated if a [SynchronousServerCallPoint](#) references a required [ClientServerOperation](#).] ([SRS_Rte_00051](#), [SRS_Rte_00111](#))

[SWS_Rte_01294] [An asynchronous [Rte_Call](#) API shall be generated if an [AsynchronousServerCallPoint](#) references a required [ClientServerOperation](#).] ([SRS_Rte_00051](#), [SRS_Rte_00111](#))

A configuration that includes both synchronous and asynchronous [ServerCallPoints](#) for a given [ClientServerOperation](#) is invalid ([\[SWS_Rte_03014\]](#)).

[SWS_Rte_CONSTR_09024] **[Rte_Call](#) API may only be used by the runnable that describe its usage** [The [Rte_Call](#) API may only be used by the runnable that contains the corresponding [ServerCallPoint](#)]()

[SWS_Rte_08566] [The optional OUT parameter `transformerError` of the API shall be generated if the [PortPrototype](#) of port

<p> is referenced by a [PortAPIOption](#) which has the attribute `errorHandling` set to `transformerErrorHandling`.] ([SRS_Rte_00249](#))

Description: Client function to initiate client-server communication. The [Rte_Call](#) API is used for both synchronous and asynchronous calls.

The [Rte_Call](#) API includes zero or more IN, IN/OUT and OUT parameters.

[SWS_Rte_06639] [IN/OUT parameters are passed by value when they are "Primitive Implementation Data Type"s and the call is asynchronous.] ([SRS_Rte_00051](#), [SRS_Rte_00111](#))

Rational: In case of an asynchronous call, the IN/OUT parameters are only IN parameters.

The IN, IN/OUT and OUT parameters are passed by value or reference according to the [ImplementationDataType](#) as described in the section [5.2.6.5](#).

The pointers to all parameters passed by reference must remain valid until the API call returns.

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#).

Return Value: None in case [returnValueProvision](#) of the related [Server-CallPoint](#)(s) is set to `noReturnValueProvided`. Otherwise: **[SWS_Rte_01103]** [The return value shall be used to indicate infrastructure errors detected by the RTE during execution of the [Rte_Call](#) call and, for synchronous communication, infrastructure and application errors during execution of the server.] ([SRS_Rte_00094](#), [SRS_Rte_00123](#), [SRS_Rte_00124](#))

- **[SWS_Rte_01104]** [RTE_E_OK – The API call completed successfully.] ([SRS_Rte_00094](#))

Note: This means that RTE_E_OK is returned when neither an infrastructure error nor an overlay error occurred at the invocation of the server runnable and the invoked server runnable was returning a value equal to E_OK.

- **[SWS_Rte_01105]** [RTE_E_LIMIT – The client has multiple outstanding asynchronous client-server invocations of the same operation in the same port. The server invocation shall be discarded, the buffers of the return parameters shall not be modified (see also [\[SWS_Rte_02658\]](#)).] ([SRS_Rte_00094](#), [SRS_Rte_00079](#))

- **[SWS_Rte_08727]** [RTE_E_TRANSFORMER_LIMIT – The RTE is not able to allocate the buffer needed to transform the data.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08728]** [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain represented a hard transformer error.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08555]** [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_01106]** [RTE_E_COM_STOPPED – the RTE could not perform the operation because the communication service is currently not available (inter ECU communication only). RTE shall return RTE_E_COM_STOPPED when:
 - in case of COM the corresponding service returns COM_SERVICE_NOT_AVAILABLE
 - in case of LdCom the corresponding [LdCom_Transmit](#) returns E_NOT_OK

The buffers of the return parameters shall not be modified.] ([SRS_Rte_00094](#))
- **[SWS_Rte_01107]** [RTE_E_TIMEOUT – (synchronous inter-task and inter-ECU only) No reply was received within the configured timeout. The buffers of the return parameters shall not be modified.] ([SRS_Rte_00094](#), [SRS_Rte_00069](#))
- RTE_E_UNCONNECTED – Indicates that the client port is not connected [[SWS_Rte_01334](#)].
- **[SWS_Rte_02744]** [RTE_E_IN_EXCLUSIVE_AREA – Used only for the blocking API. RTE_E_IN_EXCLUSIVE_AREA indicates that the runnable can not enter wait, as one of the [ExecutableEntity](#)s in the call stack of this task is currently in an exclusive area, see [[SWS_Rte_02739](#)]. - In a properly configured system, this error should not occur. The check can be disabled according to [[SWS_Rte_08321](#)].] ([SRS_Rte_00092](#), [SRS_Rte_00046](#), [SRS_Rte_00032](#))
- **[SWS_Rte_08321]** [If [RteInExclusiveAreaCheckEnabled](#) is set to *false* the RTE generator shall omit the check and return of [[SWS_Rte_02744](#)].] ([SRS_Rte_00092](#), [SRS_Rte_00046](#), [SRS_Rte_00032](#))

- **[SWS_Rte_02755]** [RTE_E_SEG_FAULT – a segmentation violation is detected in the handed over parameters to the RTE API as required in [SWS_Rte_02752] and [SWS_Rte_02753]. No transmission is executed.] ([SRS_Rte_00210](#))
- **[SWS_Rte_02577]** [The application error (synchronous client-server) from a server shall only be returned if none of the above infrastructure errors (other than RTE_E_OK) have occurred.] ([SRS_Rte_00123](#))
- **[SWS_Rte_01392]** [RTE_E_COM_BUSY – The transmission is rejected due to a currently ongoing transmission. The transmission is not executed.] ([SRS_Rte_00246](#))
- **[SWS_Rte_04553]** [RTE_E_TIMEOUT – if the call is ignored according to [SWS_Rte_02535]] ()

Note: API call can be retried after the currently ongoing request has finished.

[SWS_Rte_08594] [In case of multiple faults during a call of [Rte_Call](#) the resulting return value shall be derived according to the following priority rules (highest priority first):

1. RTE_E_UNCONNECTED
2. RTE_E_IN_EXCLUSIVE_AREA
3. RTE_E_LIMIT
4. RTE_E_SEG_FAULT
5. RTE_E_TRANSFORMER_LIMIT
6. RTE_E_HARD_TRANSFORMER_ERROR
7. RTE_E_COM_STOPPED / RTE_E_COM_BUSY
8. RTE_E_TIMEOUT
9. "application error"
10. RTE_E_SOFT_TRANSFORMER_ERROR

] ([SRS_Rte_00028](#))

Note that the RTE_E_OK return value indicates that the [Rte_Call](#) API call completed successfully. In case of a synchronous client server call it also indicates successful processing of the request by the server.

An asynchronous server invocation is considered to be outstanding, if alternatively

1. no timeout has occurred, an `AsynchronousServerCallResultPoint` exists, and the client has not retrieved the result successfully yet.
2. no timeout has occurred, no `AsynchronousServerCallResultPoint` exists, and the server has not finished to process the last request of the client yet.
3. a timeout has been detected by the RTE in inter-ECU and inter-partition communication.
4. the server runnable has terminated after a timeout was detected in intra-ECU communication.

When the `RTE_E_TIMEOUT` error occurs, RTE shall discard any subsequent responses to that request, (see [[SWS_Rte_02657](#)]).

Notes: **[SWS_Rte_01109]** [The interface operation's OUT parameters shall be omitted for an *asynchronous* call.]([SRS_Rte_00029](#), [SRS_Rte_00079](#))

In case of asynchronous communication:

- the `Rte_Call` only includes IN and IN/OUT parameters.
- the `Rte_Result` only includes IN/OUT and OUT parameters to collect the result of the server call.
- the IN/OUT parameters provided during the `Rte_Call` can be a different addresse than the IN/OUT parameter passed during the `Rte_Result`.

5.6.14 Rte_Result

Purpose: Get the result of an asynchronous client-server call.

Signature: **[SWS_Rte_01111]** [If `returnValueProvision` of the related `AsynchronousServerCallResultPoint(s)` is not set to `noReturnValueProvided`:

```
Std_ReturnType
Rte_[Byps_]Result_<p>_<o>([IN Rte_Instance <instance>],
    [IN/OUT|OUT <param 1>]...
    [IN/OUT|OUT <param n>],
    [OUT Std_TransformerError transformerError])
```

If `returnValueProvision` of the related `AsynchronousServerCallResultPoint(s)` is set to `noReturnValueProvided`:

```
void
Rte_[Byps_]Result_<p>_<o>([IN Rte_Instance <instance>],
    [IN/OUT|OUT <param 1>]...
    [IN/OUT|OUT <param n>],
    [OUT Std_TransformerError transformerError])
```

Where <p> is the port name and <o> the operation within the client-server interface categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2.)
[\(SRS_BSW_00310\)](#)

The signature can include zero or more IN/OUT and OUT parameters depending on the signature of the operation in the client-server interface.

Existence: [\[SWS_Rte_01296\]](#) [A non-blocking [Rte_Result](#) API shall be generated if an [AsynchronousServerCallResultPoint](#) exists for the specific [RunnableEntity](#) and this [AsynchronousServerCallResultPoint](#) references an [AsynchronousServerCallPoint](#) which according to [\[SWS_Rte_01294\]](#) leads to the generation of an asynchronous [Rte_Call](#) API but no [WaitPoint](#) (of the [RunnableEntity](#)) references an [AsynchronousServerCallReturnsEvent](#) that references the [AsynchronousServerCallResultPoint](#).][\(SRS_Rte_00051\)](#)

Please note that a non-blocking [Rte_Result](#) API does not require the existence of a [AsynchronousServerCallReturnsEvent](#). If the [AsynchronousServerCallReturnsEvent](#) exists it can be used to trigger the execution of a [RunnableEntity](#) in which the non-blocking [Rte_Result](#) API function may be called.

[\[SWS_Rte_01297\]](#) [A blocking [Rte_Result](#) API shall be generated if an [AsynchronousServerCallResultPoint](#) exists for the specific [RunnableEntity](#) and this [AsynchronousServerCallResultPoint](#) references an [AsynchronousServerCallPoint](#) which according to [\[SWS_Rte_01294\]](#) leads to the generation of an asynchronous [Rte_Call](#) API and a [WaitPoint](#) (of the [RunnableEntity](#)) references an [AsynchronousServerCallReturnsEvent](#) that references the [AsynchronousServerCallResultPoint](#).][\(SRS_Rte_00051\)](#)

[\[SWS_Rte_CONSTR_09025\]](#) **Blocking [Rte_Result](#) API may only be used by the runnable that describe the [WaitPoint](#)** [The blocking [Rte_Result](#) API may only be used by the runnable that contains the corresponding [WaitPoint](#)][\(\)](#)

[\[SWS_Rte_01298\]](#) [If an [AsynchronousServerCallReturnsEvent](#) references a [RunnableEntity](#) and a required

`ClientServerOperation`, the `RunnableEntity` shall be activated when the operation's result is available or when a timeout was detected by the RTE [SWS_Rte_01133].] (SRS_Rte_00051)

Requirement [SWS_Rte_01298] merely affects when the runnable is activated – an API call should still be created to actually read the reply based on requirement [SWS_Rte_01296].

[SWS_Rte_01312] [An `AsynchronousServerCallReturnsEvent` that references a runnable entity and is referenced by a `WaitPoint` is invalid.] (SRS_Rte_00051)

[SWS_Rte_08567] [The optional OUT parameter `transformerError` of the API shall be generated if the `PortPrototype` of port <p> is referenced by a `PortAPIOption` which has the attribute `errorHandling` set to `transformerErrorHandling`.] (SRS_Rte_00249)

Description: The `Rte_Result` API is used by a client to collect the result of an *asynchronous* client-server communication.

The `Rte_Result` API includes zero or more IN/OUT and OUT parameters to pass back results.

The pointers to all parameters passed by reference must remain valid until the API call returns.

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter 4.10.5.

Return Value: None in case `returnValueProvision` of the related `AsynchronousServerCallResultPoint(s)` is set to `noReturnValueProvided`. Otherwise, the return value is used to indicate errors from either the `Rte_Result` call itself or communication errors detected before the API call was made.

- [SWS_Rte_01112] [RTE_E_OK – The API call completed successfully.] (SRS_Rte_00094)

Note: This means that RTE_E_OK is returned when neither an infrastructure error nor an overlay error occurred at the invocation of the server runnable and the invoked server runnable was returning a value equal to E_OK.

- [SWS_Rte_08591] [RTE_E_TRANSFORMER_LIMIT – The RTE is not able to allocate the buffer needed to transform the data.] (SRS_Rte_00094, SRS_Rte_00091)
- [SWS_Rte_08729] [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain

represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

- **[SWS_Rte_08556]** [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_01113]** [RTE_E_NO_DATA – (non-blocking read) The server's result is not available but no other error occurred within the API call or the server was not called since [Rte_Start](#) or the restart of the Partition. The buffers for the IN/OUT and OUT parameters shall not be modified.]([SRS_Rte_00094](#))
- **[SWS_Rte_08301]** [RTE_E_NO_DATA – (non-blocking read) The previous [Rte_Call](#) returned an RTE_E_SEG_FAULT, RTE_E_TRANSFORMER_LIMIT, RTE_E_HARD_TRANSFORMER_ERROR.]([SRS_Rte_00094](#))
- **[SWS_Rte_01114]** [RTE_E_TIMEOUT – The server's result is not available within the specified timeout but no other error occurred within the API call. The buffers for the IN/OUT and OUT parameters shall not be modified.]([SRS_Rte_00094](#), [SRS_Rte_00069](#))
- **[SWS_Rte_03606]** [RTE_E_COM_STOPPED – the RTE could not perform the operation because the COM service is currently not available (inter ECU communication only). RTE shall return RTE_E_COM_STOPPED when the corresponding COM service returns COM_SERVICE_NOT_AVAILABLE. The server's result has *not* been successfully retrieved from the communication service. The buffers of the return parameters shall not be modified.]([SRS_Rte_00094](#))
- RTE_E_UNCONNECTED – Indicates that the client port is not connected [[SWS_Rte_01333](#)].
- **[SWS_Rte_02745]** [RTE_E_IN_EXCLUSIVE_AREA – Used only for the blocking API. RTE_E_IN_EXCLUSIVE_AREA indicates that the runnable can not enter wait, as one of the [ExecutableEntity](#)s in the call stack of this task is currently in an exclusive area, see [[SWS_Rte_02739](#)]. - In a properly configured system, this error should not occur. The check can be disabled according to [[SWS_Rte_08322](#)].]([SRS_Rte_00092](#), [SRS_Rte_00046](#), [SRS_Rte_00032](#))
- **[SWS_Rte_08322]** [If [RteInExclusiveAreaCheckEnabled](#) is set to *false* the RTE generator shall omit the check and return of [[SWS_Rte_02745](#)].]([SRS_Rte_00092](#), [SRS_Rte_00046](#), [SRS_Rte_00032](#))

[SWS_Rte_02746] [`Rte_Result` shall not return `RTE_E_IN_EXCLUSIVE_AREA`, if the wait is resolved by a mapping of the server runnable to a task with higher priority on the same core.]([SRS_Rte_00092](#), [SRS_Rte_00046](#), [SRS_Rte_00032](#))

- **[SWS_Rte_08302]** [`RTE_E_SEG_FAULT` – a segmentation violation is detected in the handed over parameters to the RTE API as required in [\[SWS_Rte_02752\]](#) and [\[SWS_Rte_02753\]](#). No transmission is executed.]([SRS_Rte_00094](#))
- **[SWS_Rte_01393]** [`RTE_E_COM_BUSY` – The query for the result is rejected due to a currently ongoing reception. No result data can be provided.]([SRS_Rte_00246](#))
- **[SWS_Rte_04554]** [`RTE_E_TIMEOUT` – if the call is ignored according to [\[SWS_Rte_02535\]](#)]([SRS_Rte_00094](#))

Note: API call can be retried after the currently ongoing request has finished.

- **[SWS_Rte_02578]** [Application Errors – The error code of the server shall only be returned, if none of the above infrastructure errors or indications have occurred.]([SRS_Rte_00094](#), [SRS_Rte_00123](#))

[SWS_Rte_08595] [In case of multiple faults during a call of `Rte_Result` the resulting return value shall be derived according to the following priority rules (highest priority first):

1. `RTE_E_UNCONNECTED`
2. `RTE_E_IN_EXCLUSIVE_AREA`
3. `RTE_E_SEG_FAULT`
4. `RTE_E_COM_STOPPED` / `RTE_E_COM_BUSY` / `RTE_E_TIMEOUT`
5. `RTE_E_TRANSFORMER_LIMIT`
6. `RTE_E_HARD_TRANSFORMER_ERROR`
7. "application error"
8. `RTE_E_SOFT_TRANSFORMER_ERROR`

]([SRS_Rte_00028](#))

The `RTE_E_NO_DATA`, `RTE_E_TIMEOUT`, and `RTE_E_UNCONNECTED` return values are not considered to be errors but rather indicate correct operation of the API call.

When the `RTE_E_TIMEOUT` error occurs, RTE has to discard any subsequent responses to that request, (see [\[SWS_Rte_02657\]](#)).

When `RTE_E_NO_DATA` occurs, a component is free to invoke `Rte_Result` again and thus repeat the attempt to read the server's result.

Notes: The API name includes an identifier `<p>_<o>` that indicates the read access point name and is formed from the port and operation item names. See Section 5.2.6.4 for details on the naming convention.

If a `AsynchronousServerCallPoint` exists which is not referenced by a `WaitPoint`, a non-blocking `Rte_Result` API shall be generated. In this case `Rte_Result` has to return `RTE_E_NO_DATA` until the timeout expires and `RTE_E_TIMEOUT` afterwards.

5.6.15 Rte_Pim

Purpose: Provide access to the defined per-instance memory (section) of a software component.

Signature: [SWS_Rte_01118] [

```
<type>/<return reference>
Rte_[Byps_]Pim_<name>([IN Rte_Instance <instance>])
```

Where `<name>` is the (short) name of the per-instance name. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] (*SRS_BSW_00310*, *SRS_Rte_00075*)

Existence: [SWS_Rte_01299] [An `Rte_Pim` API shall be created for each defined `PerInstanceMemory` or `arTypedPerInstanceMemory` within the AUTOSAR software-component (description).] (*SRS_Rte_00051*)

Description: The `Rte_Pim` API provides access to the per-instance memory (section) defined in the context of a `SwcInternalBehavior` of a software-component description.

Return Value: [SWS_Rte_01119] [The API returns a typed reference (in C a typed pointer) to the per-instance memory.] (*SRS_Rte_00051*, *SRS_Rte_00075*)

Notes: For a `'C' typed PerInstanceMemory`, the name of the return type `<type>` has to be defined in the `type` attribute of the `PerInstanceMemory`. The type itself is defined using the `type-Definition` attribute of the `PerInstanceMemory`. It is assumed that this attribute contains a string that represents a C type definition (typedef) in valid C syntax (see [SWS_Rte_02304] and [SWS_Rte_07133]). For an `arTypedPerInstanceMemory`

the `<return reference>` is defined by the associated [Autosar-DataType](#) (see [\[SWS_Rte_07161\]](#)). For details of the `<return reference>` definition see section [5.2.6.7](#).

5.6.16 Rte_CData

Purpose: Provide access to the calibration parameter an AUTOSAR software-component defined internally. The [ParameterDataPrototype](#) in the role [perInstanceParameter](#) or [sharedParameter](#) is used to define software component internal calibration parameters. Internal because the [ParameterDataPrototype](#) cannot be reused outside the software-component. Access is read-only. It can be configured for each calibration parameter individually if it is shared by all instances of an AUTOSAR software-component or if each instance has an own data value associated with it.

Signature: [\[SWS_Rte_01252\]](#) [`<return>`
`Rte_[Byps_]CData_<name> ([IN Rte_Instance <instance>])`
 Where `<name>` is the calibration parameter name. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_BSW_00310](#), [SRS_Rte_00155](#))

Existence: [\[SWS_Rte_01300\]](#) [An [Rte_CData](#) API shall be generated if a [ParameterAccess](#) references a [ParameterDataPrototype](#) in the role [perInstanceParameter](#) or [sharedParameter](#) within the [SwcInternalBehavior](#) of an AUTOSAR software-component.] ([SRS_Rte_00051](#), [SRS_Rte_00155](#))

Description: The [Rte_CData](#) API provides access to the defined calibration parameter within a software-component. The actual data values for a software-component instance may be set after component compilation.

Return Value: The [Rte_CData](#) return value provide access to the data value of the [ParameterDataPrototype](#) in the role [perInstanceParameter](#) or [sharedParameter](#).

The return type of [Rte_CData](#) is dependent on the [ImplementationDataType](#) of the [ParameterDataPrototype](#) and can either be a value or a pointer to the location where the value can be accessed. Thus the component does not need to use type casting to convert access to the [ParameterDataPrototype](#) data.

For details of the `<return>` value definition see section [5.2.6.6](#).

[SWS_Rte_03927] [If a [ParameterDataPrototype](#) is aggregated by an [SwcInternalBehavior](#) in the role of [sharedParameter](#), the return value of the corresponding [Rte_CData](#) API shall provide access to the calibration parameter value common to all instances of the [AtomicSwComponentType](#).] ([SRS_Rte_00051](#), [SRS_Rte_00155](#))

[SWS_Rte_03952] [If a [ParameterDataPrototype](#) is aggregated by an [SwcInternalBehavior](#) in the role of [perInstanceParameter](#), the return value of the corresponding [Rte_CData](#) API shall provide access to the calibration parameter value specific to the instance of the [AtomicSwComponentType](#).] ([SRS_Rte_00051](#), [SRS_Rte_00155](#))

Notes: None.

5.6.17 Rte_Prm

Purpose: Provide access to the parameters defined by an AUTOSAR [ParameterSwComponentType](#). Access is read-only.

Signature: **[SWS_Rte_03928]** [
<return>
Rte_[Byps_]Prm_<p>_<o>([IN Rte_Instance <instance>])

Where <p> is the port name and <o> is the name of the [ParameterDataPrototype](#) within the [ParameterInterface](#) categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] ([SRS_BSW_00310](#), [SRS_Rte_00155](#))

Existence: **[SWS_Rte_03929]** [A [Rte_Prm](#) API shall be generated if a [ParameterAccess](#) references a [ParameterDataPrototype](#) in a [requirePortPrototype](#).] ([SRS_BSW_00310](#), [SRS_Rte_00155](#))

Description: The [Rte_Prm](#) API provides access to the defined parameter within a [ParameterSwComponentType](#).

In the case of a `standard` parameter (`swImplPolicy = standard`), i.e. a calibration, the actual data values for a [ParameterSwComponentType](#) instance may be set after [ParameterSwComponentType](#) compilation.

In the case of `fixed` parameter or `constant` parameter, the value is set during compilation time.

Return Value: [SWS_Rte_03930] [For primitive data types, the `Rte_Prm` API shall return the parameter value. For composite data types, the `Rte_Prm` API shall return a reference (in C, a pointer) to the parameter, which shall be const. With `fixed` parameters, only primitive data is possible.

The return type of `Rte_Prm` is specified by the `ImplementationDataType` associated to the `ParameterDataPrototype`. Thus the component does not need to use type casting to access the calibration parameter.] (*SRS_Rte_00051*, *SRS_Rte_00155*, *SRS_Rte_00171*) The `Rte_Prm` return value provide access to the data value of the `ParameterDataPrototype`.

The return type of `Rte_Prm` is dependent on the `ImplementationDataType` of the `ParameterDataPrototype` and can either be a value or a pointer to the location where the value can be accessed. Thus the component does not need to use type casting to convert access to the `ParameterDataPrototype` data.

For details of the `<return>` value definition see section 5.2.6.6.

Notes: The `Rte_Prm` API should not be used within a pre-compilation directive, e.g. `#if`. For such case, the coder should use the `Rte_SysCon` definitions which are dedicated to variant handling.

5.6.18 Rte_IRead

Purpose: Provide **read** access to the `VariableDataPrototype` referenced by `VariableAccess` in the `dataReadAccess` role.

Signature: [SWS_Rte_03741] [
`<return>`
`Rte_[Byps_]IRead_<re>_<p>_<o> (`
`[IN Rte_Instance <instance>],`
`[OUT uint8* metaDataPtr])`

Where `<re>` is the runnable entity name, `<p>` the port name and `<o>` the `VariableDataPrototype` name. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2.) (*SRS_BSW_00310*, *SRS_Rte_00128*)

Existence: [SWS_Rte_01301] [An `Rte_IRead` API shall be created for a required `VariableDataPrototype` if the `RunnableEntity` has a `VariableAccess` in the `dataReadAccess` role referring to this `VariableDataPrototype`.] (*SRS_Rte_00051*)

[SWS_Rte_CONSTR_09083] `Rte_IRead` API may only be used by the runnable that describe its usage [The `Rte_IRead` API may

only be used by the runnable that contains the corresponding `VariableAccess` in the `dataReadAccess` role.>()

Description: The `Rte_IRead` API provides access to the `VariableDataPrototype`s declared as accessed by a runnable using `VariableAccesses` in the `dataReadAccess` role. As the API can also be used in context of category 1A runnables an implementation has to ensure finite and constant execution times.

No error information is provided by this API. If required, the error status can be picked up with a separate API, see [5.6.23](#)

The data value can always be read. To provide the required consistency the API provides access to a *copy* of the data element for which it's guaranteed that it never changes during the actual execution of the runnable entity.

Implicit data read access by a SW-C should always return defined data.

[SWS_Rte_01268] [The RTE shall ensure that implicit read accesses will not deliver undefined data item values.]([SRS_Rte_00108](#), [SRS_Rte_00051](#), [SRS_Rte_00128](#))

[SWS_Rte_01394] [In case read access is not possible due to a currently ongoing reception the `invalidValue` shall be provided as the result of this implicit read access.]([SRS_Rte_00246](#))

In case where there may be an implicit read access before the first data reception an initial value has to be provided as the result of this implicit read access.

The optional OUT parameter `metaDataPtr` contains a pointer to the meta data byte array which is to be forwarded from COM or LdCom. See [\[SWS_Rte_03620\]](#).

Return Value: The `Rte_IRead` return value provides access to the data value of the `VariableDataPrototype`.

The return type of `Rte_IRead` is dependent on the `ImplementationDataType` of the `VariableDataPrototype` and can either be a value or a pointer to the location where the value can be accessed. Thus the component does not need to use type casting to convert access to the `VariableDataPrototype` data.

For details of the `<return>` value definition see section [5.2.6.6](#).

Notes: None.

5.6.19 Rte_IReadRef

Purpose: Provide a reference to the [VariableDataPrototype](#) referenced by [VariableAccess](#) in the [dataReadAccess](#) role.

Signature: **[SWS_Rte_04577]** [
 <return>
 Rte_[Byps_] IReadRef_<re>_<p>_<o> (
 [IN Rte_Instance <instance>],
 [OUT uint8* metaDataPtr])

Where <re> is the runnable entity name, <p> the port name and <o> the [VariableDataPrototype](#) name. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#).) [[SRS_BSW_00310](#), [SRS_Rte_00128](#)]

Existence: **[SWS_Rte_04578]** [An [Rte_IReadRef](#) API shall be created for a required [VariableDataPrototype](#) if the [RunnableEntity](#) has a [VariableAccess](#) in the [dataReadAccess](#) role referring to this [VariableDataPrototype](#).] ([SRS_Rte_00051](#))

[SWS_Rte_CONSTR_09094] **Rte_IReadRef API may only be used by the runnable that describes its usage** [The [Rte_IReadRef](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in the [dataReadAccess](#) role.] ()

Description: The [Rte_IReadRef](#) API provides access to the [VariableDataPrototypes](#) declared as accessed by a runnable using [VariableAccesses](#) in the [dataReadAccess](#) role. As the API can also be used in context of category 1A runnables an implementation has to ensure finite and constant execution times.

No error information is provided by this API. If required, the error status can be picked up with a separate API, see [5.6.23](#)

The data value can always be read. To provide the required consistency the API provides access to a *copy* of the data element for which it's guaranteed that it never changes during the actual execution of the runnable entity.

Implicit data read access by a SW-C should always return defined data.

The optional OUT parameter `metaDataPtr` contains a pointer to the meta data byte array which is to be forwarded from COM or LdCom. See [[SWS_Rte_03620](#)].

Return Value: The [Rte_IReadRef](#) return value provide access to the data value of the [VariableDataPrototype](#).

The return type of `Rte_IReadRef` is a pointer to the location where the value can be accessed.

Notes: None.

5.6.20 Rte_IWrite

Purpose: Provide **write** access to the `VariableDataPrototypes` referenced by `VariableAccesses` in the `dataWriteAccess` role.

Signature: **[SWS_Rte_03744]** [

```
void
Rte_[Byps_]IWrite_<re>_<p>_<o>(
    [IN Rte_Instance <instance>],
    IN <data>,
    [IN Std_TransformerForward forwardedStatus],
    [IN uint8* metaDataPtr])
```

Where `<re>` is the runnable entity name, `<p>` the port name and `<o>` the `VariableDataPrototype` name. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2.) *(SRS_BSW_00310, SRS_Rte_00129)*

Existence: **[SWS_Rte_01302]** [An `Rte_IWrite` API shall be created for a provided `VariableDataPrototype` if the `RunnableEntity` has a `VariableAccess` in the `dataWriteAccess` role referring to this `VariableDataPrototype`.] *(SRS_Rte_00051)*

[SWS_Rte_CONSTR_09084] `Rte_IWrite` API may only be used by the runnable that describe its usage [The `Rte_IWrite` API may only be used by the runnable that contains the corresponding `VariableAccess` in the `dataWriteAccess` role.] *()*

[SWS_Rte_04575]{DRAFT} [The optional IN parameter `forwardedStatus` of the API shall be generated if the `PortPrototype` of port `<p>` is referenced by a `PortAPIOption` which has the attribute `transformerStatusForwarding` set to `transformerStatusForwarding`.] *(SRS_Rte_00249)*

Description: The `Rte_IWrite` API provides write access to the `VariableDataPrototypes` declared as accessed by a runnable using `VariableAccesses` in the `dataWriteAccess` role. The API function is guaranteed to be have constant execution time and therefore can also be used within category 1A runnable entities.

No access error information is required for the user – the value can always be written. To provide the required write-back semantics the

RTE only makes written values available to other entities after the writing runnable entity has terminated.

[SWS_Rte_03746] [The [Rte_IWrite](#) API call includes the IN parameter `<data>` to pass the data element to write.]([SRS_Rte_00051](#), [SRS_Rte_00129](#))

The IN parameter `<data>` is passed by value or reference according to the [ImplementationDataType](#) as described in the section [5.2.6.5](#).

If the IN parameter `<data>` is passed by reference, the pointer must remain valid until the API call returns.

The optional IN parameter `forwardedStatus` contains the transformer status which shall be reconstructed inside the transformer chain. See ASWS TransformerGeneral [\[26\]](#).

The optional IN parameter `metaDataPtr` contains a pointer to the meta data byte array which is to be forwarded to COM or LdCom. See [\[SWS_Rte_03620\]](#).

Return Value: None.

Notes: None.

5.6.21 Rte_IWriteRef

Purpose: Provide a reference to the [VariableDataPrototype](#) referenced by a [VariableAccess](#) in the [dataWriteAccess](#) role.

Signature: **[SWS_Rte_05509]** [
`<return reference>`
`Rte_[Byps_]IWriteRef_<re>_<p>_<o>(
[IN Rte_Instance <instance>],
[IN Std_TransformerForward forwardedStatus],
[IN uint8* metaDataPtr])`

Where `<re>` is the runnable entity name, `<p>` the port name and `<o>` the [VariableDataPrototype](#) name. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_BSW_00310](#), [SRS_Rte_00129](#))

Existence: **[SWS_Rte_05510]** [An [Rte_IWriteRef](#) API shall be created for a provided [VariableDataPrototype](#) if the [RunnableEntity](#) has a [VariableAccess](#) in the [dataWriteAccess](#) role referring to this [VariableDataPrototype](#).] ([SRS_Rte_00051](#))

[SWS_Rte_CONSTR_09085] *Rte_IWriteRef* API may only be used by the runnable that describe its usage [The *Rte_IWriteRef* API may only be used by the runnable that contains the corresponding *VariableAccess* in the *dataWriteAccess* role.]()

[SWS_Rte_04576]{DRAFT} [The optional IN parameter *forwardedStatus* of the API shall be generated if the *PortPrototype* of port <p> is referenced by a *PortAPIOption* which has the attribute *transformerStatusForwarding* set to *transformerStatusForwarding*.](*SRS_Rte_00249*)

Description: The *Rte_IWriteRef* API returns a reference to the *VariableDataPrototypes* declared as accessed by a runnable using *VariableAccesses* in the *dataWriteAccess* role. The reference can be used by the runnable to directly update the corresponding data elements. This is especially useful for data elements of *Structure Implementation Data Type* or *Array Implementation Data Type*. The API function is guaranteed to be have constant execution time and therefore can also be used within category 1A runnable entities.

No error information is required for the user. To provide the required write-back semantics the RTE only makes written values available to other entities after the writing runnable entity has terminated.

[SWS_Rte_CONSTR_09026] *Rte_IWriteRef* may not return values written in previous executions [The reference returned by *Rte_IWriteRef* shall not be used by the runnables for reading the value previously written.]()

The rationale for [SWS_Rte_CONSTR_09026] is that *Rte_IWriteRef* has a write semantic. Also, in case of an unconnected port, the written data shall be discarded (similarly to [SWS_Rte_01347]), and implementations may return a reference to the same buffer for all *Rte_IWriteRef* of unconnected provide ports.

The optional IN parameter *forwardedStatus* contains the transformer status which shall be reconstructed inside the transformer chain. See ASWS TransformerGeneral [26].

The optional IN parameter *metaDataPtr* contains a pointer to the meta data byte array which is to be forwarded to COM or LdCom. See [SWS_Rte_03620].

Return Value: The *Rte_IWriteRef* return value provide access to the data write buffer of the *VariableDataPrototype*.

[SWS_Rte_05511] [*Rte_IWriteRef* returns a reference to the corresponding *VariableDataPrototype*.](*SRS_Rte_00051*)

The return reference type of `Rte_IWriteRef` is dependent on the `ImplementationDataType` of the `VariableDataPrototype` and is a pointer to the location where the value can be accessed. Thus the component does not need to use type casting to convert access to the `VariableDataPrototype` data.

For details of the `<return reference>` definition see section 5.2.6.7.

Notes: None.

5.6.22 Rte_IInvalidate

Purpose: Invalidate a `VariableDataPrototype` referenced by a `VariableAccess` in the `dataWriteAccess` role.

Signature: **[SWS_Rte_03800]** `[`
`void Rte_[Byps_]IInvalidate_<re>_<p>_<o> (`
`[IN Rte_Instance <instance>])`

Where `<re>` is the runnable entity name, `<p>` the port name and `<o>` the `VariableDataPrototype` name. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2.) (*SRS_BSW_00310*, *SRS_Rte_00078*)

Existence: **[SWS_Rte_03801]** [An `Rte_IInvalidate` API shall be created for a provided `VariableDataPrototype` if the `RunnableEntity` has `VariableAccesses` in the `dataWriteAccess` role referring to this `VariableDataPrototype` and the associated `InvalidationPolicy` of the `VariableDataPrototype` is set to `keep`, `replace` or `externalReplacement`.] (*SRS_Rte_00051*, *SRS_Rte_00078*)

[SWS_Rte_CONSTR_09086] `Rte_IInvalidate` API may only be used by the runnable that is describing an write access to the data [The `Rte_IInvalidate` API may only be used by the runnable that contains the corresponding `VariableAccess` in the `dataWriteAccess` role to the `VariableDataPrototype` where the associated `InvalidationPolicy` of the `VariableDataPrototype` is set to `keep` or `replace`.] (`()`)

Description: The `Rte_IInvalidate` API takes no parameters other than the instance handle – the return value is used to indicate the success, or otherwise, of the API call to the caller.

[SWS_Rte_03802] [In case of a primitive `VariableDataPrototype` the `Rte_IInvalidate` shall be implemented as a macro that writes the `invalidValue` to the buffer.] (*SRS_Rte_00078*)

[SWS_Rte_05064] [In case of a composite [VariableDataPrototype](#) the [Rte_IInvalidate](#) shall be implemented as a macro that writes the [invalidValue](#) of every primitive part of the composition to the buffer.]([SRS_Rte_00078](#))

[SWS_Rte_03778] [If [Rte_IInvalidate](#) is followed by an [Rte_IWrite](#) call for the same [VariableDataPrototype](#) or vice versa, the RTE shall use the last value written before the runnable entity terminates (last-is-best semantics).]([SRS_Rte_00078](#))

[SWS_Rte_03778] states that an [Rte_IWrite](#) overrules an [Rte_IInvalidate](#) call if it occurs after the [Rte_IInvalidate](#), since [Rte_IWrite](#) overwrites the contents of the internal buffer for the data element prototype before it is made known to other runnable entities.

Return Value: None.

Notes: The communication service configuration determines whether the signal receiver(s) receive an “invalid signal” notification or whether the invalidated signal is silently replaced by the signal’s initial value.

5.6.23 Rte_IStatus

Purpose: Provide the error status of a [VariableDataPrototype](#) referenced by a [VariableAccess](#) in the [dataReadAccess](#) role.

Signature: **[SWS_Rte_02599]** [
Std_ReturnType
Rte_[Byps_]IStatus_<re>_<p>_<o>(
[IN Rte_Instance <instance>],
[OUT Std_TransformerError transformerError])

Where <re> is the runnable entity name, <p> the port name and <o> the [VariableDataPrototype](#) name. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).]([SRS_Rte_00147](#), [SRS_Rte_00078](#))

Existence: **[SWS_Rte_02600]** [An [Rte_IStatus](#) API shall be created for a required [VariableDataPrototype](#) if a [RunnableEntity](#) has a [VariableAccess](#) in the [dataReadAccess](#) role referring to this [VariableDataPrototype](#), and

- if at the [RPortPrototype](#) or [PRPortPrototype](#) a [Non-queuedReceiverComSpec](#) with either
 - the attribute [aliveTimeout](#) set to a value greater than zero and/or

- the attribute `handleNeverReceived` set to `TRUE` **and/or**
- the attribute `handleOutOfRange` not set to `none` **and/or**
- the attribute `handleDataStatus` set to `TRUE`

and/or

- if at the `SenderReceiverInterface` classifying the `RPort-Prototype` or `PRPortPrototype` an `InvalidationPolicy` set to `keep`

is specified for this `VariableDataPrototype`.] (*SRS_Rte_00147*, *SRS_Rte_00078*)

[SWS_Rte_CONSTR_09027] `Rte_IStatus` API shall only be used by a `RunnableEntity` describing an read access to the related data [The `Rte_IStatus` API shall only be used by a `RunnableEntity` that has a `VariableAccess` in the `dataReadAccess` role referring to the `VariableDataPrototype` to which the status belongs.] ()

[SWS_Rte_08568] [The optional OUT parameter `transformerError` of the API shall be generated if the `PortPrototype` of port `<p>` is referenced by a `PortAPIOption` which has the attribute `errorHandling` set to `transformerErrorHandling`.] (*SRS_Rte_00249*)

Description: The `Rte_IStatus` API provides access to the current status of the data elements declared as accessed by a runnable using a `VariableAccess` in the `dataReadAccess` role. The API function is guaranteed to be have constant execution time and therefore can also be used within category 1A runnable entities.

To provide the required consistency access by a runnable is to a *copy* of the status together with the data that is guaranteed never to be modified by the RTE during the lifetime of the runnable entity.

The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#).

Return Value: The return value is used to indicate errors detected by the communication system.

- **[SWS_Rte_02602]** [`RTE_E_OK` – no errors.] (*SRS_Rte_00094*)
- **[SWS_Rte_02603]** [`RTE_E_INVALID` – `data element invalid`.] (*SRS_Rte_00078*)

- **[SWS_Rte_02604]** [RTE_E_MAX_AGE_EXCEEDED – data element outdated. This Overlaid Error can be combined with any other error code.]([SRS_Rte_00147](#))
- **[SWS_Rte_07644]** [RTE_E_NEVER_RECEIVED – No data received since system start or partition restart.]([SRS_Rte_00184](#), [SRS_Rte_00224](#))
- **[SWS_Rte_01372]** [RTE_E_OUT_OF_RANGE – data element out of range.]([SRS_Rte_00180](#))
- **[SWS_Rte_06828]** [RTE_E_COM_STOPPED – the RTE could not perform the operation because the communication service is currently not available (inter ECU communication only). RTE shall return RTE_E_COM_STOPPED when:
 - in case of COM the corresponding service returns COM_SERVICE_NOT_AVAILABLE
 - in case of LdCom the corresponding LdCom_Transmit returns E_NOT_OK

In case of stopped I-PDUS the last known value (or init value) is given back as data by the according Rte_IRead API.]([SRS_Rte_00094](#))
- RTE_E_UNCONNECTED – Indicates that the receiver port is not connected [[SWS_Rte_03785](#)].
- **[SWS_Rte_08572]** [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08573]** [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

Notes:

[SWS_Rte_06829] [In case of multiple faults during reception of the related data the resulting return value of Rte_IStatus shall be derived according to the following priority rules (highest priority first):

1. RTE_E_UNCONNECTED
2. RTE_E_COM_STOPPED
3. RTE_E_NEVER_RECEIVED
4. RTE_E_HARD_TRANSFORMER_ERROR
5. RTE_E_INVALID

6. RTE_E_OUT_OF_RANGE

7. RTE_E_SOFT_TRANSFORMER_ERROR

]([SRS_Rte_00147](#), [SRS_Rte_00078](#), [SRS_Rte_00184](#), [SRS_Rte_00180](#))

Please note that RTE_E_MAX_AGE_EXCEEDED is an overlay error and could be combined with any other error. Nevertheless in case of RTE_E_UNCONNECTED or RTE_E_COM_STOPPED time out monitoring is NOT active which in turn excludes the coincidence of RTE_E_MAX_AGE_EXCEEDED.

5.6.24 Rte_IrvIRead

Purpose: Provide **read** access to the *InterRunnableVariables* with *implicit* behavior of an AUTOSAR SW-C.

Signature: **[SWS_Rte_03550]** [
<return> Rte_[Byps_]IrvIRead_<re>_<o>(
[IN RTE_Instance <instance>])

Where <re> is the name of the runnable entity the API might be used in, <o> is the name of the [VariableDataPrototype](#) in role [implicitInterRunnableVariable](#). [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_BSW_00310](#), [SRS_Rte_00142](#))

Existence: **[SWS_Rte_01303]** [An [Rte_IrvIRead](#) API shall be created for each [VariableAccess](#) in role [readLocalVariable](#) to an [implicitInterRunnableVariable](#).] ([SRS_Rte_00051](#), [SRS_Rte_00142](#))

[SWS_Rte_CONSTR_09087] [Rte_IrvIRead](#) API may only be used by the runnable that describe its usage [The [Rte_IrvIRead](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in the [readLocalVariable](#) role.] ()

Description: The [Rte_IrvIRead](#) API provides read access to the defined *InterRunnableVariables* with *implicit* behavior within a component description.

The return value is used to deliver the requested data value. The return value is not required to pass error information to the user because no inter-ECU communication is involved and there will always be a readable value present.

Return Value: The `Rte_IrvIRead` return value provide access to the data value of the `InterRunnableVariable`.

The return type of `Rte_IrvIRead` is dependent on the `ImplementationDataType` of the `InterRunnableVariable` and can either be a value or a pointer to the location where the value can be accessed. Thus the component does not need to use type casting to convert access to the `InterRunnableVariable` data.

For details of the `<return>` value definition see section 5.2.6.6.

Notes: The runnable entity name in the signature allows runnable context specific optimizations.

The concept of `InterRunnableVariables` is explained in section 4.2.6.6. More details about `InterRunnableVariables` with *implicit* behavior is explained in section 4.2.6.6.1.

5.6.25 Rte_IrvIReadRef

Purpose: Provide **read** access to the *InterRunnableVariables* with *implicit* behavior of an AUTOSAR SW-C.

Signature: **[SWS_Rte_04579]** [
`<return> Rte_[Byps_]IrvIReadRef_<re>_<o> (`
`[IN RTE_Instance <instance>])`

Where `<re>` is the name of the runnable entity the API might be used in, `<o>` is the name of the `VariableDataPrototype` in role `implicitInterRunnableVariable`. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] (*SRS_BSW_00310*, *SRS_Rte_00142*)

Existence: **[SWS_Rte_04580]** [An `Rte_IrvIReadRef` API shall be created for each `VariableAccess` in role `readLocalVariable` to an `implicitInterRunnableVariable`.] (*SRS_Rte_00051*, *SRS_Rte_00142*)

[SWS_Rte_CONSTR_09095] **`Rte_IrvIReadRef` API may only be used by the runnable that describes its usage** [The `Rte_IrvIReadRef` API may only be used by the runnable that contains the corresponding `VariableAccess` in the `readLocalVariable` role.] ()

Description: The `Rte_IrvIReadRef` API provides read access to the defined `InterRunnableVariables` with *implicit* behavior within a component description.

Return Value: The `Rte_IrvIReadRef` return value provides access to the data value of the `InterRunnableVariable`.

The return type of `Rte_IrvIReadRef` is a pointer to the location where the value can be accessed.

Notes: The runnable entity name in the signature allows runnable context specific optimizations.

The concept of `InterRunnableVariables` is explained in section 4.2.6.6. More details about `InterRunnableVariables` with *implicit* behavior is explained in section 4.2.6.6.1.

5.6.26 Rte_IrvIWrite

Purpose: Provide **write** access to the *InterRunnableVariables* with *implicit behavior* of an AUTOSAR SW-C.

Signature: **[SWS_Rte_03553]** [

```
void Rte_[Byp_]IrvIWrite_<re>_<o>(  

    [IN RTE_Instance <instance>],  

    IN <data>)
```

Where `<re>` is the name of the `RunnableEntity` the API might be used in, `<o>` is the name of the `VariableDataPrototype` in the role `implicitInterRunnableVariable` to access and `<data>` is the placeholder for the data the `InterRunnableVariable` shall be set to. `[Byp_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] (*SRS_BSW_00310*, *SRS_Rte_00142*)

Existence: **[SWS_Rte_01304]** [An `Rte_IrvIWrite` API shall be created for each `VariableAccess` in role `writtenLocalVariable` to an `implicitInterRunnableVariable`.] (*SRS_Rte_00142*, *SRS_Rte_00051*)

[SWS_Rte_CONSTR_09088] **`Rte_IrvIWrite` API may only be used by the runnable that describe its usage** [The `Rte_IrvIWrite` API may only be used by the runnable that contains the corresponding `VariableAccess` in the `writtenLocalVariable` role.]
()

Description: The `Rte_IrvIWrite` API provides write access to the `InterRunnableVariables` with *implicit* behavior within a component description. The runnable entity name in the signature allows runnable context specific optimizations.

The data given by `Rte_IrvIWrite` is dependent on the `InterRunnableVariable` data type. Thus the component does not need to use type casting to write the `InterRunnableVariable`.

The return value is unused. The return value is not required to pass error information to the user because no inter-ECU communication is involved and the value can always be written.

The IN parameter `<data>` is passed by value or reference according to the `ImplementationDataType` as described in the section 5.2.6.5.

Return Value: None.

Notes: The runnable entity name in the signature allows runnable context specific optimizations.

The concept of `InterRunnableVariables` is explained in section 4.2.6.6. Further details about `InterRunnableVariables` with *implicit* behavior are explained in Section 4.2.6.6.1.

5.6.27 Rte_IrvIWriteRef

Purpose: Provide a reference to the `VariableDataPrototype` defined with the `implicitInterRunnableVariable` role referenced by a `VariableAccess` in the `writtenLocalVariable` role.

Signature: **[SWS_Rte_06207]** [
`<return reference> Rte_[Byps_]IrvIWriteRef_<re>_<o>(
 [IN RTE_Instance <instance>])`

Where `<re>` is the name of the `RunnableEntity` the API might be used in, `<o>` is the name of the `VariableDataPrototype` in the role `implicitInterRunnableVariable` to access. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] (*SRS_BSW_00310*, *SRS_Rte_00142*)

Existence: **[SWS_Rte_06208]** [An `Rte_IrvIWriteRef` API shall be created for each `VariableAccess` in role `writtenLocalVariable` to an `implicitInterRunnableVariable`.] (*SRS_Rte_00142*, *SRS_Rte_00051*)

[SWS_Rte_CONSTR_09092] `Rte_IrvIWriteRef` API may only be used by the runnable that describe its usage [The `Rte_IrvIWriteRef` API may only be used by the runnable that contains the corresponding `VariableAccess` in the `writtenLocalVariable` role.] ()

Description: The `Rte_IrvIWriteRef` API returns a reference to the `VariableDataPrototypes` declared as accessed by a runnable using `VariableAccess` in the `writtenLocalVariable` role. The reference can be used by the runnable to directly update the corresponding data elements. This is especially useful for data elements of Structure Implementation Data Type or Array Implementation Data Type. The API function is guaranteed to have constant execution time and therefore can also be used within category 1A runnable entities.

No error information is required for the user. To provide the required write-back semantics the RTE only makes written values available to other entities after the writing runnable entity has terminated.

[SWS_Rte_CONSTR_09093] `Rte_IrvIWriteRef` may not return values written in previous executions [The reference returned by `Rte_IrvIWriteRef` shall not be used by the runnables for reading the value previously written.]()

Return Value: The `Rte_IrvIWriteRef` return value provides access to the data write buffer of the `VariableDataPrototype`.

[SWS_Rte_06209] [`Rte_IrvIWriteRef` returns a reference to the corresponding `VariableDataPrototype`.](*SRS_Rte_00051*)

The return reference type of `Rte_IrvIWriteRef` is dependent on the `ImplementationDataType` of the `VariableDataPrototype` and is a pointer to the location where the value can be accessed. Thus the component does not need to use type casting to convert access to the `VariableDataPrototype` data. For details of the `<return reference>` definition see section 5.2.6.7.

Notes: None.

5.6.28 Rte_IrvRead

Purpose: Provide **read** access to the *InterRunnableVariables with explicit behavior* of an AUTOSAR SW-C.

Signature: **[SWS_Rte_03560]** [primitive type signature:

```
<return> Rte_[Byps_]IrvRead_<re>_<o>(
    [IN RTE_Instance <instance>])
```

complex type signature:


```
void Rte_[Byps_]IrvRead_<re>_<o>(
    [IN RTE_Instance <instance>],
    OUT <data>)
```

Where <re> is the name of the runnable entity the API might be used in, <o> is the name of the InterRunnableVariables. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).

The complex type signature is used, if the [ImplementationDataType](#) of the [InterRunnableVariable](#) resolves to [Array Implementation Data Type](#) or [Structure Implementation Data Type](#), otherwise the primitive type signature is used.]([SRS_BSW_00310](#), [SRS_Rte_00142](#))

Existence: [\[SWS_Rte_01305\]](#) [An [Rte_IrvRead](#) API shall be created for each read [InterRunnableVariable](#) using explicit access.]([SRS_Rte_00142](#), [SRS_Rte_00051](#))

[\[SWS_Rte_CONSTR_09089\]](#) **[Rte_IrvRead](#) API may only be used by the runnable that describe its usage** [The [Rte_IrvRead](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in the [readLocalVariable](#) role.]([/](#))

Description: The [Rte_IrvRead](#) API provides read access to the defined [InterRunnableVariables](#) with *explicit* behavior within a component description.

The return value is not required to pass error information to the user because no inter-ECU communication is involved and there will always be a readable value present.

For the primitive type signature, the return value is used to deliver the requested data value. For the complex type signature, the return value is void.

For the complex type signature, the [Rte_IrvRead](#) API call includes the OUT parameter <data> to pass back the received data. The OUT parameter <data> is typed as reference (pointer) to the type of the [InterRunnableVariable](#). The pointer to the OUT parameter <data> must remain valid until the API call returns.

Return Value: The [Rte_IrvRead](#) return value provide access to the data value of the [InterRunnableVariable](#).

The return type of [Rte_IrvRead](#) is dependent on the [ImplementationDataType](#) of the [InterRunnableVariable](#). Thus the component does not need to use type casting to convert access to the [InterRunnableVariable](#) data.

For details of the `<return>` value definition see section [5.2.6.6](#).

Please note that the `Rte_IrvRead` API Signature only has a return value if the `InterRunnableVariable` is typed by a [Primitive Implementation Data Type](#) or [Redefinition Implementation Data Type](#) redefining a [Primitive Implementation Data Type](#).

[SWS_Rte_03562] [For the primitive type signature, the `Rte_IrvRead` call shall return the value of the accessed `InterRunnableVariable`.] ([SRS_Rte_00142](#), [SRS_Rte_00051](#))

For complex type signature, the `Rte_IrvRead` call does not return any value (void).

Notes: The runnable entity name in the signature allows runnable context specific optimizations.

The concept of `InterRunnableVariables` is explained in section [4.2.6.6](#). Further details about `InterRunnableVariables` with *explicit* behavior are explained in Section [4.2.6.6.2](#).

5.6.29 Rte_IrvWrite

Purpose: Provide **write** access to the *InterRunnableVariables* with *explicit behavior* of an AUTOSAR SW-C.

Signature: **[SWS_Rte_03565]** [

```
void Rte_[Byps_]IrvWrite_<re>_<o>(  

    [IN RTE_Instance <instance>],  

    IN <data>)
```

Where `<re>` is the name of the runnable entity the API might be used in, `<o>` is the name of the `InterRunnableVariable` to access and `<data>` is the placeholder for the data the `InterRunnableVariable` shall be set to. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_BSW_00310](#), [SRS_Rte_00142](#))

Existence: **[SWS_Rte_01306]** [An `Rte_IrvWrite` API shall be created for each written `InterRunnableVariable` using explicit access.] ([SRS_Rte_00142](#), [SRS_Rte_00051](#))

[SWS_Rte_CONSTR_09090] `Rte_IrvWrite` API may only be used by the runnable that describe its usage [The `Rte_IrvWrite` API may only be used by the runnable that contains the corresponding `VariableAccess` in the `writtenLocalVariable` role.]()

Description: The `Rte_IrvWrite` API provides write access to the `InterRunnableVariables` with *explicit* behavior within a component description.

The return value is unused. The return value is not required to pass error information to the user because no inter-ECU communication is involved and the value can always be written.

[SWS_Rte_03567] [The `Rte_IrvWrite` API call include the IN parameter `<data>` to pass the data element to write.]([SRS_Rte_00142](#), [SRS_Rte_00051](#))

The IN parameter `<data>` is passed by value or reference according to the `ImplementationDataType` as described in the section [5.2.6.5](#).

If the IN parameter `<data>` is passed by reference, the pointer must remain valid until the API call returns.

Return Value: None.

Notes: The runnable entity name in the signature allows runnable context specific optimizations.

The concept of `InterRunnableVariables` is explained in section [4.2.6.6](#). Further details about `InterRunnableVariables` with *explicit* behavior are explained in Section [4.2.6.6.2](#).

5.6.30 Rte_Enter

Purpose: Enter an exclusive area.

Signature: **[SWS_Rte_01120]** [
`void`
`Rte_[Byp_]Enter_[<re>]<name> (`
`[IN Rte_Instance <instance>])`

Where `<re>` is the runnable entity name, `<name>` is the exclusive area name. The sub part in squared brackets `[<re>_]` is emitted if the attribute `SwcExclusiveAreaPolicy.apiPrinciple` is set to "perExecutable". `[Byp_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).]([SRS_BSW_00310](#), [SRS_Rte_00046](#), [SRS_Rte_00115](#))

Existence: **[SWS_Rte_01307]** [An `Rte_Enter` API shall be created for each `ExclusiveArea` that is declared and which has an `canEnterExclusiveArea` association.]([SRS_Rte_00115](#), [SRS_Rte_00051](#))

Description: The `Rte_Enter` API call is invoked by an AUTOSAR software-component to define the start of an exclusive area.

Return Value: None.

Notes: The RTE is not required to support nested invocations of `Rte_Enter` for the same exclusive area.

[SWS_Rte_01122] [The RTE shall permit calls to `Rte_Enter` and `Rte_Exit` to be nested as long as different exclusive areas are exited in the reverse order they were entered.]([SRS_Rte_00046](#), [SRS_Rte_00032](#), [SRS_Rte_00115](#))

[SWS_Rte_CONSTR_09028] `Rte_Enter` and `Rte_Exit` API may only be used by runnables describing its usage [The `Rte_Enter` and `Rte_Exit` API may only be used by *Runnable Entities* that contain a corresponding *canEnterExclusiveArea* association]()

[SWS_Rte_CONSTR_09029] Nested call of `Rte_Enter` and `Rte_Exit` is restricted [The `Rte_Enter` and `Rte_Exit` API may only be called nested if different exclusive areas are invoked; in this case exclusive areas shall be exited in the reverse order they were entered.]()

Within the AUTOSAR OS an attempt to lock a resource cannot fail because the lock is already held. The lock attempt can only fail due to configuration errors (e.g. caller not declared as accessing the resource) or invalid handle. Therefore the return type from this function is `void`.

5.6.31 Rte_Exit

Purpose: Leave an exclusive area.

Signature: **[SWS_Rte_01123]** [`void`
`Rte_[Byp_]Exit_[<re>]<name>(
[IN Rte_Instance <instance>])`

Where `<re>` is the runnable entity name, `<name>` is the exclusive area name. The sub part in squared brackets `[<re>_]` is emitted if the attribute `SwcExclusiveAreaPolicy.apiPrinciple` is set to "perExecutable". `[Byp_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).]([SRS_BSW_00310](#), [SRS_Rte_00046](#), [SRS_Rte_00051](#))

Existence: **[SWS_Rte_01308]** [An `Rte_Exit` API shall be created for each *ExclusiveArea* that is declared and which has an *canEnterExclusiveArea* association.]([SRS_Rte_00115](#), [SRS_Rte_00051](#))

Description: The `Rte_Exit` API call is invoked by an AUTOSAR software-component to define the end of an exclusive area.

Return Value: None.

Notes: The RTE is not required to support nested invocations of `Rte_Exit` for the same exclusive area.

Requirement [SWS_Rte_01122] permits calls to `Rte_Enter` and `Rte_Exit` to be nested as long as different exclusive areas are exited in the reverse order they were entered.

5.6.32 Rte_Mode

There exist two versions of the `Rte_Mode` API. Depending on the attribute `enhancedModeApi` in the *software component description* there shall be provided different versions of this API (see also 5.6.33).

Purpose: Provides the currently active mode of a mode switch port.

Signature: [SWS_Rte_02628] [
`<return>`
`Rte_[Byp_]Mode_<p>_<o>([IN Rte_Instance <instance>])`
 Where `<p>` is the port name, and `<o>` the `ModeDeclarationGroupPrototype` name within the `ModeSwitchInterface` categorizing the port. `[Byp_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] (SRS_Rte_00144)

Existence: [SWS_Rte_02629] [If a `ModeAccessPoint` exists and if the attribute `enhancedModeApi` of the `ModeSwitchSenderComSpec` resp. `ModeSwitchReceiverComSpec` is set to *false* or does not exist a `Rte_Mode` API according to [SWS_Rte_02628] shall be generated.] (SRS_Rte_00147, SRS_Rte_00078)

[SWS_Rte_CONSTR_09030] **`Rte_Mode` API may only be used by the runnable that describe its usage** [The `Rte_Mode` API may only be used by the runnable that contains the corresponding `ModeAccessPoint`]()

Description: The `Rte_Mode` API tells the AUTOSAR software-component which mode of a `ModeDeclarationGroup` of a given port is currently active. This is the information that the RTE uses for the *mode disabling dependency*'s. A new mode will not be indicated immediately after the reception of a *mode switch notification* from a *mode manager*, see section 4.4.4. During mode transitions, i.e. during the execution of runnables that are triggered on exiting one mode or on entering the next mode, overlapping mode disablings

of two modes are active. In this case, the `Rte_Mode` will return `RTE_TRANSITION_<ModeDeclarationGroup>`.

The `Rte_Mode` will return the same mode for all `mode switch ports` that are connected to the same `mode switch port` of the `mode manager` (see [SWS_Rte_02630]).

It is supported to have `ModeAccessPoint(s)` referring the provide `mode switch ports` of the `mode manager` to provide access for the `mode manager` on the information that the RTE uses for the `mode disabling dependency's`.

Return Value: The return type of `Rte_Mode` is dependent on the `ImplementationDataType` of the `ModeDeclarationGroup`. It shall return the value of the `ModeDeclarationGroupPrototype`. The type name shall be equal to the `shortName` of the `ImplementationDataType`.

The return value of the `Rte_Mode` is used to inform the caller about the current mode of the `mode machine instance`. The `Rte_Mode` API shall return the following values:

[SWS_Rte_07666] [During a transition of the `mode machine instance`, `Rte_Mode` shall return `RTE_TRANSITION_<ModeDeclarationGroup>`, where `<ModeDeclarationGroup>` is the short name of the `ModeDeclarationGroup`.] (SRS_Rte_00144)

[SWS_Rte_02660] [When the `mode machine instance` is in a defined mode, `Rte_Mode` shall return `RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>`, where `<ModeDeclarationGroup>` is the short name of the `ModeDeclarationGroup` and `<ModeDeclaration>` is the short name of the currently active `ModeDeclaration`.] (SRS_Rte_00144)

[SWS_Rte_06742] [The API `Rte_Mode` shall return the value `RTE_TRANSITION_<ModeDeclarationGroup>` for a `mode machine instance` assigned to the RTE ([SWS_Rte_07533]) until the RTE has been initialized and where `<ModeDeclarationGroup>` is the short name of the `ModeDeclarationGroup`.] (SRS_Rte_00144)

[SWS_Rte_06781] [If `modeManagerErrorBehavior.errorReactionPolicy` is set to `defaultMode` the API `Rte_Mode` shall return the value `RTE_TRANSITION_<ModeDeclarationGroup>` for a `mode machine instance` while the partition of the `mode users` is stopped or restarting and until the RTE dequeues the next `mode switch notifications`.

<ModeDeclarationGroup> is the short name of the [ModeDeclarationGroup](#).] ([SRS_Rte_00144](#)) This indicates a transition and therefore the behavior is identical as during the initialization of the RTE (see [[SRS_Rte_00144](#)]).

[SWS_Rte_06782] [If the [modeManagerErrorBehavior.errorReactionPolicy](#) is set to [lastMode](#), the API enhanced [Rte_Mode](#) shall return the value [RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>](#) of the last mode for a [mode machine instance](#) while the partition of the [mode users](#) is stopped or restarting and until the RTE dequeues the next [mode switch notifications](#).
 <ModeDeclarationGroup> is the short name of the [ModeDeclarationGroup](#).] ([SRS_Rte_00144](#)) This indicates a stable mode during the re-initialization of the partition until the RTE is capable to dequeue the first [mode switch notification](#) after the partition restart.

[SWS_Rte_06743] [The [Rte_Mode](#) API shall return the values according [[SWS_Rte_07666](#)] and [[SWS_Rte_02660](#)] for a [common mode machine instance](#) already after initialization of the *Basic Software Scheduler*.] ([SRS_Rte_00144](#))

In inter partition mode management, RTE on the [mode manager](#) sided partition might not have direct access to the state variables of the [mode machine instance](#).

[SWS_Rte_02732] [In inter partition mode management, the return value of the [Rte_Mode](#) API to the [mode manager](#) shall be consistent with the start of a transition by the [Rte_Switch](#) API and the inter partition communication of the [ModeSwitchedAckEvent](#).] ([SRS_Rte_00144](#), [SRS_Rte_00210](#))

Notes:

The [Rte_Mode](#) API may already indicate the next [ModeDeclaration](#), before the [mode manager](#) has picked up the [ModeSwitchedAckEvent](#) with the [Rte_SwitchAck](#). This is not in contradiction to [[SWS_Rte_02732](#)].

[SWS_Rte_06744] [The RTE shall support calls of [Rte_Mode](#) after initialization of the *Basic Software Scheduler* but before the RTE is initialized.] ([SRS_Rte_00144](#))

5.6.33 Enhanced Rte_Mode

Purpose:

Provides the currently active mode of a mode switch port. If the [mode machine instance](#) is in transition additionally the values of the previous and the next mode are provided.

Signature: [SWS_Rte_08500] [

```

<return>
Rte_[Byps_]Mode_<p>_<o>([IN Rte_Instance <instance>],
                        OUT <previousmode>,
                        OUT <nextmode>)

```

Where <p> is the port name, and <o> the [ModeDeclarationGroupPrototype](#) name within the [ModeSwitchInterface](#) categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).] ([SRS_Rte_00144](#))

Existence: [SWS_Rte_08501] [The existence of a [ModeAccessPoint](#) given that the attribute *enhancedModeApi* of the [ModeSwitchSenderComSpec](#) resp. [ModeSwitchReceiverComSpec](#) is set to *true* shall result in the generation of a [Rte_Mode](#) API according to [\[SWS_Rte_08500\]](#).] ([SRS_Rte_00147](#), [SRS_Rte_00078](#))

[SWS_Rte_CONSTR_09031] [Rte_Mode](#) API may only be used by the runnable that describe its usage [The [Rte_Mode](#) API may only be used by the runnable that contains the corresponding [ModeAccessPoint](#)]()

Description: The [Rte_Mode](#) API tells the AUTOSAR software-component which mode of a [ModeDeclarationGroup](#) of a given port is currently active. This is the information that the RTE uses for the [mode disabling dependency](#)'s. A new mode will not be indicated immediately after the reception of a [mode switch notification](#) from a [mode manager](#), see section [4.4.4](#). During mode transitions, i.e. during the execution of runnables that are triggered on exiting one mode or on entering the next mode, overlapping mode disablings of two modes are active. In this case, the [Rte_Mode](#) will return [RTE_TRANSITION_<ModeDeclarationGroup>](#). The parameter <previousmode> than contains the mode currently being left, the parameter <nextmode> the mode being entered.

The [Rte_Mode](#) will return the same mode for all [mode switch ports](#) that are connected to the same [mode switch port](#) of the [mode manager](#) (see [\[SWS_Rte_02630\]](#)).

It is supported to have [ModeAccessPoint](#)(s) referring the provided [mode switch ports](#) of the [mode manager](#) to provide access for the [mode manager](#) on the information that the RTE uses for the [mode disabling dependency](#)'s.

Return Value: The return type of [Rte_Mode](#) is dependent on the [ImplementationDataType](#) of the [ModeDeclarationGroup](#). It shall return the value of the [ModeDeclarationGroupPrototype](#). The type name shall be equal to the [shortName](#) of the [ImplementationDataType](#). The return value of the [Rte_Mode](#) and the parameters

<previousmode> and <nextmode> are used to inform the caller about the current mode of the [mode machine instance](#).

[SWS_Rte_08504] [During a transition of a [mode machine instance](#) [Rte_Mode](#) shall return the following values

- the return value shall be
RTE_TRANSITION_<ModeDeclarationGroup>,
- <previousmode> shall contain the value of the
RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>
of the mode being left,
- <nextmode> shall contain the
RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>
of the mode being entered,

where <ModeDeclarationGroup> is the short name of the [Mode-DeclarationGroup](#) and <ModeDeclaration> is the short name of the [ModeDeclaration](#).] ([SRS_Rte_00144](#), [SRS_Rte_00210](#))

[SWS_Rte_08505] [When the [mode machine instance](#) is in a defined mode, [Rte_Mode](#) shall return the following values

- the return value shall contain the value of
RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>,
- <previousmode> shall contain the value of the
RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>
- <nextmode> shall contain the
RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>

where <ModeDeclarationGroup> is the short name of the [Mode-DeclarationGroup](#) and <ModeDeclaration> is the short name of the currently active [ModeDeclaration](#).] ([SRS_Rte_00144](#))

[SWS_Rte_06745] [The API enhanced [Rte_Mode](#) shall return the following values for a [mode machine instance](#) assigned to the RTE ([SWS_Rte_07533](#)) until the RTE has been initialized:

- the return value shall be
RTE_TRANSITION_<ModeDeclarationGroup>,
- <previousmode> shall contain the value of the
RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>
of the [initialMode](#) of the [ModeDeclarationGroup](#)
- <nextmode> shall contain the value of the
RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>
of the [initialMode](#) of the [ModeDeclarationGroup](#)

where `<ModeDeclarationGroup>` is the short name of the `ModeDeclarationGroup`.] (*SRS_Rte_00144*)

[SWS_Rte_06783] [If

`modeManagerErrorBehavior.errorReactionPolicy` is set to `defaultMode` the API enhanced `Rte_Mode` shall return the following values for a `mode machine instance` while the partition of the mode users is stopped or restarting and until the RTE dequeues the next `mode switch notifications`.

- the return value shall be
`RTE_TRANSITION_<ModeDeclarationGroup>`,
- `<previousmode>` shall contain the value of the `RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>` of the `modeUserErrorBehavior.defaultMode` of the `ModeDeclarationGroup`
- `<nextmode>` shall contain the value of the `RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>` of the `modeUserErrorBehavior.defaultMode` of the `ModeDeclarationGroup`

where `<ModeDeclarationGroup>` is the short name of the `ModeDeclarationGroup`.] (*SRS_Rte_00144*) This indicates a transition from and to the `defaultMode`. If the `defaultMode` is identical to the `initialMode` the behavior is identical as during the initialization of the RTE (see [*SRS_Rte_00144*]).

[SWS_Rte_06784] [If the

`modeManagerErrorBehavior.errorReactionPolicy` is set to `lastMode`, the API enhanced `Rte_Mode` shall return the following values for a `mode machine instance` while the partition of the mode users is stopped or restarting and until the RTE dequeues the next `mode switch notifications`.

- the return value shall be
`RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>` of the last mode,
- `<previousmode>` shall contain the value of the `RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>` of the last mode
- `<nextmode>` shall contain the value of the `RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>` of the last mode

where `<ModeDeclarationGroup>` is the short name of the `ModeDeclarationGroup`.] (*SRS_Rte_00144*) This indicates a stable mode during the re-initialization of the partition until the RTE is

capable to dequeue the first `mode switch notification` after the partition restart.

[SWS_Rte_06746] [The enhanced `Rte_Mode` API shall return the values according [SWS_Rte_08504] and [SWS_Rte_08505] for a `common mode machine instance` already after initialization of the *Basic Software Scheduler*.] (*SRS_Rte_00144*)

In inter partition mode management, RTE on the `mode manager` sided partition might not have direct access to the state variables of the `mode machine instance`.

[SWS_Rte_08506] [In inter partition mode management, the return value and the contents of the parameters `<previousmode>` and `<nextmode>` of the `Rte_Mode` API to the `mode manager` shall be consistent with the start of a transition by the `Rte_Switch` API and the inter partition communication of the `ModeSwitchedAckEvent`.] (*SRS_Rte_00144*, *SRS_Rte_00210*)

Notes: The `Rte_Mode` API may already indicate the next `ModeDeclaration`, before the `mode manager` has picked up the `ModeSwitchedAckEvent` with the `Rte_SwitchAck`. This is not in contradiction to [SWS_Rte_02732].

[SWS_Rte_06747] [The RTE shall support calls of the enhanced `Rte_Mode` after initialization of the *Basic Software Scheduler* but before the RTE is initialized.] (*SRS_Rte_00144*)

5.6.34 Rte_Trigger

Purpose: Raise an external trigger of a trigger port.

Signature: **[SWS_Rte_07200]** [signature if `returnValueProvision` of the related `ExternalTriggeringPoint(s)` is set to `noReturnValueProvided`:

```
void Rte_[Byps_]Trigger_<p>_<o> (
    [IN Rte_Instance <instance>],
    [OUT Std_TransformerError transformerError])
```

signature if `returnValueProvision` of the related `ExternalTriggeringPoint(s)` not set to `noReturnValueProvided`:

```
Std_ReturnType Rte_[Byps_]Trigger_<p>_<o> (
    [IN Rte_Instance <instance>])
```

Where `<p>` is the port name and `<o>` the `Trigger` within the trigger interface categorizing the port. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for

the related software component type (See chapter 4.9.2).](SRS_Rte_00162)

Data Transformation of external triggers is only supported for external triggers without queueing support.

Existence: [SWS_Rte_07201] [The existence of an `ExternalTriggeringPoint` shall result in the generation of a `Rte_Trigger` API.](SRS_Rte_00162)

[SWS_Rte_05300] [The optional OUT parameter `transformerError` of the API shall be generated if the `PortPrototype` of port <p> is referenced by a `PortAPIOption` which has the attribute `errorHandling` set to `transformerErrorHandling`.](SRS_Rte_00249)

[SWS_Rte_CONSTR_09032] **`Rte_Trigger` API may only be used by the runnable that describe its usage** [The `Rte_Trigger` API may only be used by the runnable that contains the corresponding `ExternalTriggeringPoint`.]()

Description: The `Rte_Trigger` API triggers an execution for all runnables whose `ExternalTriggerOccurredEvent` is associated to the `Trigger`. The OUT parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter 4.10.5.

Return Value: None if `returnValueProvision` of the related `ExternalTriggeringPoint(s)` is set to `noReturnValueProvided`.

[SWS_Rte_06720] [The `Rte_Trigger` API shall return the following values:

- `RTE_E_OK` if the trigger was successfully queued
- `RTE_E_LIMIT` if the trigger was not queued because the maximum queue size is already reached.

if `returnValueProvision` of the related `ExternalTriggeringPoint(s)` not set to `noReturnValueProvided`.](SRS_Rte_00235)

5.6.35 Rte_IrTrigger

Purpose: Raise an internal trigger to activate Runnable entities of the same software component instance.

Signature: [SWS_Rte_07203] [signature if `returnValueProvision` of the related `InternalTriggeringPoint(s)` is set to `noReturnValueProvided`:

```
void Rte_[Byps_]IrTrigger_<re>_<o>(
    [IN Rte_Instance <instance>])
```

signature if `returnValueProvision` of the related `InternalTriggeringPoint(s)` not set to `noReturnValueProvided`:

```
Std_ReturnType Rte_[Byps_]IrTrigger_<re>_<o>(
    [IN Rte_Instance <instance>])
```

Where `<re>` is the name of the runnable entity the API might be used in and `<o>` is the name of the `InternalTriggeringPoint`. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] (*SRS_Rte_00163*)

Existence: [SWS_Rte_07204] [The existence of an `InternalTriggeringPoint` shall result in the generation of a `Rte_IrTrigger` API.] (*SRS_Rte_00163*)

[SWS_Rte_CONSTR_09033] **`Rte_IrTrigger` API may only be used by the runnable that describe its usage** [The `Rte_IrTrigger` API may only be used by the runnable that contains the corresponding `InternalTriggeringPoint`.]()

Description: The `Rte_IrTrigger` triggers an execution for all runnables whose `InternalTriggerOccurredEvent` is associated to the `InternalTriggeringPoint`.

Return Value: None if `returnValueProvision` of the related `InternalTriggeringPoint(s)` is set to `noReturnValueProvided`.

[SWS_Rte_06721] [The `Rte_IrTrigger` API shall return the following values:

- RTE_E_OK if the trigger was successfully queued
- RTE_E_LIMIT if the trigger was not queued because the maximum queue size is already reached.

if `returnValueProvision` of the related `InternalTriggeringPoint(s)` not set to `noReturnValueProvided`.] (*SRS_Rte_00235*)

Notes: None.

5.6.36 Rte_IFeedback

Purpose: Provide access to acknowledgement notifications for implicit sender receiver communication and to pass error notification to senders.

Signature: [SWS_Rte_07367] [

```
Std_ReturnType
Rte_[Byps_]IFeedback_<re>_<p>_<o> (
    [IN RTE_Instance <instance>])
```

Where <re> is the runnable entity name, <p> the port name and <o> the [VariableDataPrototype](#) within the sender-receiver interface categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] ([SRS_BSW_00310](#), [SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))

Existence: Note: according to [[SWS_Rte_01283](#)], acknowledgment is enabled for a provided [VariableDataPrototype](#) by the existence of a [TransmissionAcknowledgementRequest](#) in the [SenderComSpec](#).

[SWS_Rte_07646] [An [Rte_IFeedback](#) API shall be created for a provided [VariableDataPrototype](#) if acknowledgment is enabled and the [RunnableEntity](#) has a [VariableAccess](#) in the [dataWriteAccess](#) role referring to this [VariableDataPrototype](#).] ([SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))

[SWS_Rte_07647] [An [Rte_IFeedback](#) API shall be created for a provided [VariableDataPrototype](#) if acknowledgment is enabled and a [DataWriteCompletedEvent](#) references the [RunnableEntity](#) as well as the [VariableAccess](#) which in turn references the [VariableDataPrototype](#).] ([SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))

[SWS_Rte_07648] [If acknowledgment is enabled for a provided [VariableDataPrototype](#) and a [DataWriteCompletedEvent](#) references a runnable entity as well as the [VariableAccess](#) which in turn references the [VariableDataPrototype](#), the runnable entity shall be activated when the transmission acknowledgment occurs or when a timeout was detected by the RTE. See [[SWS_Rte_07379](#)].] ([SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))

[SWS_Rte_CONSTR_09000] [Rte_IFeedback](#) API may only be used by the [RunnableEntity](#)s that describe its usage [The [Rte_IFeedback](#) API shall only be used by a [RunnableEntity](#) that either has a [VariableAccess](#) in the [dataWriteAccess](#) role referring to the [VariableDataPrototype](#) or is triggered by a [DataWriteCompletedEvent](#) referring to the [VariableAccess](#) which in turn references the [VariableDataPrototype](#).] ()

Description: The [Rte_IFeedback](#) API takes no parameters other than the instance handle – the return value is used to indicate the acknowledgment status to the caller.

The `Rte_IFeedback` API applies only to implicit sender-receiver communication.

The `Rte_IFeedback` API provides access to the transmission feedback of the data elements, declared as sent by a runnable using a `VariableAccess` in the `dataWriteAccess` role, and sent after the previous invocation of the runnable. The API function is guaranteed to be have constant execution time and therefore can also be used within category 1A runnable entities.

The required consistency access by a runnable can be provided by copying of the status before the execution of the runnable so that it cannot be modified by the RTE during the lifetime of the runnable entity.

Return Value: The return value is used to indicate the “status” status and errors detected by the RTE during execution of the `Rte_IFeedback` call.

- **[SWS_Rte_07374]** `[RTE_E_NO_DATA` – No acknowledgments or error notifications were received from COM when the runnable entity was started.]([SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))
- **[SWS_Rte_07375]** `[RTE_E_COM_STOPPED` – (Inter-ECU communication only) The last transmission was rejected (when the local buffer was sent), with an `RTE_E_COM_STOPPED` return code or an error notification was received from COM before any timeout notification.]([SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))
- **[SWS_Rte_07650]** `[RTE_E_TIMEOUT` – (Inter-ECU only) A timeout notification was received from COM before any error notification.]([SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))
- **[SWS_Rte_07376]** `[RTE_E_TRANSMIT_ACK` – A transmission acknowledgment was received. This error code is valid for both inter-ECU and intra-ECU communication.]([SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))
- **[SWS_Rte_07660]** `[RTE_E_UNCONNECTED` – Indicates that the sender port is not connected.]([SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#), [SRS_Rte_00139](#))
- **[SWS_Rte_08580]** `[RTE_E_HARD_TRANSFORMER_ERROR` – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_08581]** `[RTE_E_SOFT_TRANSFORMER_ERROR` – The return value of at least one transformer in the transformer

chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

The RTE_E_NO_DATA, RTE_E_TRANSMIT_ACK and RTE_E_UNCONNECTED return values are not considered to be an error but rather indicates correct operation of the API call.

[SWS_Rte_07651] [The initial return value of the [Rte_IFeedback](#) API, when the runnable entity is executed before any attempt to write some data shall be RTE_E_TRANSMIT_ACK.]([SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00129](#), [SRS_Rte_00185](#))

[SWS_Rte_08074] [In case of multiple faults during a call of [Rte_IFeedback](#) the resulting return value shall be derived according to the following priority rules (highest priority first): (1) RTE_E_UNCONNECTED, (2) RTE_E_TIMEOUT, (3) RTE_E_HARD_TRANSFORMER_ERROR, (4) RTE_E_COM_STOPPED, (5) RTE_E_NO_DATA, (6) RTE_E_SOFT_TRANSFORMER_ERROR, (7) RTE_E_TRANSMIT_ACK.]([SRS_Rte_00122](#))

Notes: See the notes for the [Rte_Feedback](#) API in section [5.6.8](#).

5.6.37 Rte_IsUpdated

Purpose: Provide access to the update flag for an explicit receiver.

Signature: **[SWS_Rte_07390]** [

```
boolean Rte_[Byps_]IsUpdated_<p>_<o>(  

    [IN RTE_Instance <instance>])
```

Where <p> is the port name and <o> the [VariableDataPrototype](#) within the sender-receiver interface categorizing the port. [Byps_] is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter [4.9.2](#)).]([SRS_BSW_00310](#), [SRS_Rte_00179](#))

Existence: **[SWS_Rte_07391]** [An [Rte_IsUpdated](#) API shall be created for a required [VariableDataPrototype](#) if a [RunnableEntity](#) has a [VariableAccess](#) in the [dataReceivePointByArgument](#) or [dataReceivePointByValue](#) role referring to the [VariableDataPrototype](#) and the [enableUpdate](#) attribute is enabled in the [NonqueuedReceiverComSpec](#) of the [VariableDataPrototype](#).]([SRS_Rte_00179](#))

[SWS_Rte_CONSTR_09034] **Rte_IsUpdated** API may only be used by the runnable that describe the access to the corresponding data [The [Rte_IsUpdated](#) API may only be used by the runnable that contains the corresponding [VariableAccess](#) in

the `dataReceivePointByArgument` or `dataReceivePointByValue` role.](`()`)

Description: The `Rte_IsUpdated` API takes no parameters other than the instance handle – the return value is used to indicate if the `VariableDataPrototype` has been updated or not.

The `Rte_IsUpdated` API applies only to sender-receiver communication.

Return Value: The return value is used to indicate if the `VariableDataPrototype` has been updated or not.

- **[SWS_Rte_07392]** [TRUE – Data element updated since last read.](`SRS_Rte_00094`, `SRS_Rte_00179`)
- **[SWS_Rte_07393]** [FALSE – Data element not updated since last read.](`SRS_Rte_00094`, `SRS_Rte_00179`)

Notes: None.

5.6.38 Rte_PBCon

Purpose: Provide access to the individual post-build artifacts of a `VariationPointProxy` for SWCs of a system containing different variants.

Signature: **[SWS_Rte_08066]** [`<return>`
`Rte_[Byps_]PBCon_<vpp> ()`]

Where `<vpp>` is the `shortName` of the `VariationPointProxy`. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).](`SRS_Rte_00191`)

Existence: **[SWS_Rte_08067]** [A `Rte_PBCon` API shall be generated, if a `PostBuildVariantCriterion` or at least one `PostBuildVariantCondition` is defined for the `VariationPointProxy`.](`SRS_Rte_00191`)

Description: Depending on the `category` of the `VariationPointProxy` (see Software Component Template [2]), the `Rte_PBCon` API provides either access to the `PostBuildVariantCriterion` or to the result of the evaluation of the `PostBuildVariantConditions` against the `PostBuildVariantCriterion`.

Return Value: **[SWS_Rte_08068]** [For `VariationPointProxys` of `category` VALUE the return value of `Rte_PBCon` shall be an integer value yielding from the `VariationPointProxy.postBuildValueAccess`.

The return type of `Rte_PBCon` shall be in this case conform with the `ImplementationDataType` defined by `VariationPointProxy.implementationDataType`.] ([SRS_Rte_00191](#))

[SWS_Rte_08069] [For `VariationPointProxys` of category `CONDITION` the return value of `Rte_PBCon` shall be the result of the evaluated expression $PBExp \wedge_{PBVarCon} (VariationPointProxy.postBuildValueAccess = PostBuildVariantCondition.value)$, where $PBVarCon$ is the set of all `postBuildVariantConditions` of the `VariationPointProxy`. If a pre-build condition is defined in addition the return value shall be the result of the evaluated expression $PPBExp: VariationPointProxy.conditionAccess \wedge PBExp$.

The return type of `Rte_PBCon` shall be in this case the Platform Type `boolean`.] ([SRS_Rte_00191](#))

Notes: **[SWS_Rte_08070]** [For `VariationPointProxys` of category `CONDITION` that are using both `conditionAccess` and `postBuildVariantCondition` the RTE shall ensure in `Rte_PBCon` that pre-build conditions have precedence over post-build conditions.] ([SRS_Rte_00191](#))

More details regarding `Rte_PBCon` API can be found in section [4.7.5](#).

5.6.39 Rte_IsAvailable

Purpose: Provide access to the availability information for an optional member of an `ImplementationDataType` of category `STRUCTURE`.

Signature: **[SWS_Rte_03611]** [
`boolean`
`Rte_IsAvailable_<i>_<e>(IN <data>)`

Where `<i>` is the `shortName` of the `ImplementationDataType` of category `STRUCTURE` and `<e>` the `shortName` of the `ImplementationDataTypeElement`.] ([SRS_Rte_00261](#))

Existence: **[SWS_Rte_03612]** [An `Rte_IsAvailable` API shall be generated for an `ImplementationDataTypeElement` of an `ImplementationDataType` when the attribute `isOptional` of the `ImplementationDataTypeElement` is set to true.] ([SRS_Rte_00261](#))

Description: The `Rte_IsAvailable` API takes a concrete variable as input by reference (e.g. the returned data of `Rte_Read`). The variable must be of type `<i>`. The return value is used to indicate whether the optional member `<e>` is available within the variable of type `<i>`.

- Return Value:**
- **[SWS_Rte_03613]** [TRUE – The optional member <i> is available.]([SRS_Rte_00261](#))
 - **[SWS_Rte_03614]** [FALSE – The optional member <i> is not available.]([SRS_Rte_00261](#))

Notes: None.

5.6.40 Rte_SetAvailable

Purpose: Sets the availability information for an optional member of an [ImplementationDataType](#) of category STRUCTURE.

Signature: **[SWS_Rte_03615]** [
void
Rte_SetAvailable_<i>_<e>(IN/OUT <data>,
boolean available)

Where <i> is the [shortName](#) of the [ImplementationDataType](#) of category STRUCTURE and <e> the [shortName](#) of the [ImplementationDataTypeElement](#).]([SRS_Rte_00261](#))

Existence: **[SWS_Rte_03616]** [An [Rte_SetAvailable](#) API shall be generated for an [ImplementationDataTypeElement](#) of an [ImplementationDataType](#) when the attribute [isOptional](#) of the [ImplementationDataTypeElement](#) is set to true.]([SRS_Rte_00261](#))

Description: The [Rte_SetAvailable](#) API takes a concrete variable as input by reference (e.g. a variable which will be passed to an [Rte_Write](#) call). The variable must be of type <i>. The API sets the availability of the struct member <e> within the variable to the value defined by the [available](#) parameter.

Return Value: None.

Notes: None.

5.6.41 Rte_SetMetaDatum

Purpose: Sets the value of a [MetaDatum](#) of optional meta data of a data element.

Signature: **[SWS_Rte_03622]** [
void
Rte_SetMetaDatum_<o>_<m>(IN/OUT <metaDataPtr>, IN <metaDatumValue>)

Where `<o>` is the [VariableDataPrototype](#) which is referenced by a [MetaDataItemSet](#) and `<m>` is the [shortLabel](#) of the [ValueSpecification](#) aggregated by the [MetaDataItem](#). `<metaDataPtr>` is the pointer to the meta data byte array. `<metaDataItemValue>` is an integer determined by the [length](#) of the [MetaDataItem](#).] ([SRS_Rte_00322](#))

Existence: **[SWS_Rte_03623]** [An [Rte_SetMetaDataItem](#) API shall be generated for each [MetaDataItem](#) of a [MetaDataItemSet](#) which references a [VariableDataPrototype](#).] ([SRS_Rte_00322](#))

Description: The [Rte_SetMetaDataItem](#) API takes a meta data byte array as input and writes the given `<metaDataItemValue>` into this byte array. The position in the byte array can be determined by the position of the [MetaDataItem](#) in the [MetaDataItemSet](#) and by the [length](#) attribute of the [MetaDataItems](#).

Return Value: None.

Notes: None.

5.6.42 Rte_GetMetaDataItem

Purpose: Gets the value of a [MetaDataItem](#) of optional meta data of a data element.

Signature: **[SWS_Rte_03624]** [
`<metaDataItemValue>`
[Rte_GetMetaDataItem_<o>_<m>](#) (IN `<metaDataPtr>`)

Where `<o>` is the [VariableDataPrototype](#) which is referenced by a [MetaDataItemSet](#) and `<m>` is the [shortLabel](#) of the [ValueSpecification](#) aggregated by the [MetaDataItem](#). `<metaDataPtr>` is the pointer to the meta data byte array. `<metaDataItemValue>` is an integer determined by the [length](#) of the [MetaDataItem](#).] ([SRS_Rte_00322](#))

Existence: **[SWS_Rte_03625]** [An [Rte_GetMetaDataItem](#) API shall be generated for each [MetaDataItem](#) of a [MetaDataItemSet](#) which references a [VariableDataPrototype](#).] ([SRS_Rte_00322](#))

Description: The [Rte_GetMetaDataItem](#) API takes a meta data byte array as input and returns the value of the [MetaDataItem](#) as stored in this byte array. The position in the byte array can be determined by the position of the [MetaDataItem](#) in the [MetaDataItemSet](#) and by the [length](#) attribute of the [MetaDataItems](#).

Return Value: The value of the [MetaDataItem](#).

Notes: None.

5.6.43 Rte_GetMetaDataLength

Purpose: Gets the length of the meta data byte array of optional meta data of a data element.

Signature: **[SWS_Rte_03626]** [
<length>
Rte_GetMetaDataLength_<o> ()

Where <o> is the [VariableDataPrototype](#) which is referenced by a [MetaDataItemSet](#). <length> is an integer determined by the sum of all [MetaDataItem.length](#) in the [MetaDataItemSet](#).] ([SRS_Rte_00322](#))

Existence: **[SWS_Rte_03627]** [An [Rte_GetMetaDataLength](#) API shall be generated for each [VariableDataPrototype](#) which is referenced by a [MetaDataItemSet](#).] ([SRS_Rte_00322](#))

Description: The [Rte_GetMetaDataLength](#) API returns the length of the meta data byte array.

Return Value: The length of the meta data byte array.

Notes: None.

5.7 Runnable Entity Reference

An AUTOSAR component defines one or more “runnable entities”. A runnable entity is a piece of code with a single entry point and an associate set of data. A software-component description provides definitions for each runnable entity within the software-component.

For components implemented using C or C++ the entry point of a runnable entity is implemented by a function with global scope defined within a software-component’s source code. The following sections consider the function signature and prototype.

5.7.1 Signature

The definition of all runnable entities, whatever the [RTEEvent](#) that triggers their execution, follows the same basic form.

[SWS_Rte_01126] [
<void|Std_ReturnType> [Byps_] <prefix><name> (
 [IN Rte_Instance <instance>],
 [IN Rte_ActivatingEvent_<name> <activation>],
 [role parameters])

Where `<name>`⁸ is the `symbol` describing the runnable's entry point and `<prefix>` is the optional `SymbolProps.symbol` attribute of the `AtomicSwComponentType` owning the `RunnableEntity`, i.e. `<prefix>` will only appear if the attribute `SymbolProps.symbol` exists. The usage of `Rte_ActivatingEvent` is optional and defined in [SWS_Rte_08051]. The definition of the *role parameters* is defined in Section 5.7.3. `[Byps_]` is an optional infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] ([SRS_Rte_00031](#), [SRS_Rte_00011](#), [SRS_Rte_00238](#))

Section 5.2.6.4 contains details on a recommended naming conventions for runnable entities based on the `RTEEvent` that triggers the runnable entity. The recommended naming convention makes explicit the functions that implement runnable entities as well as clearly associating the runnable entity and the applicable data element or operation.

5.7.2 Entry Point Prototype

The RTE determines the required role parameters, and hence the prototype of the entry point, for a runnable entity based on information in the input information. The entry point defined in the component source *must* be compatible with the parameters passed by the RTE when the runnable entity is triggered by the RTE and therefore the RTE generator is required to emit a prototype for the function.

[SWS_Rte_01132] [The RTE generator shall emit a prototype for the runnable entity's entry point in the *Application Header File*, if the `RunnableEntity` is triggered by an `RTEEvent` and no `SwcBswRunnableMapping` exists for it.] ([SRS_Rte_00087](#), [SRS_Rte_00051](#), [SRS_Rte_00031](#))

The prototype for a function implementing the entry point of a runnable entity is emitted for both "RTE Contract" and "RTE Generation" phases. The function name for the prototype is the runnable entity's entry point. The prototype of the entry point function includes the runnable entity's instance handle and its role parameters, see Listing 5.1.

[SWS_Rte_07194] [The RTE Generator shall wrap each `RunnableEntity`'s *Entry Point Prototype* in the *Application Header File* with the *Memory Mapping* and *Compiler Abstraction* macros.

```

1  #define [Byps_] <c>_START_SEC_<sadm>
2  #include "[Byps_] <c>_MemMap.h"
3
4  FUNC(<void|Std_ReturnType>, <c>_<sadm>) [Byps_]<prefix><name> (
5                                     [IN Rte_Instance <instance>],
6                                     [IN Rte_ActivatingEvent_<name> <activation>],
7                                     [role parameters]);
8

```

⁸Runnable entities have two "names" associated with them in the AUTOSAR Software Component Template; the runnable's identifier and the entry point's symbol. The identifier is used to reference the runnable entity within the input data and the symbol used within code to identify the runnable's implementation. In the context of a prototype for a runnable entity, "name" is the runnable entity's entry point symbol.

```

9  #define [Byps_] <c>_STOP_SEC_<sadm>
10 #include "[Byps_] <c>_MemMap.h"

```

where `<c>` is the `shortName` of the software component type,

`<sadm>` is the `shortName` of the referred `swAddrMethod`.

`<prefix>` is the optional `SymbolProps.symbol` attribute of the `AtomicSwComponentType` owning the `RunnableEntity`, i.e. `<prefix>` will only appear if the attribute `SymbolProps.symbol` exists.

`<name>` is the attribute `symbol` describing the `RunnableEntity`'s entry point.

The usage of `Rte_ActivatingEvent` is optional and defined in [SWS_Rte_08051]. The definition of the *role parameters* is defined in Section 5.7.3. The Memory Mapping macros could wrap several *Entry Point Prototype* if these are referring to the same `swAddrMethod`. If `RunnableEntity` does not refer a `swAddrMethod` the `<sadm>` is set to default CODE. `[Byps_]` is an optionnal infix used when component wrapper method for bypass support is enabled for the related software component type (See chapter 4.9.2).] ([SRS_Rte_00148](#), [SRS_Rte_00149](#), [SRS_Rte_00238](#), [SRS_Rte_00011](#))

[SWS_Rte_06531] [The RTE Generator shall wrap each *Entry Point Prototype* in the *Application Header File* of a variant existent `RunnableEntity` if the variability shall be implemented.] ([SRS_Rte_00201](#))

```

1  #if (<condition>)
2
3  <Entry Point Prototype>
4
5  #endif

```

where `condition` is the *Condition Value Macro* of the `VariationPoint` relevant for the variant existence of the `RunnableEntity` (see table 4.26), *Entry Point Prototype* is the code according an invariant *Entry Point Prototype* (see also [SWS_Rte_01131], [SWS_Rte_07177], [SWS_Rte_02512], [SWS_Rte_01133], [SWS_Rte_01359], [SWS_Rte_01166], [SWS_Rte_01135], [SWS_Rte_01137], [SWS_Rte_07207], [SWS_Rte_07208], [SWS_Rte_07379]).

[SWS_Rte_01016] [The function implementing the entry point of a runnable entity shall define an instance handle as the first formal parameter if and only if the software component's `supportsMultipleInstantiation` attribute is set to TRUE.] ([SRS_Rte_00011](#), [SRS_Rte_00031](#))

The RTE will ensure that when the runnable entity is triggered the instance handle parameter indicates the correct component instance. The remaining parameters passed to the runnable entity depend on the `RTEEvent` that triggers execution of the runnable entity.

Due to the global name space of a C Linker Locator symbols of `RunnableEntity`s have to be unique in the ECU. When `AtomicSwComponentTypes` of several vendors

are integrated in the same ECU name clashes might occur if the same symbol is accidentally used twice. To ease the dissolving of name clashes the RTE supports an abstraction of the `RunnableEntity` symbol in the implementation of the software component.

[SWS_Rte_06713] [The RTE generator shall emit for each `RunnableEntity` a define for a symbolic name of the `RunnableEntity`.

```
1 #define RTE_RUNNABLE_<name> <prefix><symbol>
```

where `<name>` is the `shortName` of the `RunnableEntity`,

`<prefix>` is the optional `SymbolProps.symbol` attribute of the `AtomicSwComponentType` owning the `RunnableEntity`.

`<symbol>` is the attribute `symbol` describing the `RunnableEntity`'s entry point.

]([SRS_Rte_00087](#), [SRS_Rte_00051](#), [SRS_Rte_00031](#))

This symbolic name of the `RunnableEntity` can be used as follows in the software component implementation.

Example 5.29

For software component "HugeSwc" with a runnable "FOO" where the `SymbolProps.symbol` is set to "TinySwc" the *Application Header File* contains the definition:

```
1 /* Application Header File of HugeSwc */
2 #define RTE_RUNNABLE_FOO TinySwcfoo
```

This can be used in the software components c file for the definition of the runnable:

```
1 /* software component c file */
2 RTE_RUNNABLE_FOO()
3 {
4     /* The algorithm of foo */
5     return;
6 }
```

A change of the `SymbolProps.symbol` valued would have no effect on the c implementation of the software component but it would change the contract and the used labels in a object code delivery.

In case that the `RunnableEntity` is mapped to `BswModuleEntity` the RTE Generator has to additionally respect the definitions in [6.3.2.3.4](#).

5.7.3 Role Parameters

The *role parameters* are optional and their presence and types depend on the `RTE-Event` that triggers the execution of the runnable entity. The role parameters that are necessary for each triggering `RTEEvent` are defined in [Section 5.7.5](#).

[SWS_Rte_06703] [The RTE Generator shall name role parameters according to the value of the `symbol` attribute of `RunnableEntityArguments` if `RunnableEntityArguments` are defined for the related `RunnableEntity` and if no mapping to a `BswModuleEntry` is defined.] ([SRS_Rte_00087](#))

[SWS_Rte_06704] [The RTE Generator shall name role parameters according to the `shortName` of the `SwServiceArgs` of the mapped `BswModuleEntry` if a mapping of the `RunnableEntity` to a `BswModuleEntry` is defined.] ([SRS_Rte_00087](#))

Please note that `RunnableEntityArguments` defined for a `RunnableEntity` which is mapped to a `BswModuleEntry` are irrelevant.

[SWS_Rte_06705] [The RTE Generator shall generate nameless role parameters if neither `RunnableEntityArguments` nor a mapping to a `BswModuleEntry` is defined for the `RunnableEntity`.] ([SRS_Rte_00087](#))

Further details about the mapping of `RunnableEntity`s and `BswModuleEntry` can be found section "Synchronization with a Corresponding SWC" of the document [9]

5.7.4 Return Value

A function in C or C++ is required to have a return type. The RTE only uses the function return value to return application error codes of a server operation.

[SWS_Rte_01130] [A function implementing a runnable entity entry point shall only have the return type `Std_ReturnType`, if the runnable entity represents a server operation and the AUTOSAR interface description of that client server communication lists potential application errors. All other functions implementing a runnable entity entry point shall have a return type of `void`.] ([SRS_Rte_00124](#), [SRS_Rte_00031](#))

Note: If the potential application errors include `RTE_E_OK`, this shall also lead to a return type of `Std_ReturnType`.

[SWS_Rte_CONSTR_09045] **The upper two bits of the of the server return value are reserved** [Only the least significant six bit of the return value of a server runnable shall be used by the application to indicate an error. The upper two bit shall be zero.] ()

See also [[SWS_Rte_02573](#)].

5.7.5 Triggering Events

The RTE is the *sole* entity that can trigger the execution of a runnable entity. The RTE triggers runnable entities in response to different `RTEEvents`.

The most basic `RTEEvent` that can trigger a runnable entity is the `TimingEvent` that causes a runnable entity to be periodically triggered by the RTE. In contrast, the remaining `RTEEvents` that can trigger runnable entities all occur as a result of communication activity or as a result of mode switches.

The following subsections describe the conditions that can trigger execution of a runnable entity. For each triggering event the signature of the function (the “entry point”) that implements the runnable entity is defined. The signature definition includes two classes of parameters for each function;

1. The instance handle – the parameter type is always `Rte_Instance`. ([\[SWS_Rte_01016\]](#))
2. The role parameters – used to pass information required by the runnable entity as a consequence of the triggering condition. The presence (and number) of role parameters depends solely on the triggering condition.

5.7.5.1 TimingEvent

Purpose: Trigger a runnable entity periodically at a rate defined within the software-component description.

Signature: [\[SWS_Rte_01131\]](#) [
`void <name>([IN Rte_Instance <instance>])`
[\]\(SRS_Rte_00072\)](#)

5.7.5.2 BackgroundEvent

Purpose: A recurring [RTEEvent](#) which is used to perform background activities. It is similar to a [TimingEvent](#) but has no fixed time period and is activated only with low priority.

Signature: [\[SWS_Rte_07177\]](#) [
`void <name>([IN Rte_Instance <instance>])`
[\]\(SRS_Rte_00072\)](#)

5.7.5.3 SwcModeSwitchEvent

Purpose: Trigger of a runnable entity as a result of a mode switch. See also sections [4.4.4](#) and [4.4.7](#) for reference.

Signature: [\[SWS_Rte_02512\]](#) [
`void <name>([IN Rte_Instance <instance>])`
[\]\(SRS_Rte_00072, SRS_Rte_00143\)](#)

5.7.5.4 AsynchronousServerCallReturnsEvent

- Purpose:** Triggers a runnable entity used to “collect” the result and status information of an asynchronous client-server operation.
- Signature:** **[SWS_Rte_01133]** [
void <name>([IN Rte_Instance <instance>])
]([SRS_Rte_00072](#), [SRS_Rte_00029](#), [SRS_Rte_00079](#))
- Notes:** The runnable entity triggered by an [AsynchronousServerCallReturnsEvent RTEEvent](#) should use the [Rte_Result](#) API to actually receive the result and the status of the server operation.

5.7.5.5 DataReceiveErrorEvent

- Purpose:** Triggers a runnable entity used to “collect” the error status of a [data element](#) with “data” semantics on the receiver side.
- Signature:** **[SWS_Rte_01359]** [
void <name>([IN Rte_Instance <instance>])
]([SRS_Rte_00072](#), [SRS_Rte_00029](#), [SRS_Rte_00079](#))
- Notes:** The runnable entity triggered by a [DataReceiveErrorEvent RTEEvent](#) should use the [Rte_IStatus](#) API to actually read the status.

5.7.5.6 OperationInvokedEvent

- Purpose:** An [RTEEvent](#) that causes the RTE to trigger a runnable entity whose entry point provides an implementation for a client-server operation. This event occurs in response to a received request from a client to execute the operation.
- Signature:** **[SWS_Rte_01166]** [
<void|Std_ReturnType> <name>
([IN Rte_Instance <instance>],
[IN <portDefArg 1>, ...
IN <portDefArg n>],
[IN|INOUT|OUT] <param 1>, ...
[IN|INOUT|OUT] <param n>,
[IN Std_TransformerError transformerError])
- Where <portDefArg 1>, ..., <portDefArg n> represent the port-defined argument values (see Section [4.3.2.4](#)) and <param 1>, ... <param n> indicates the operation IN, INOUT and OUT parameters.]([SRS_Rte_00029](#), [SRS_Rte_00079](#), [SRS_Rte_00072](#), [SRS_Rte_00152](#))

The data type of each port defined argument is taken from the software component template, as defined in [valueType](#).

Note that the port-defined argument values are optional, depending upon the server's internal behavior.

[SWS_Rte_07023] [The operation parameters `<param 1>`, ... `<param n>` are the specified [ArgumentDataPrototypes](#) of the [ClientServerOperation](#) that is associated with the [OperationInvokedEvent](#). The operation parameters shall be ordered according to the [ClientServerOperation](#)'s ordered list of the [ArgumentDataPrototypes](#).] ([SRS_Rte_00029](#), [SRS_Rte_00079](#), [SRS_Rte_00072](#))

[SWS_Rte_07024] [If the `ServerArgumentImplPolicy` is set to [useArgumentType](#) the data type of the `<param>` is derived from the [ArgumentDataPrototype](#)'s [ImplementationDataType](#).] ([SRS_Rte_00029](#), [SRS_Rte_00079](#), [SRS_Rte_00072](#))

In case of [\[SWS_Rte_07024\]](#) the [RunnableEntity](#)s parameter are equally typed as the parameter for the [Rte_Call](#) API described in section [5.2.6.5](#)

[SWS_Rte_08569] [The optional IN parameter `transformerError` of the API shall be generated if the [PortPrototype](#) of port `<p>` is referenced by a [PortAPIOption](#) which has the attribute [errorHandling](#) set to `transformerErrorHandling`.] ([SRS_Rte_00249](#))

The IN parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#). Because the runnable can only be triggered if the error is no hard error, the error given here is always a soft error.

Hard errors are notified via [TransformerHardErrorEvents](#).

[SWS_Rte_07026] [The RTE-Generator shall reject configurations violating `[constr_1297]`.] ([SRS_Rte_00029](#), [SRS_Rte_00079](#), [SRS_Rte_00072](#), [SRS_Rte_00018](#))

[SWS_Rte_07027] [If the `ServerArgumentImplPolicy` is set to [useVoid](#) the data type of the `<param>` is set to `void *` for any kind of data type.] ([SRS_Rte_00029](#), [SRS_Rte_00079](#), [SRS_Rte_00072](#))

It is considered an invalid configuration if `ServerArgumentImplPolicy` uses `void` in case of primitive IN arguments. See `[constr_1286]` in Software Component Template specification.

[SWS_Rte_08800] [The RTE-Generator shall reject configurations violating `[constr_1286]`.] ([SRS_Rte_00079](#), [SRS_Rte_00018](#))

Return Value: If the AUTOSAR interface description of the client server communication lists possible error codes, these are returned by the function using the return type `Std_ReturnType`. If no error codes are defined for this interface, the return type shall be `void` (see [\[SWS_Rte_01130\]](#)).

This means that even if a runnable entity implementing a server "only" returns `E_OK`, application errors have to be defined. Else the return types do not match.

5.7.5.7 DataReceivedEvent

Purpose: A runnable entity triggered by the RTE to receive and process a signal received on a sender-receiver interface.

Signature: [\[SWS_Rte_01135\]](#) [
`void <name>([IN Rte_Instance <instance>])`
[\]\(SRS_Rte_00072, SRS_Rte_00028, SRS_Rte_00131, SRS_Rte_00107\)](#)

Notes: The data or event is not passed as an additional parameter. Instead, the previously described reception API should be used to access the data/event. This approach permits the same signature for runnables that are triggered by time ([TimingEvent](#)) or data reception.

Caution: For intra-ECU communication, the [DataReceivedEvent](#) is fired after each completed write operation to the shared data. In case of implicit access, write operation is considered to be completed when the runnable ends. While for inter-ECU communication, the [DataReceivedEvent](#) is fired by the RTE after a callback from COM or LdCom due to data reception. Over a physical network, 'data' is commonly transmitted periodically and hence not only will the latency and jitter of [DataReceivedEvents](#) vary depending on whether a configuration uses intra or inter-ECU communication, but also the number and frequency of these [RTEEvents](#) may change significantly. This means that a [TimingEvent](#) should be used to periodically activation of a runnable rather than relying on the periodic transmission of data.

5.7.5.8 DataSendCompletedEvent

Purpose: A runnable entity triggered by the RTE to receive and process transmit acknowledgment notifications.

Signature: [\[SWS_Rte_01137\]](#) [
`void <name>([IN Rte_Instance <instance>])`

]([SRS_Rte_00072](#), [SRS_Rte_00122](#), [SRS_Rte_00107](#))

Notes: The runnable entity triggered by a [DataSendCompletedEvent](#) [RTEEvent](#) should use the [Rte_Feedback](#) API to actually receive the status of the acknowledgment.

5.7.5.9 ModeSwitchedAckEvent

Purpose: A runnable entity triggered by the RTE to receive and process mode switched acknowledgment notifications.

Signature: **[SWS_Rte_02758]** [
void <name>([IN Rte_Instance <instance>])
]([SRS_Rte_00072](#), [SRS_Rte_00122](#), [SRS_Rte_00107](#))

Notes: The runnable entity triggered by an [ModeSwitchedAckEvent](#) should use the [Rte_SwitchAck](#) API to actually receive the status of the acknowledgment.

5.7.5.10 SwcModeManagerErrorEvent

Purpose: A runnable entity triggered by the RTE to react on errors occurring during mode handling.

Signature: **[SWS_Rte_06771]** [
void <name>([IN Rte_Instance <instance>])
]([SRS_Rte_00072](#), [SRS_Rte_00122](#), [SRS_Rte_00107](#))

Notes: –

5.7.5.11 ExternalTriggerOccurredEvent

Purpose: A runnable entity triggered by the RTE at the occurrence of an external event.

Signature: **[SWS_Rte_07207]** [
void <name>([IN Rte_Instance <instance>],
[IN Std_TransformerError transformerError])
]([SRS_Rte_00162](#), [SRS_Rte_00072](#))

[SWS_Rte_05301] [The optional IN parameter `transformerError` of the API shall be generated if the [PortPrototype](#) of port

<p> is referenced by a [PortAPIOption](#) which has the attribute [errorHandling](#) set to [transformerErrorHandling](#).]([SRS_Rte_00249](#))

The IN parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#). Because the [RunnableEntity](#) can only be triggered if the error is no hard error, the error given here is always a soft error. Hard errors are notified via [TransformerHardErrorEvents](#).

Notes: —

5.7.5.12 InternalTriggerOccurredEvent

Purpose: A runnable entity triggered by the RTE by an inter runnable trigger.

Signature: **[SWS_Rte_07208]** [
void <name>([IN Rte_Instance <instance>])
]([SRS_Rte_00163](#), [SRS_Rte_00072](#))

Notes: —

5.7.5.13 DataWriteCompletedEvent

Purpose: A runnable entity triggered by the RTE to receive and process transmit acknowledgment notifications for implicit communication.

Signature: **[SWS_Rte_07379]** [
void <name>([IN Rte_Instance <instance>])
]([SRS_Rte_00072](#), [SRS_Rte_00122](#), [SRS_Rte_00185](#))

Notes: The runnable entity triggered by a [DataWriteCompletedEvent](#) [RTEEvent](#) should use the [Rte_IFeedback](#) API to actually receive the status of the acknowledgment.

5.7.5.14 InitEvent

Purpose: A runnable entity triggered by the RTE for initialization.

Signature: **[SWS_Rte_06748]** [
void <name>([IN Rte_Instance <instance>])
]([SRS_Rte_00072](#), [SRS_Rte_00240](#))

Notes: The runnable entity triggered by an [InitEvent](#) [RTEEvent](#) is supposed to be used for initialization purposes, i.e. for starting and

restarting a partition. It is not guaranteed that all [RunnableEntities](#) referenced by this [InitEvent](#) are executed before the 'regular' [RunnableEntities](#) are executed for the first time.

5.7.5.15 TransformerErrorEvent

Purpose: A [RunnableEntity](#) triggered by the RTE because a transformation error occurred during the transformation of a server runnable's arguments or during the transformation of an external trigger event (external trigger sink).

Signature: **[SWS_Rte_08791]** [
void <name>([IN Rte_Instance <instance>],
IN Std_TransformerError transformerError)
]([SRS_Rte_00072](#), [SRS_Rte_00249](#))

Notes: The [RunnableEntity](#) triggered by a [TransformerHardErrorEvent](#) [RTEEvent](#) is supposed to be used for reaction on a hard transformer error on the server side of a client/server communication or in the external trigger sink. The IN parameter `transformerError` contains the transformer error which occurred during execution of the transformer chain. See chapter [4.10.5](#).

5.7.5.16 OsTaskExecutionEvent

Purpose: The [RunnableEntity](#) triggered by a [OsTaskExecutionEvent](#) is supposed to react on the execution of specific OS Tasks.

Signature: **[SWS_Rte_82008]{DRAFT}** [
void <name>([IN Rte_Instance <instance>])
]([SRS_Rte_00072](#))

Notes: The runnable entity triggered by an [OsTaskExecutionEvent](#) reacts on the execution of the OS Task to which it is mapped. The main use case for this event is scheduling of [RunnableEntities](#) of complex drivers which have to react on task executions.

5.7.6 Reentrancy

A runnable entity is declared within a software-component type. The RTE ensures that concurrent activation of same instance of a runnable entity is only allowed if the runnables attribute "canBeInvokedConcurrently" is set to TRUE (see Section [4.2.7](#)).

When a software-component is multiple instantiated each separate instance has its own instance of the runnable entities in the software-component. Whilst instances of a software-component are independent, the runnable entities instances share the same code ([SWS_Rte_03015]).

Example 5.30

Consider a component `c1` with runnable entity `re1` and entry point `ep` that is instantiated twice on the same ECU.

The two instances of `c1` each has a separate *instance* of `re1`. Software-component instances are scheduled independently and therefore each instance of `re1` could be concurrently executing `ep`.

The potential for concurrent execution of runnable entities when multiple instances of a software-component are created means that each entry point should be reentrant.

5.8 RTE Lifecycle API Reference

This section documents the API functions used to start and stop the RTE. RTE Lifecycle API functions are not invoked from AUTOSAR software-components – instead they are invoked from other basic software module(s).

5.8.1 Rte_Start

The API `Rte_Start` initializes the RTE itself.

□ [

Service Name	Rte_Start	
Syntax	<pre>Std_ReturnType Rte_Start (void)</pre>	
Service ID [hex]	0x70	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	RTE_E_OK: No error occurred. RTE_E_LIMIT: An internal limit has been exceeded. The allocation of a required resource has failed.
Description	Rte_Start is intended to allocate and initialize system resources and communication resources used by the RTE.	





Available via	Rte.h
---------------	-------

]()

5.8.1.1 Signature

[SWS_Rte_02569] [
Std_ReturnType Rte_Start(void)
]*(SRS_BSW_00310, SRS_Rte_00116)*

5.8.1.2 Existence

[SWS_Rte_01309] [The *Rte_Start* API is always created.] *(SRS_Rte_00051)*

5.8.1.3 Description

[SWS_Rte_CONSTR_09035] *Rte_Start* shall be called only once [The *Rte_Start* shall be called only once by the EcuStateManager from trusted OS context on a core after the basic software modules required by RTE are initialized.]()

These modules include:

- OS
- COM
- memory services

The *Rte_Start* API shall not be invoked from AUTOSAR software components.

[SWS_Rte_CONSTR_09036] *Rte_Start* API may only be used after call of *SchM_Init* [The *Rte_Start* API may only be used after the *Basic Software Scheduler* is initialized (after termination of the *SchM_Init*).]()

[SWS_Rte_CONSTR_09037] *Rte_Start* API shall be called on every core [The *Rte_Start* API shall be called on every core that hosts AUTOSAR software-components of the ECU.]()

[SWS_Rte_02585] [The *Rte_Start* shall return within finite execution time – it must not enter an infinite loop.] *(SRS_Rte_00116)*

Rte_Start may be implemented as a function or a macro.

5.8.1.4 Return Value

If the allocation of a resource fails, `Rte_Start` shall return with an error.

- **[SWS_Rte_01261]** `[RTE_E_OK – No error occurred.]` ([SRS_Rte_00094](#))
- **[SWS_Rte_01262]** `[RTE_E_LIMIT – An internal limit has been exceeded. The allocation of a required resource has failed.]` ([SRS_Rte_00094](#))

5.8.1.5 Notes

`Rte_Start` is declared in the lifecycle header file `Rte_Main.h`. The initialization of AUTOSAR software-components takes place after the termination of `Rte_Start` and is triggered by a mode change event on entering run state.

5.8.2 Rte_Stop

The API `Rte_Stop` finalizes the RTE itself.

[

Service Name	Rte_Stop	
Syntax	<pre>Std_ReturnType Rte_Stop (void)</pre>	
Service ID [hex]	0x71	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	RTE_E_OK: No error occurred. RTE_E_LIMIT: A resource could not be released.
Description	Rte_Stop is used to finalize the RTE on the core it is called. This service releases all system and communication resources allocated by the RTE on that core.	
Available via	Rte.h	

]

5.8.2.1 Signature

[SWS_Rte_02570] `[`

```
Std_ReturnType Rte_Stop(void)
```

`]` ([SRS_Rte_00116](#))

5.8.2.2 Existence

[SWS_Rte_01310] [The [Rte_Stop](#) API is always created.] ([SRS_Rte_00051](#))

5.8.2.3 Description

[SWS_Rte_CONSTR_09038] [Rte_Stop](#) shall be called before BSW shutdown [[Rte_Stop](#) shall be called by the EcuStateManager before the basic software modules required by RTE are shut down.] ()

These modules include:

- OS
- COM
- memory services

[Rte_Stop](#) shall be called from trusted context and not by an AUTOSAR software component.

[SWS_Rte_02584] [[Rte_Stop](#) shall return within finite execution time.] ([SRS_Rte_00116](#))

[Rte_Stop](#) may be implemented as a function or a macro.

5.8.2.4 Return Value

- [SWS_Rte_01259] [RTE_E_OK – No error occurred.] ([SRS_Rte_00094](#))
- [SWS_Rte_01260] [RTE_E_LIMIT – a resource could not be released.] ([SRS_Rte_00094](#))

5.8.2.5 Notes

[Rte_Stop](#) is declared in the lifecycle header file `Rte_Main.h`.

5.8.3 Rte_PartitionTerminated

The API [Rte_PartitionTerminated](#) indicates to the RTE that a partition is going to be terminated, and the communication with the Partition shall be ignored.

[] [

Service Name	Rte_PartitionTerminated_<PID>
Syntax	<pre>void Rte_PartitionTerminated_<PID> (void)</pre>
Service ID [hex]	0x72
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_PartitionTerminated is intended to notify the RTE that a given partition is terminated or is being restarted.
Available via	Rte.h

]()

5.8.3.1 Signature

[SWS_Rte_07330] [
void Rte_PartitionTerminated_<PID>(void)
][\(SRS_Rte_00223\)](#)

Where <PID> is the name of the [EcucPartition](#) according to the ECU Configuration Description [\[5\]](#).

5.8.3.2 Existence

[SWS_Rte_07331] [An [Rte_PartitionTerminated](#) API shall be created for every Partition.][\(SRS_Rte_00223\)](#)

5.8.3.3 Description

[SWS_Rte_CONSTR_09039] [Rte_PartitionTerminated](#) shall be called only once [[Rte_PartitionTerminated](#) shall be called only once by the ProtectionHook.][\(\)](#)

[Rte_PartitionTerminated](#) may be implemented as a function or a macro.

[SWS_Rte_07334] [The treatments in [Rte_PartitionTerminated](#) shall be restricted to the ones allowed in the context of a ProtectionHook.][\(SRS_Rte_00223\)](#)

Since `Rte_PartitionTerminated` is called from the `ProtectionHook` context, it should be as fast as possible. Moreover, it cannot be assumed any more that partition local data including RTE data is consistent. Therefore, actions should be limited to setting a flag. Actual cleanup needs to be deferred to another task.

The notification provided by `Rte_PartitionTerminated` can be used later by the RTE to immediately return an error status when SW-Cs of other partitions tries to communicate with the stopped partition. See [SWS_Rte_02710] and [SWS_Rte_02709].

[SWS_Rte_07335] [Terminating an already terminated Partition shall be ignored.]
(SRS_Rte_00223)

5.8.3.4 Return Value

None.

5.8.3.5 Notes

`Rte_PartitionTerminated` is declared in the lifecycle header file `Rte_Main.h`.

5.8.4 Rte_PartitionRestarting

The API `Rte_PartitionRestarting` indicates to the RTE that a `Partition` is going to be restarted and that the communication with the Partition shall be ignored.

□ [

Service Name	Rte_PartitionRestarting_<PID>
Syntax	<pre>void Rte_PartitionRestarting_<PID> (void)</pre>
Service ID [hex]	0x73
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_PartitionRestarting is intended to notify the RTE that a given partition is being restarted. As <code>Rte_PartitionTerminated</code> , <code>Rte_PartitionRestarting</code> indicates that the communication with the partition shall be ignored, but in case of <code>Rte_PartitionRestarting</code> , the partition may be restarted later in the ECU lifecycle.
Available via	Rte.h

]()

5.8.4.1 Signature

[SWS_Rte_07620] [
void Rte_PartitionRestarting_<PID>(void)

Where <PID> is the name of the [EcucPartition](#) according to the ECU Configuration Description [5].] ([SRS_Rte_00223](#))

5.8.4.2 Existence

[SWS_Rte_07619] [An [Rte_PartitionRestarting](#) API shall be created for any Partition which can be restarted (i.e. a Partition whose [PartitionCanBeRestarted](#) parameter is enabled).] ([SRS_Rte_00223](#))

5.8.4.3 Description

[SWS_Rte_CONSTR_09040] [Rte_PartitionRestarting](#) shall be called only once [[Rte_PartitionRestarting](#) shall be called only once by the ProtectionHook.]
()

[Rte_PartitionRestarting](#) may be implemented as a function or a macro.

[SWS_Rte_07617] [The treatments in [Rte_PartitionRestarting](#) shall be restricted to the ones allowed in the context of a ProtectionHook.] ([SRS_Rte_00223](#))

Since [Rte_PartitionRestarting](#) is called from the ProtectionHook context, it should be as fast as possible. It should be limited to setting a flag. Actual cleanup should be deferred to another task.

[SWS_Rte_07622] [Restarting an already terminated [Partition](#) or restarting a [Partition](#) during an ongoing restart shall be ignored.] ([SRS_Rte_00223](#))

5.8.4.4 Return Value

None.

5.8.4.5 Notes

[Rte_PartitionRestarting](#) is declared in the lifecycle header file [Rte_Main.h](#).

5.8.5 Rte_RestartPartition

The API `Rte_RestartPartition` initializes the RTE resources allocated for a partition.

□ [

Service Name	Rte_RestartPartition_<PID>	
Syntax	<pre>Std_ReturnType Rte_RestartPartition_<PID> (void)</pre>	
Service ID [hex]	0x74	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	RTE_E_OK: No error occurred. RTE_E_LIMIT: An internal limit has been exceeded. The allocation of a required resource has failed.
Description	Rte_RestartPartition is intended to notify the RTE that a given partition will be restarted.	
Available via	Rte.h	

]()

5.8.5.1 Signature

[SWS_Rte_07188] [

Std_ReturnType Rte_RestartPartition_<PID>(void)

Where <PID> is the name of the `EcucPartition` according to the ECU Configuration Description [5].] (*SRS_Rte_00224*)

5.8.5.2 Existence

[SWS_Rte_07336] [An `Rte_RestartPartition` API shall be created for any Partition which can be restarted (i.e. a Partition whose `PartitionCanBeRestarted` parameter is enabled).] (*SRS_Rte_00224*)

5.8.5.3 Description

[SWS_Rte_CONSTR_09041] `Rte_RestartPartition` shall be called from `RestartTask` [`Rte_RestartPartition` shall be called only in the context of the `RestartTask` of the given partition.](/)

[SWS_Rte_07338] `Rte_RestartPartition` shall return within finite execution time – it must not enter an infinite loop. (*SRS_Rte_00224*)

`Rte_RestartPartition` may be implemented as a function or a macro.

[SWS_Rte_07339] The `Rte_RestartPartition` shall restore an initial RTE environment for the partition and re-activate communication with this partition. (*SRS_Rte_00224*)

This includes:

- signal initial values,
- modes,
- queued events,
- sequence counters.

[SWS_Rte_07340] `Rte_RestartPartition` shall be ignored if the given partition was not stopped before (with `Rte_PartitionTerminated` or `Rte_PartitionRestarting`). (*SRS_Rte_00224*)

5.8.5.4 Return Value

If the allocation of a resource fails, `Rte_RestartPartition` shall return with an error.

- **[SWS_Rte_07341]** `RTE_E_OK` – No error occurred. (*SRS_Rte_00224*)
- **[SWS_Rte_07342]** `RTE_E_LIMIT` – An internal limit has been exceeded. The allocation of a required resource has failed. (*SRS_Rte_00224*)

5.8.5.5 Notes

`Rte_RestartPartition` is declared in the lifecycle header file `Rte_Main.h`.

5.8.6 Rte_Init

The API `Rte_Init` schedules `RunnableEntity`s for initialization purpose.

□ [

Service Name	Rte_Init_<InitContainer>
Syntax	<pre>void Rte_Init_<InitContainer> (void)</pre>
Service ID [hex]	0x75
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Init is intended schedule RunnableEntitys for initialization purpose which are mapped to the related RteInitializationRunnableBatch container.
Available via	Rte.h

]()

5.8.6.1 Signature

[SWS_Rte_06749] [

void Rte_Init_<InitContainer>(void)

Where <InitContainer> is the short name of the [RteInitializationRunnableBatch](#) container.]([SRS_Rte_00240](#))

5.8.6.2 Existence

[SWS_Rte_06750] [An [Rte_Init](#) API shall be created for each [RteInitializationRunnableBatch](#) container.]([SRS_Rte_00240](#))

5.8.6.3 Description

[SWS_Rte_06751] [An [Rte_Init](#) API shall invoke the [RunnableEntitys](#) which are associated with an [RTEEvent](#) mapped to the related [RteInitializationRunnableBatch](#) container in the order defined by the [RtePositionInTask](#) parameters.]([SRS_Rte_00240](#))

[SWS_Rte_06752] [[Rte_Init](#) shall return within finite execution time – it must not enter an infinite loop.]([SRS_Rte_00240](#))

[SWS_Rte_06753] [[Rte_Init](#) shall be implemented as a function.]([SRS_Rte_00240](#))

[SWS_Rte_CONSTR_09060] **Rte_Init** API may only be used after call of **Rte_Start** [The **Rte_Init** API may only be used after the *RTE* is initialized (after termination of the **Rte_Start**).]()

5.8.6.4 Return Value

none

5.8.6.5 Notes

Rte_Init is declared in the lifecycle header file `Rte_Main.h`.

5.8.7 Rte_StartTiming

The API **Rte_StartTiming** starts the triggering of recurrent events.

[] [

Service Name	Rte_StartTiming
Syntax	<pre>void Rte_StartTiming (void)</pre>
Service ID [hex]	0x76
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_StartTiming API is intended to release the activation of RunnableEntitys triggered by TimingEvents and BackgroundEvents after the last call of a Rte_Init function.
Available via	Rte.h

]()

5.8.7.1 Signature

[SWS_Rte_06754] [
void Rte_StartTiming(void)
](SRS_Rte_00240)

5.8.7.2 Existence

[SWS_Rte_06755] [An `Rte_StartTiming` API shall be created if any `Rte_Init` API is created.]([SRS_Rte_00240](#))

5.8.7.3 Description

[SWS_Rte_06756] [`Rte_StartTiming` API shall release the activation of `RunnableEntity`s triggered by `TimingEvents` and `BackgroundEvents`.]([SRS_Rte_00240](#))

See as well [[SWS_Rte_06759](#)] and [[SWS_Rte_06760](#)].

[SWS_Rte_06757] [`Rte_StartTiming` shall return within finite execution time – it must not enter an infinite loop.]([SRS_Rte_00240](#))

[SWS_Rte_06758] [`Rte_StartTiming` shall be implemented as a function.]([SRS_Rte_00240](#))

[SWS_Rte_CONSTR_09061] **`Rte_StartTiming` API may only be used after call of `Rte_Start`** [The `Rte_StartTiming` API may only be used after the *RTE* is initialized (after termination of the `Rte_Start`).]()

5.8.7.4 Return Value

none

5.8.7.5 Notes

`Rte_StartTiming` is declared in the lifecycle header file `Rte_Main.h`.

5.9 RTE Call-backs Reference

This section documents the call-backs that are generated by the RTE that must be invoked by other components, such as the communication service, and therefore must have a well-defined name and semantics.

[SWS_Rte_01165] [A call-back implementation created by the RTE generator is not permitted to block.]([SRS_Rte_00022](#))

Requirement [[SWS_Rte_01165](#)] serves to constrain RTE implementations so that all implementations can work with all basic software.

5.9.1 RTE-COM Message Naming Conventions

The COM signals used for communication are defined in the input information provided by Com.

[SWS_Rte_03007] [The RTE shall initiate an inter-ECU transmission using the COM API with the handle id of the corresponding COM signal for primitive data element [SenderReceiverToSignalMapping.](#)]([SRS_Rte_00019](#))

[SWS_Rte_03008] [The RTE shall initiate an inter-ECU transmission using the COM API with the handle id of the corresponding COM signal group for composite data elements or operation arguments [SenderReceiverToSignalGroupMapping.](#)]([SRS_Rte_00019](#))

5.9.2 Communication Service Call-backs

Purpose: Implement the call-back functions that AUTOSAR COM / LdCom invokes as a result of inter-ECU communication, where:

- A data item/event is ready for reception by a receiver.
- A transmission acknowledgment shall be routed to a sender.
- An operation shall be invoked by a server.
- The result of an operation is ready for reading by a client.

Signature: **[SWS_Rte_03000]** [

```
void <CallbackRoutineName> (void);
```


]([SRS_Rte_00019](#))

Where <CallbackRoutineName> is the name of the call-back function.

Description: Prototypes for the call-back <CallbackRoutineName> provided by AUTOSAR COM / LdCom.

Return Value: No return value : void

In the following sections, the naming convention of <CallBackRoutineName> are defined:

5.9.2.1 Call-backs for communication over AUTOSAR COM

5.9.2.1.1 Rte_COMCbk_<sn>

□ [

Service Name	Rte_COMCbK_<sn>
Syntax	<pre>void Rte_COMCbK_<sn> (void)</pre>
Service ID [hex]	0x9f
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that the signal of the primitive data item/event is ready for reception.
Available via	Rte_Cbk.h

]()

[SWS_Rte_03001] [

void Rte_COMCbK_<sn>(void)

where <sn> is the name of the COM signal.]([SRS_Rte_00019](#))

This callback function indicates that the signal of the primitive data item/event is ready for reception by a receiver.

It is called from

1. the [ComMainFunctionRx](#) referenced by the [ComIPdu](#) related to the signal (see [SWS_Com_00885]), if the [ComIPduSignalProcessing](#) is set to DEFERRED (see [SWS_Com_00301]). This [ComMainFunctionRx](#) will be executed in the [EcucPartition](#) referenced by its [ComMainRxPartitionRef](#).
2. the [EcucPartition](#) referenced by the [ComMainRxPartitionRef](#) of the [ComMainFunctionRx](#) in turn referenced by the [ComIPdu](#) related to the signal (see [SWS_Com_00885]), if the [ComIPdu](#) references one and [ComIPduSignalProcessing](#) is set to IMMEDIATE (see [SWS_Com_00300]).
3. the partition referenced by the [Pdu](#) related to the signal via [EcucPduDedicatedPartitionRef](#), if there is such a reference and the [ComIPdu](#) related to the signal does not reference a [ComMainFunctionRx](#).
4. the partition referenced by the [Pdu](#) related to the signal via [EcucPduDefaultPartitionRef](#), if there is such a reference and the [ComIPdu](#) related to the signal does not reference a [ComMainFunctionRx](#) and the [Pdu](#) related to the signal has no [EcucPduDedicatedPartitionRef](#).

Configured in Com: [ComNotification](#) [ECUC_Com_00498] as part of [ComSignal](#)

5.9.2.1.2 Rte_COMCbkTack_<sn>

□ [

Service Name	Rte_COMCbkTack_<sn>
Syntax	<pre>void Rte_COMCbkTack_<sn> (void)</pre>
Service ID [hex]	0x90
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that the signal of the primitive data item/event is already handed over by COM to the PDU router.
Available via	Rte_Cbk.h

]()

[SWS_Rte_03002] [

void Rte_COMCbkTack_<sn>(void)

where <sn> is the name of the COM signal.]([SRS_Rte_00019](#), [SRS_Rte_00122](#))

“Tack” is literal text indicating transmission acknowledgment. This callback function is used to route a transmission acknowledgment of a primitive data item/event to a sender.

Configured in Com: [ComNotification](#) [ECUC_Com_00498] as part of [ComSignal](#)

5.9.2.1.3 Rte_COMCbkTErr_<sn>

□ [

Service Name	Rte_COMCbkTErr_<sn>
Syntax	<pre>void Rte_COMCbkTErr_<sn> (void)</pre>
Service ID [hex]	0x91
Sync/Async	Synchronous





Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that an error occurred when the signal of the primitive data item/event was handed over by COM to the PDU router.
Available via	Rte_Cbk.h

⌋()

[SWS_Rte_03775] ⌈

```
void Rte_COMCbktErr_<sn>(void)
```

where <sn> is the name of the COM signal.⌋([SRS_Rte_00019](#), [SRS_Rte_00122](#))

“TErr” is literal text indicating transmission error. This callback function is used to route a transmission error notification of a primitive data item/event to a sender.

Configured in Com: [ComErrorNotification](#) [ECUC_Com_00499] as part of [Com-Signal](#)

5.9.2.1.4 Rte_COMCbklInv_<sn>

⌈ ⌋

Service Name	Rte_COMCbklInv_<sn>
Syntax	<pre>void Rte_COMCbklInv_<sn> (void)</pre>
Service ID [hex]	0x92
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that COM has received a signal and parsed it as "invalid".
Available via	Rte_Cbk.h

⌋()

[SWS_Rte_02612] ⌈

```
void Rte_COMCbklInv_<sn>(void)
```

where <sn> is the name of the COM signal.]([SRS_Rte_00019](#), [SRS_Rte_00122](#))

“Inv” is literal text indicating signal invalidation. This callback function is used to route a signal invalidation of a primitive data item to a receiver.

Configured in Com: [ComInvalidNotification](#) [ECUC_COM_00315] as part of [ComSignal](#)

5.9.2.1.5 Rte_COMCbKRxTOut_<sn>

□ [

Service Name	Rte_COMCbKRxTOut_<sn>
Syntax	<pre>void Rte_COMCbKRxTOut_<sn> (void)</pre>
Service ID [hex]	0x93
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that the aliveTimeout after the last successful reception of the signal of the primitive data item/event has expired (data element outdated).
Available via	Rte_Cbk.h

]()

[SWS_Rte_02610] [

```
void Rte_COMCbKRxTOut_<sn>(void)
```

where <sn> is the name of the COM signal.]([SRS_Rte_00019](#), [SRS_Rte_00147](#))

“RxTOut” is literal text indicating reception signal time out. This callback function is used to indicate that a signal of a primitive data item is outdated and no new data is available.

Configured in Com: [ComTimeoutNotification](#) [ECUC_Com_00552] as part of [ComSignal](#)

5.9.2.1.6 Rte_COMCbKTxTOut_<sn>

□ [

Service Name	Rte_COMCbkTxTOut_<sn>
Syntax	<pre>void Rte_COMCbkTxTOut_<sn> (void)</pre>
Service ID [hex]	0x94
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that the timeout of TransmissionAcknowledgementRequest for sending the signal of the primitive data item/event has expired.
Available via	Rte_Cbk.h

]()

[SWS_Rte_05084] [

void Rte_COMCbkTxTOut_<sn> (void)

where <sn> is the name of the COM signal.] ([SRS_Rte_00019](#), [SRS_Rte_00122](#))

“TxTOut” is literal text indicating transmission failure and time out. This callback function is used to indicate that transmission has failed and timed out for a primitive data item.

Configured in Com: [ComTimeoutNotification](#) [ECUC_Com_00552] as part of [ComSignal](#)

5.9.2.1.7 Rte_COMCbk_<sg>

[] [

Service Name	Rte_COMCbk_<sg>
Syntax	<pre>void Rte_COMCbk_<sg> (void)</pre>
Service ID [hex]	0x95
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None





Parameters (out)	None
Return value	None
Description	This callback function indicates that the signals of the composite data item/event or the arguments of an operation are ready for reception.
Available via	Rte_Cbk.h

]()

[SWS_Rte_03004] [

```
void Rte_COMCbk_<sg>(void)
```

where <sg> is the name of the COM signal group, which contains all the signals of the composite data item/event or an operation.]([SRS_Rte_00019](#))

This callback function indicates that the signals of the composite data item/event or the arguments of an operation are ready for reception.

It is called from

1. the [ComMainFunctionRx](#) referenced by the [ComIPdu](#) related to the signal group (see [SWS_Com_00885]), if the [ComIPduSignalProcessing](#) is set to DEFERRED (see [SWS_Com_00301]). This [ComMainFunctionRx](#) will be executed in the [EcucPartition](#) referenced by its [ComMainRxPartitionRef](#).
2. the [EcucPartition](#) referenced by the [ComMainRxPartitionRef](#) of the [ComMainFunctionRx](#) in turn referenced by the [ComIPdu](#) related to the signal group (see [SWS_Com_00885]), if the [ComIPdu](#) references one and [ComIPduSignalProcessing](#) is set to IMMEDIATE (see [SWS_Com_00300]).
3. the partition referenced by the [Pdu](#) related to the signal group via [EcucPduDedicatedPartitionRef](#), if there is such a reference and the [ComIPdu](#) related to the signal group does not reference a [ComMainFunctionRx](#).
4. the partition referenced by the [Pdu](#) related to the signal group via [EcucPduDefaultPartitionRef](#), if there is such a reference and the [ComIPdu](#) related to the signal group does not reference a [ComMainFunctionRx](#) and the [Pdu](#) related to the signal group has no [EcucPduDedicatedPartitionRef](#).

Configured in Com: [ComNotification](#) [ECUC_Com_00498] as part of [ComSignalGroup](#)

5.9.2.1.8 Rte_COMCbkTack_<sg>

[] [

Service Name	Rte_COMCbktAck_<sg>
Syntax	<pre>void Rte_COMCbktAck_<sg> (void)</pre>
Service ID [hex]	0x96
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that the signals of the composite data item/event is already handed over by COM to the PDU router.
Available via	Rte_Cbk.h

]()

[SWS_Rte_03005] [

void Rte_COMCbktAck_<sg>(void)

where <sg> is the name of the COM signal group, which contains all the signals of the composite data item/event or an operation.]([SRS_Rte_00019](#), [SRS_Rte_00122](#))

“Ack” is literal text indicating transmission acknowledgment. This callback function indicates that the signals of the composite data item/event is already handed over by COM to the PDU router.

Configured in Com: [ComNotification](#) [ECUC_Com_00498] as part of [ComSignalGroup](#)

5.9.2.1.9 Rte_COMCbktErr_<sg>

[] [

Service Name	Rte_COMCbktErr_<sg>
Syntax	<pre>void Rte_COMCbktErr_<sg> (void)</pre>
Service ID [hex]	0x97
Sync/Async	Synchronous
Reentrancy	Non Reentrant





Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that an error occurred when the signal of the composite data item/event was handed over by COM to the PDU router.
Available via	Rte_Cbk.h

]()

[SWS_Rte_03776] [

```
void Rte_COMCbktErr_<sg>(void)
```

where <sg> is the name of the COM signal group, which contains all the signals of the composite data item/event or an operation.]([SRS_Rte_00019](#), [SRS_Rte_00122](#))

“TErr” is literal text indicating transmission error. This callback function indicates that an error occurred when the signal of the composite data item/event was handed over by COM to the PDU router.

Configured in Com: [ComErrorNotification](#) [ECUC_Com_00499] as part of [ComSignalGroup](#)

5.9.2.1.10 Rte_COMCbklInv_<sg>

[] [

Service Name	Rte_COMCbklInv_<sg>
Syntax	<pre>void Rte_COMCbklInv_<sg> (void)</pre>
Service ID [hex]	0x98
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that COM has received a signal group and parsed it as "invalid".
Available via	Rte_Cbk.h

]()

[SWS_Rte_05065] [

```
void Rte_COMCbkJnv_<sg>(void)
```

where <sg> is the name of the COM signal group, which contains all the signals of the composite data item/event or an operation.]([SRS_Rte_00019](#), [SRS_Rte_00122](#))

“Inv” is literal text indicating signal group invalidation. This callback function indicates that COM has received a signal group and parsed it as “invalid”.

Configured in Com: [ComInvalidNotification](#) [ECUC_Com_00315] as part of [ComSignalGroup](#)

5.9.2.1.11 Rte_COMCbkJRxTOut_<sg>

□ [

Service Name	Rte_COMCbkJRxTOut_<sg>
Syntax	<pre>void Rte_COMCbkJRxTOut_<sg> (void)</pre>
Service ID [hex]	0x99
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that the aliveTimeout after the last successful reception of the signal group carrying the composite data item has expired (data element outdated).
Available via	Rte_Cbk.h

]()

[SWS_Rte_02611] [

```
void Rte_COMCbkJRxTOut_<sg>(void)
```

where <sg> is the name of the COM signal group, which contains all the signals of the composite data item/event or an operation.]([SRS_Rte_00019](#), [SRS_Rte_00147](#))

“RxTOut” is literal text indicating reception signal time out. This callback function indicates that the [aliveTimeout](#) after the last successful reception of the signal group carrying the composite data item has expired ([data element outdated](#)).

Configured in Com: [ComTimeoutNotification](#) [ECUC_Com_00552] as part of [ComSignalGroup](#)

5.9.2.1.12 Rte_COMCbKTxTOut_<sg>

□ [

Service Name	Rte_COMCbKTxTOut_<sg>
Syntax	<pre>void Rte_COMCbKTxTOut_<sg> (void)</pre>
Service ID [hex]	0x9a
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that the timeout of <code>TransmissionAcknowledgementRequest</code> for sending the signal group of the composite data item/event has expired.
Available via	Rte_Cbk.h

]()

[SWS_Rte_05085] [

```
void Rte_COMCbKTxTOut_<sg>(void)
```

where <sg> is the name of the COM signal group, which contains all the signals of the composite data item/event or an operation.]([SRS_Rte_00019](#), [SRS_Rte_00122](#))

“TxTOut” is literal text indicating transmission failure and time out. This callback function indicates that the timeout of `TransmissionAcknowledgementRequest` for sending the signal group of the composite data item/event has expired.

Configured in Com: `ComTimeoutNotification` [ECUC_Com_00552] as part of `ComSignalGroup`

5.9.2.1.13 Rte_COMCbKTxPrep_<mn>

□ [

Service Name	Rte_COMCbKTxPrep_<mn>
Syntax	<pre>void Rte_COMCbKTxPrep_<mn> (void)</pre>
Service ID [hex]	0xA8
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	This callback function indicates that the signals/signal groups to be sent via a dedicated Com_MainFunctionTx instance will now be prepared for transmission.
Available via	Rte_Cbk.h

]()

[SWS_Rte_08907] [

void Rte_COMCbKTxPrep_<mn>(void)

where <mn> is the name of the Com_MainFunctionTx instance.]([SRS_Rte_00019](#))

“TxPrep” is literal text indicating transmission preparation. This callback function indicates that COM is preparing the signals/signal groups to be sent via the COM instance of this partition.

The transmission preparation callback ([Rte_COMCbKTxPrep_mn](#)) for a signal or signal group is called from the [ComMainFunctionTx](#) (see [SWS_Com_00886]) referenced by the [ComIPdu](#) related to the signal or signal group (see [SWS_Com_00885]). This [ComMainFunctionTx](#) will be executed in the [EcucPartition](#) referenced by its [ComMainTxPartitionRef](#).

Configured in Com: [ComPreparationNotification](#) [ECUC_Com_10020] as part of [ComMainFunctionTx](#)

5.9.2.2 Call-backs for communication over AUTOSAR LdCom

[SWS_Rte_01412] [The RTE shall import the following type from [Com-Stack_Types.h](#):

- [BufReq_ReturnType](#)
- [PduIdType](#)
- [PduInfoType](#)
- [PduLengthType](#)
- [RetryInfoType](#)

]([SRS_BSW_00384](#))

5.9.2.2.1 Rte_LdComCbkJRxIndication_<sn>

□ [

Service Name	Rte_LdComCbkJRxIndication_<sn>	
Syntax	<pre>void Rte_LdComCbkJRxIndication_<sn> (const PduInfoType* PduInfoPtr)</pre>	
Service ID [hex]	0xA0	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant for same sn, otherwise Reentrant	
Parameters (in)	PduInfoPtr	Contains the length (SduLength) of the received PDU, a pointer to a buffer (SduDataPtr) containing the PDU, and the MetaData related to this PDU.
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	Indication of a received PDU from a lower layer communication interface module.	
Available via	Rte_Cbk.h	

]()

[SWS_Rte_01395] [

```
void Rte_LdComCbkJRxIndication_<sn> (
    IN const PduInfoType* info
);
```

Where <sn> is a LdCom signal/I-PDU name.]([SRS_Rte_00246](#))

It is configured in LdCom:

[LdComRxIndication](#) [ECUC_LdCom_00014] as part of [LdComIPdu](#)

5.9.2.2.2 Rte_LdComCbkJStartOfReception_<sn>

□ [

Service Name	Rte_LdComCbKStartOfReception_<sn>	
Syntax	<pre> BufReq_ReturnType Rte_LdComCbKStartOfReception_<sn> (const PduInfoType* info, PduLengthType TpSduLength, PduLengthType* bufferSizePtr) </pre>	
Service ID [hex]	0xA1	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant for same sn, otherwise Reentrant	
Parameters (in)	info	Pointer to a PduInfoType structure containing the payload data (without protocol information) and payload length of the first frame or single frame of a transport protocol I-PDU reception, and the MetaData related to this PDU. If neither first/single frame data nor MetaData are available, this parameter is set to NULL_PTR.
	TpSduLength	Total length of the N-SDU to be received.
Parameters (inout)	None	
Parameters (out)	bufferSizePtr	Available receive buffer in the receiving module. This parameter will be used to compute the Block Size (BS) in the transport protocol module.
Return value	BufReq_ReturnType	<p>BUFREQ_OK: Connection has been accepted. bufferSizePtr indicates the available receive buffer; reception is continued. If no buffer of the requested size is available, a receive buffer size of 0 shall be indicated by bufferSizePtr.</p> <p>BUFREQ_E_NOT_OK: Connection has been rejected; reception is aborted. bufferSizePtr remains unchanged.</p> <p>BUFREQ_E_OVFL: No buffer of the required length can be provided; reception is aborted. bufferSizePtr remains unchanged.</p>
Description	This function is called at the start of receiving an N-SDU. The N-SDU might be fragmented into multiple N-PDUs (FF with one or more following CFs) or might consist of a single N-PDU (SF). The service shall provide the currently available maximum buffer size when invoked with TpSduLength equal to 0.	
Available via	Rte_Cbk.h	

](

[SWS_Rte_01396] [

```

BufReq_ReturnType Rte_LdComCbKStartOfReception_<sn> (
    IN const PduInfoType* SduInfoPtr,
    IN PduLengthType SduLength,
    OUT PduLengthType* RxBufferSizePtr
)

```

Where <sn> is a LdCom signal/I-PDU name.]([SRS_Rte_00246](#))

It is configured in LdCom:

[LdComRxStartOfReception](#) [ECUC_LdCom_00015] as part of [LdComIPdu](#)

[SWS_Rte_01397] [The Rte_LdComCbKStartOfReception_<sn> Call back shall return BUFREQ_OK when connection has been accepted. RxBufferSizePtr indicates the available receive buffer.]([SRS_Rte_00246](#))

[SWS_Rte_01398] [The Rte_LdComCbKStartOfReception_<sn> Call back shall return BUFREQ_E_NOT_OK when connection has been rejected. RxBufferSizePtr remains unchanged.]([SRS_Rte_00246](#))

[SWS_Rte_01399] [The `Rte_LdComCbkJStartOfReception_<sn>` Call back shall return `BUFREQ_E_OVFL` when configured buffer size as specified via `LdComPduRef.PduLength` is smaller than `TpSduLength`.]([SRS_Rte_00246](#))

5.9.2.2.3 Rte_LdComCbkJCopyRxData_<sn>

□ [

Service Name	Rte_LdComCbkJCopyRxData_<sn>	
Syntax	<pre>BufReq_ReturnType Rte_LdComCbkJCopyRxData_<sn> (const PduInfoType* info, PduLengthType* bufferSizePtr)</pre>	
Service ID [hex]	0xA2	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant for same sn, otherwise Reentrant	
Parameters (in)	info	Provides the source buffer (<code>SduDataPtr</code>) and the number of bytes to be copied (<code>SduLength</code>). An <code>SduLength</code> of 0 can be used to query the current amount of available buffer in the upper layer module. In this case, the <code>SduDataPtr</code> may be a <code>NULL_PTR</code> .
Parameters (inout)	None	
Parameters (out)	bufferSizePtr	Available receive buffer after data has been copied.
Return value	BufReq_ReturnType	<code>BUFREQ_OK</code> : Data copied successfully <code>BUFREQ_E_NOT_OK</code> : Data was not copied because an error occurred.
Description	This function is called to provide the received data of an I-PDU segment (N-PDU) to the upper layer. Each call to this function provides the next part of the I-PDU data. The size of the remaining data is written to the position indicated by <code>bufferSizePtr</code> .	
Available via	Rte_Cbk.h	

]()

[SWS_Rte_01400] [

```
BufReq_ReturnType Rte_LdComCbkJCopyRxData_<sn> (
    IN const PduInfoType* SduInfoPtr,
    OUT PduLengthType* RxBufferSizePtr
)
```

Where <sn> is a LdCom signal/I-PDU name.]([SRS_Rte_00246](#))

It is configured in LdCom:

[LdComRxCopyRxData](#) [ECUC_LdCom_00013] as part of [LdComIPdu](#)

[SWS_Rte_01401] [The `Rte_LdComCbkJCopyRxData_<sn>` Call back shall return `BUFREQ_OK` when data has been copied to the receive buffer completely as requested.]([SRS_Rte_00246](#))

[SWS_Rte_01402] [The Rte_LdComCbkJCopyRxData_<sn> Call back shall return BUFREQ_E_NOT_OK when data has not been copied. Request failed.](SRS_Rte_00246)

5.9.2.2.4 Rte_LdComCbkJTpRxIndication_<sn>

□ [

Service Name	Rte_LdComCbkJTpRxIndication_<sn>	
Syntax	<pre>void Rte_LdComCbkJTpRxIndication_<sn> (Std_ReturnType result)</pre>	
Service ID [hex]	0xA3	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant for same sn, otherwise Reentrant	
Parameters (in)	result	Result of the reception.
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	Called after an I-PDU has been received via the TP API, the result indicates whether the transmission was successful or not.	
Available via	Rte_Cbk.h	

]()

[SWS_Rte_01403] [

```
void Rte_LdComCbkJTpRxIndication_<sn> (  
    IN Std_ReturnType Result  
)
```

where <sn> is a LdCom signal/I-PDU name.](SRS_Rte_00246)

It is configured in LdCom:

LdComTpRxIndication [ECUC_LdCom_00016] as part of LdComIPdu

5.9.2.2.5 Rte_LdComCbkJCopyTxData_<sn>

□ [

Service Name	Rte_LdComCbKCopyTxData_<sn>	
Syntax	<pre> BufReq_ReturnType Rte_LdComCbKCopyTxData_<sn> (const PduInfoType* info, const RetryInfoType* retry, PduLengthType* availableDataPtr) </pre>	
Service ID [hex]	0xA4	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant for same sn, otherwise Reentrant	
Parameters (in)	info	Provides the destination buffer (SduDataPtr) and the number of bytes to be copied (SduLength). If not enough transmit data is available, no data is copied by the upper layer module and BUFREQ_E_BUSY is returned. The lower layer module may retry the call. An SduLength of 0 can be used to indicate state changes in the retry parameter or to query the current amount of available data in the upper layer module. In this case, the Sdu DataPtr may be a NULL_PTR.
	retry	Will not be handled by LdCom and its upper layer.
Parameters (inout)	None	
Parameters (out)	availableDataPtr	Indicates the remaining number of bytes that are available in the upper layer module's Tx buffer. availableDataPtr can be used by TP modules that support dynamic payload lengths (e.g. FrlsoTp) to determine the size of the following CFs.
Return value	BufReq_ReturnType	BUFREQ_OK: Data has been copied to the transmit buffer completely as requested. BUFREQ_E_BUSY: Request could not be fulfilled, because the required amount of Tx data is not available. The lower layer module may retry this call later on. No data has been copied. BUFREQ_E_NOT_OK: Data has not been copied. Request failed.
Description	This function is called to acquire the transmit data of an I-PDU segment (N-PDU). Each call to this function provides the next part of the I-PDU data unless retry->TpDataState is TP_DATA_RETRY. In this case the function restarts to copy the data beginning at the offset from the current position indicated by retry->TxTpDataCnt. The size of the remaining data is written to the position indicated by availableDataPtr	
Available via	Rte_Cbk.h	

⌋()

[SWS_Rte_01404] ⌈

```

BufReq_ReturnType Rte_LdComCbKCopyTxData_<sn> (
    IN const PduInfoType* SduInfoPtr,
    IN RetryInfoType* RetryInfoPtr,
    OUT PduLengthType* TxDataCntPtr
)

```

Where <sn> is a LdCom signal/I-PDU name.⌋([SRS_Rte_00246](#))

It is configured in LdCom:

[LdComTxCopyTxData](#) [ECUC_LdCom_00018] as part of [LdComIPdu](#)

[SWS_Rte_01405] ⌈The Rte_LdComCbKCopyTxData_<sn> Call back shall return BUFREQ_OK when data has been copied to the receive buffer completely as requested.⌋([SRS_Rte_00246](#))

[SWS_Rte_01406] [The `Rte_LdComCbkJCopyTxData_<sn>` Call back shall return `BUFREQ_E_NOT_OK` when data has not been copied to the receive buffer completely as requested.] ([SRS_Rte_00246](#))

5.9.2.2.6 Rte_LdComCbkJTpTxConfirmation_<sn>

□ [

Service Name	Rte_LdComCbkJTpTxConfirmation_<sn>	
Syntax	<pre>void Rte_LdComCbkJTpTxConfirmation_<sn> (Std_ReturnType result)</pre>	
Service ID [hex]	0xA5	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant for same sn, otherwise Reentrant	
Parameters (in)	result	E_OK - transmission successful E_NOT_OK - transmission not successful
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	This function is called after a Signal has been transmitted via the TP-API on its network.	
Available via	Rte_Cbk.h	

]()

[SWS_Rte_01407] [

```
void Rte_LdComCbkJTpTxConfirmation_<sn> (
    IN Std_ReturnType Result
)
```

where <sn> is a LdCom signal/I-PDU name.] ([SRS_Rte_00246](#), [SRS_Com_02044](#))

It is configured in LdCom:

[LdComTpTxConfirmation](#) [ECUC_LdCom_00017] as part of [LdComIPdu](#)

5.9.2.2.7 Rte_LdComCbkJTriggerTransmit_<sn>

□ [

Service Name	Rte_LdComCbkJTriggerTransmit_<sn>	
Syntax	<pre>Std_ReturnType Rte_LdComCbkJTriggerTransmit_<sn> (PduInfoType* PduInfoPtr)</pre>	
Service ID [hex]	0xA6	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant for same sn, otherwise Reentrant	
Parameters (in)	None	
Parameters (inout)	PduInfoPtr	Contains a pointer to a buffer (SduDataPtr) to where the SDU data shall be copied, and the available buffer size in SduLength. On return, the service will indicate the length of the copied SDU data in SduLength.
Parameters (out)	None	
Return value	Std_ReturnType	E_OK: SDU has been copied and SduLength indicates the number of copied bytes. E_NOT_OK: No SDU data has been copied. PduInfoPtr must not be used since it may contain a NULL pointer or point to invalid data.
Description	Within this API, the upper layer module (called module) shall check whether the available data fits into the buffer size reported by PduInfoPtr->SduLength. If it fits, it shall copy its data into the buffer provided by PduInfoPtr->SduDataPtr and update the length of the actual copied data in PduInfoPtr->SduLength. If not, it returns E_NOT_OK without changing PduInfoPtr.	
Available via	Rte_Cbk.h	

]()

[SWS_Rte_01408] [

```
Std_ReturnType Rte_LdComCbkJTriggerTransmit_<sn> (
    PduInfoType* PduInfoPtr
)
```

where <sn> is a LdCom signal/I-PDU name.](SRS_Rte_00246)

It is configured in LdCom:

LdComTxTriggerTransmit [ECUC_LdCom_00019] as part of LdComIPdu

[SWS_Rte_01409] [The Rte_LdComCbkJTriggerTransmit_<sn> Call back shall return E_OK when SDU has been copied. In this case PduInfoPtr->SduLength shall indicate the number of copied bytes.](SRS_Rte_00246)

[SWS_Rte_01410] [The Rte_LdComCbkJTriggerTransmit_<sn> Call back shall return E_NOT_OK when No SDU data has been copied.](SRS_Rte_00246)

In case of failure, PduInfoPtr must not be used since it may contain a NULL pointer or point to invalid data.

5.9.2.2.8 Rte_LdComCbkJTxConfirmation_<sn>

[] [

Service Name	Rte_LdComCbKTxConfirmation_<sn>	
Syntax	<pre>void Rte_LdComCbKTxConfirmation_<sn> (Std_ReturnType result)</pre>	
Service ID [hex]	0xA7	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant for same sn, otherwise Reentrant	
Parameters (in)	result	E_OK: The PDU was transmitted. E_NOT_OK: Transmission of the PDU failed.
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	The lower layer communication interface module confirms the transmission of a PDU, or the failure to transmit a PDU.	
Available via	Rte_Cbk.h	

⌋()

[SWS_Rte_01411] ⌈

```
void Rte_LdComCbKTxConfirmation_<sn> (
    Std_ReturnType result
)
```

where <sn> is a LdCom signal/I-PDU name.⌋ ([SRS_Rte_00246](#), [SRS_Com_02044](#))

It is configured in LdCom:

[LdComTxConfirmation](#) [ECUC_LdCom_00021] as part of [LdComIPdu](#)

5.9.3 NVM Service Call-backs

5.9.3.1 Rte_SetMirror

⌈

Service Name	Rte_SetMirror__<d>	
Syntax	<pre>Std_ReturnType Rte_SetMirror__<d> (const void* NVMBuffer)</pre>	
Service ID [hex]	0x9b	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	NVMBuffer	source buffer pointer
Parameters (inout)	None	
Parameters (out)	None	





Return value	Std_ReturnType	E_OK: the copy is successful. E_NOT_OK: the copy could not be performed.
Description	The Rte_SetMirror API copies the values of the VariableDataPrototypes contained in a NvBlockDescriptor from a NVM internal buffer to their locations in the RTE.	
Available via	<application.h> or Rte_<Mip>.h	

]()

Rte_SetMirror warrants the consistency of the VariableDataPrototypes contained in a NvBlockSwComponentType, when the associated NVM block is read and copied to the VariableDataPrototypes storage locations.

[SWS_Rte_07310] [

Std_ReturnType

Rte_SetMirror__<d> (const void *NVMBuffer)

where is the SwComponentPrototype's name of the NvBlockSwComponentType and <d> is the NvBlockDescriptor name.](SRS_Rte_00178)

[SWS_Rte_07311] [An Rte_SetMirror API shall be created for each instance of a NvBlockDescriptor.](SRS_Rte_00178)

[SWS_Rte_07312] [The Rte_SetMirror API shall copy the specified buffer to the NvBlockDescriptor's ramBlock, according to the NvBlockDescriptor's NvBlockDataMapping.](SRS_Rte_00177)

The RTE is responsible for ensuring the data consistency, see section 4.2.6 In particular for the NvBlockDescriptor, the Sender-Receiver ports, the Rte_SetMirror, and Rte_GetMirror may access concurrently the same VariableDataPrototypes.

[SWS_Rte_07319] [The Rte_SetMirror API shall be callable before the Rte is started (with Rte_Start), and can rely on a running OS.](SRS_Rte_00178)

The NVM module uses the return value of the Rte_SetMirror API to check if the copy was successful. In case of failure, the NVM may retry later.

[SWS_Rte_07602] [The Rte_SetMirror API shall return E_OK if the copy is successful.](SRS_Rte_00178)

[SWS_Rte_07613] [The Rte_SetMirror API shall return E_NOT_OK if the copy could not be performed.](SRS_Rte_00178)

The NVM shall be configured to use this function when ReadBlock requests are processed (see NvmWriteRamBlockFromNvm in [21]).

5.9.3.2 Rte_GetMirror

[] [

Service Name	Rte_GetMirror__<d>	
Syntax	<pre>Std_ReturnType Rte_GetMirror__<d> (void* NVMBuffer)</pre>	
Service ID [hex]	0x9c	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	NVMBuffer	destination buffer pointer
Return value	Std_ReturnType	E_OK: the copy is successful. E_NOT_OK: the copy could not be performed.
Description	The Rte_GetMirror API copies the values of the VariableDataPrototypes contained in a NvBlock Descriptor to a specified NVM internal buffer.	
Available via	<application.h> or Rte_<Mip>.h	

]()

Rte_GetMirror warrants the consistency of the VariableDataPrototypes contained in a NvBlockSwComponentType, when their values are written to the NVRAM device by the NVM.

[SWS_Rte_07315] [

```
Std_ReturnType
Rte_GetMirror_<b>_<d> (void *NVMBuffer)
```

where is the SwComponentPrototype's name of the NvBlockSwComponentType and <d> is the NvBlockDescriptor name.](SRS_Rte_00178)

[SWS_Rte_07316] [An Rte_GetMirror API shall be created for each instance of a NvBlockDescriptor.](SRS_Rte_00178)

The Rte_GetMirror API copies the values of the VariableDataPrototypes contained in a NvBlockDescriptor to a specified NVM internal buffer.

[SWS_Rte_07317] [The Rte_GetMirror API shall copy the NvBlockDescriptor's ramBlock to the specified buffer, according to the NvBlockDescriptor's NvBlockDataMapping.](SRS_Rte_00177)

The RTE is responsible for ensuring the data consistency, see section 4.2.6 In particular for the NvBlockDescriptor, the Sender-Receiver ports, the Rte_SetMirror, and Rte_GetMirror may access concurrently the same VariableDataPrototypes.

[SWS_Rte_07350] [The Rte_GetMirror API shall be callable after the Rte is stopped (with Rte_Stop), and can rely on a running OS.](SRS_Rte_00178)

The NVM module uses the return value of the Rte_GetMirror API to check if the copy was successful. In case of failure, the NVM may retry later.

[SWS_Rte_07601] [The [Rte_GetMirror](#) API shall return E_OK if the copy is successful.] ([SRS_Rte_00178](#))

[SWS_Rte_07614] [The [Rte_GetMirror](#) API shall return E_NOT_OK if the copy could not be performed.] ([SRS_Rte_00178](#))

The NVM shall be configured to use this function when WriteBlock requests are processed (see `NvmWriteRamBlockToNvm` in [21]).

5.9.3.3 Rte_NvMNotifyJobFinished

□ [

Service Name	Rte_NvMNotifyInitBlock__<d>	
Syntax	<pre>Std_ReturnType Rte_NvMNotifyInitBlock__<d> (NvM_BlockRequestType BlockRequest, NvM_RequestResultType JobResult)</pre>	
Service ID [hex]	0x9d	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	BlockRequest	The request type (read, write, ... etc.) of the previous processed block job
	JobResult	Covers the job result of the processed NvM job.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	The <code>Rte_NvMNotifyJobFinished</code> API shall return E_OK.
Description	The <code>Rte_NvMNotifyJobFinished</code> receives the notification from the NvM when a job is finished and forward it to the SW-C.	
Available via	Rte_NvM.h	

]()

[Rte_NvMNotifyJobFinished](#) forwards notifications back to the SW-Cs.

[SWS_Rte_07623] [

```
Std_ReturnType
Rte_NvMNotifyJobFinished_<b>_<d> (
    NvM_BlockRequestType BlockRequest,
    NvM_RequestResultType JobResult)
```

where is the [SwComponentPrototype](#)'s name of the [NvBlockSwComponentType](#) and <d> is the [NvBlockDescriptor](#) name.] ([SRS_Rte_00228](#))

[SWS_Rte_07624] [An [Rte_NvMNotifyJobFinished](#) API shall be created for each instance of a [NvBlockDescriptor](#).] ([SRS_Rte_00228](#))

[SWS_Rte_07625] [The [Rte_NvMNotifyJobFinished](#) API shall call the servers referenced by [RoleBasedPortAssignment](#) with a `NvMNotifyJobFinished` role which are aggregated to the [NvBlockDescriptor](#).] ([SRS_Rte_00228](#))

[SWS_Rte_07671] [The `Rte_NvMNotifyJobFinished` API shall return without any action when the RTE is not started, when the RTE is stopped, or when the partition containing the `NvBlockSwComponentType` is terminated or restarting.] (*SRS_Rte_00228*)

[SWS_Rte_07626] [The `Rte_NvMNotifyJobFinished` API shall return `E_OK`.] (*SRS_Rte_00228*)

The NVM shall be configured to use this function (see `NvmSingleBlockCallback` in [21]).

5.9.3.4 Rte_NvMNotifyInitBlock

□ [

Service Name	Rte_NvMNotifyInitBlock__<d>	
Syntax	<pre>Std_ReturnType Rte_NvMNotifyInitBlock__<d> (NvM_InitBlockRequestType InitBlockRequest)</pre>	
Service ID [hex]	0x9e	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	InitBlockRequest	The request type (read, restore, ... etc.) of the currently processed block
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	The <code>Rte_NvMNotifyInitBlock</code> API shall return <code>RTE_E_RAM_UNCHANGED</code> if the <code>NvBlockDescriptor</code> 's RAM block was not changed, otherwise it shall return <code>E_OK</code> .
Description	The <code>Rte_NvMNotifyInitBlock</code> API receives the notification from the NvM when initialization of the RAM block is requested.	
Available via	Rte_NvM.h	

]()

`Rte_NvMNotifyInitBlock` indicates to the SW-Cs that initialization of the RAM block is requested by the NvM.

[SWS_Rte_07627] [

```
Std_ReturnType
Rte_NvMNotifyInitBlock_<b>_<d> (
    NvM_InitBlockRequestType InitBlockRequest)
```

where is the `SwComponentPrototype`'s name of the `NvBlockSwComponentType` and <d> is the `NvBlockDescriptor` name.] (*SRS_Rte_00228*)

[SWS_Rte_07628] [An `Rte_NvMNotifyInitBlock` API shall be created for each instance of a `NvBlockDescriptor`.] (*SRS_Rte_00228*)

[SWS_Rte_07629] [If the `NvBlockDescriptor` is configured with a `romBlock` `initValue`, this `initValue` shall be copied into the `NvBlockDescriptor`'s RAM block before calling any SW-C server.]([SRS_Rte_00228](#))

[SWS_Rte_07630] [The `Rte_NvMNotifyInitBlock` API shall call the servers referenced by `RoleBasedPortAssignment` with a `NvMNotifyInitBlock` role which are aggregated to the `NvBlockDescriptor`.]([SRS_Rte_00228](#))

[SWS_Rte_07672] [The `Rte_NvMNotifyInitBlock` API shall return without any action when the RTE is not started, when the RTE is stopped, or when the partition containing the `NvBlockSwComponentType` is terminated or restarting.]([SRS_Rte_00228](#))

[SWS_Rte_07631] [The `Rte_NvMNotifyInitBlock` API shall return `RTE_E_RAM_UNCHANGED` if the `NvBlockDescriptor`'s RAM block was not changed, otherwise it shall return `E_OK`.]([SRS_Rte_00228](#))

The `Rte_NvMNotifyInitBlock` API shall consider a RAM block as changed if either the ROM block default values are copied to the RAM block (see [\[SWS_Rte_07629\]](#)) or if the servers for the `NvMNotifyInitBlock` are called (see [\[SWS_Rte_07630\]](#)).

The NVM shall be configured to use this function (see `InitBlockCallbackFunction` in [\[21\]](#)).

5.10 Expected interfaces

5.10.1 Expected Interfaces from Com

The specification of the RTE requires the usage of the following COM API functions.

Com API function	Context
<code>Com_SendSignal</code>	to transmit a data element of primitive type using COM.
<code>Com_SendDynSignal</code>	to transmit a data element of primitive dynamic type <code>uint8[n]</code> using COM.
<code>Com_ReceiveSignal</code>	to retrieve the new value of a data element of primitive type from COM.
<code>Com_ReceiveDynSignal</code>	to retrieve the new value of a data element of primitive dynamic type <code>uint8[n]</code> from COM.
<code>Com_SendSignalWithMetaData</code>	to transmit a data element of primitive type and meta data using COM.
<code>Com_SendDynSignalWithMetaData</code>	to transmit a data element of primitive dynamic type <code>uint8[n]</code> and meta data using COM.
<code>Com_ReceiveSignalWithMetaData</code>	to retrieve the new value of a data element of primitive type and meta data from COM.
<code>Com_ReceiveDynSignalWithMetaData</code>	to retrieve the new value of a data element of primitive dynamic type <code>uint8[n]</code> and meta data from COM.
<code>Com_SendSignalGroup</code>	to initiate sending of a data element of composite type using COM.
<code>Com_ReceiveSignalGroup</code>	to retrieve the new value of a data element of composite type from COM.

Com API function	Context
Com_SendSignalGroup WithMetaData	to initiate sending of a data element of composite type and meta data using COM.
Com_ReceiveSignalGroup WithMetaData	to retrieve the new value of a data element of composite type and meta data from COM.
Com_InvalidateSignal	to invalidate a data element of primitive type using COM.
Com_InvalidateSignalGroup	to invalidate a whole signal group using COM.
Com_SendSignalGroupArray	to initiate sending of a data element of composite type using COM array based signal group API.
Com_ReceiveSignalGroup Array	to retrieve the new data element of composite type using COM array based signal group API.
Com_SendSignalGroup ArrayWithMetaData	to initiate sending of a data element of composite type and meta data using COM array based signal group API.
Com_ReceiveSignalGroup ArrayWithMetaData	to retrieve the new data element of composite type and meta data using COM array based signal group API.

Table 5.6: COM API functions used by the RTE

Please note that [\[SWS_Rte_02761\]](#) may require to access COM through the use of call trusted function in a partitioned system.

5.10.2 Expected Interfaces from LdCom

The specification of the RTE requires the usage of the following LdCom API functions.

LdCom API function	Context
LdCom_Transmit	to transmit a data element of primitive type or uint8[n] using LdCom API.

Table 5.7: LdCom API functions used by the RTE

Please note that [\[SWS_Rte_02761\]](#) may require to access LdCom through the use of call trusted function in a partitioned system.

5.10.3 Expected Interfaces from Os

The usage of APIs provided by the Os module [\[4\]](#) is up to the implementation of a specific RTE Generator, System description and Ecu configuration. In general a RTE may utilize any standardized API. Therefore no dedicated list of expected APIs is specified here.

In case of multi-core the RTE may utilize the *IOC*-Module [\[4\]](#) to implement the inter-core communication. The *IOC*-Module is specified to be part of the Os. Therefore no specific APIs are listed here.

5.10.4 Expected Interfaces for Data Transformation

The specification of the RTE requires the usage of the following Transformer API functions.

Transformer API function	Context
<Mip>_<transformerId>	API of a transformer on the sending/calling side of the communication. The name pattern follows [SWS_Xfrm_00062].
<Mip>_Inv_<transformerId>	API of a transformer on the receiving/called side of the communication. The name pattern follows [SWS_Xfrm_00062].

Table 5.8: Transformer API functions used by the RTE

Please note that the exact names of the API depend on the EcuC of the respective transformer module.

The EcuC of a transformer module contains a mapping from the transformer and [ISignal](#) or [ISignalGroup](#) with the to the [BswModuleEntry](#) which implements this specific transformer. (See [ECUC_Xfrm_00001].

This mapping can be used by the RTE to determine which [BswModuleEntry](#) shall be executed by the RTE for a specific transformer.

5.10.5 Expected Interfaces from NvM

The specification of the RTE requires the usage of the following NvM API functions.

NvM API function	Context
NvM_SetBlockProtection	to set/reset the write protection for a NV block
NvM_EraseBlock	to erase a NV block.
NvM_GetDataIndex	to get the currently set DataIndex of a dataset NVRAM block.
NvM_GetErrorStatus	to read the block dependent error/status information.
NvM_InvalidateNvBlock	to invalidate a NV block.
NvM_ReadBlock	to copy the data of the NV block to its corresponding RAM block.
NvM_ReadPRAMBlock	to copy the data of the NV block to its corresponding permanent RAM block.
NvM_RestoreBlockDefaults	to restore the default data to its corresponding RAM block.
NvM_RestorePRAMBlock Defaults	to restore the default data to its corresponding permanent RAM block.
NvM_SetDataIndex	to set the DataIndex of a dataset NVRAM block.
NvM_SetRamBlockStatus	to set the RAM block status of an NVRAM block.
NvM_WriteBlock	to copy the data of the RAM block to its corresponding NV block.
NvM_WritePRAMBlock	to copy the data of the RAM block to its corresponding permanent RAM block.

NvM API function	Context
------------------	---------

Table 5.9: NvM API functions used by the RTE

5.11 VFB Tracing Reference

The RTE's "VFB Tracing" functionality permits the monitoring of AUTOSAR signals as they are sent and received across the VFB.

The RTE supports a two-step approach to define if and which VFB Trace hooks shall be called. In a first step [RteVfbTraceEnabled](#) globally enables or disables the VFB Tracing feature at generation time of the RTE. If disabled, no trace hooks are called by the RTE at all. If enabled, the trace hooks configured via [RteVfbTraceFunction](#) are called. This is a second, finer grained step.

Note that a trace client might introduce more steps to switch tracing on or off globally or individually per hook. This corresponds to the possibility in previous releases to switch VFB Tracing on or off via compiler switches (e.g. `RTE_VFB_TRACE`). The responsibility and decision to offer such possibilities is now handed over to the trace clients.

[SWS_Rte_01327] [The RTE generator shall support a mode where no VFB events are traced.] ([SRS_Rte_00005](#))

[SWS_Rte_01328] [The RTE generator shall support a mode that traces (configured) VFB events.] ([SRS_Rte_00005](#))

The RTE generator's 'trace' mode is enabled or disabled through parameter [RteVfbTraceEnabled](#) in the RTE Configuration. Note that this 'trace' mode is intended to enable debugging of software components and not the RTE itself.

5.11.1 Principle of Operation

The "VFB Tracing" mechanism is designed to offer a lightweight means to monitor the interactions of AUTOSAR software-components with the VFB.

The VFB tracing in 'debug' mode is implemented by a series of "hook" functions that are invoked automatically by the generated RTE when "interesting events" occur. Each hook function corresponds to a single event.

The supported trace events are defined in Section 5.11.5. A mechanism is described in Section 5.11.6 for configuring which of the many potential trace events are of interest.

The overall VFB Trace workflow consists of three phases: configuration, RTE generation and trace client generation.

1. During configuration phase each trace client creates its [RteVfbTraceClient](#) container and configures the prefixes covering all interesting trace hooks in its

[RteVfbTraceFunction](#) and optionally references via [RteVfbTraceHooksRef](#) the container where the RTE shall place extended information about the created hooks.

2. During RTE generation an RTE calling all configured trace hooks will be generated. The RTE's BSWMD will contain descriptions of the called trace hooks – at least as far as the RTE can judge their properties. I.e. the RTE knows which hooks it calls and which signature they have, but it does not know their [swServiceImplPolicy](#) or [MemorySection](#). See Section 5.11.4. Also the referenced container in the trace client's configuration will contain extended descriptions of the hooks generated for the respective client.
3. During trace client generation the trace client will examine RTE's BSWMD and/or the [RteVfbTraceHooks](#) created by the RTE generator in the client's own configuration for the called trace hooks and create an implementation of them. It will also update RTE's BSWMD with the missing information, i.e. [swServiceImplPolicy](#) and [MemorySection](#).

Note that (just as RIPS plugins) the trace clients are functionally seen as part of the RTE even though they might be implemented by a party different from the RTE vendor. Trace clients can therefore enrich RTE's BSWMD.

5.11.2 Support for multiple clients

The “VFB Tracing” mechanism is designed to support multiple clients for each trace event.

[SWS_Rte_05093] [For each [RteVfbTraceClient](#) configured in the RTE Configuration input each Trace Event shall be generated using that [RteVfbTraceClient](#)'s [shortName](#) as the *client prefix* in the optional <client> position of the API function name.]([SRS_Rte_00005](#), [SRS_Rte_00008](#), [SRS_Rte_00192](#))

[SWS_Rte_05091] [The RTE Generator shall provide each Trace Event without a *client prefix* if [RteVfbTraceAnonymousClientEnabled](#) is set to TRUE.]([SRS_Rte_00005](#), [SRS_Rte_00008](#), [SRS_Rte_00192](#))

There are cases where the default (alphabetical) VFB Trace hook ordering is not desired. In such cases the VFB Trace hooks have to be called in a different, user defined order. This order can be defined by aggregating a call position to the trace client configuration. If the user decides to define the trace hook order he has to do this for all configured clients of course.

[SWS_Rte_CONSTR_09065] [Either all or no [RteVfbTraceClient](#) shall have a [RteVfbTraceClientPosition](#).]([SRS_Rte_00005](#), [SRS_Rte_00008](#), [SRS_Rte_00192](#))

[SWS_Rte_CONSTR_09066] [[RteVfbTraceClientPosition](#) shall have unique values.]([SRS_Rte_00005](#), [SRS_Rte_00008](#), [SRS_Rte_00192](#))

[SWS_Rte_04591] [The RTE shall reject configurations violating **[SWS_Rte_CONSTR_09065]** and **[SWS_Rte_CONSTR_09066]**] ([SRS_Rte_00018](#))

[SWS_Rte_05092] [In case of multiple clients for one Trace Event the individual action or start trace functions (i.e. *RTE API Start*, *BSW Scheduler API Start*, *COM Trace Events*, *OS Trace Events*, *Runnable Entity Invocation*, *BSW Schedulable Entity Invocation* and *RPT Trace Events*) shall be called in the following order:

1. The trace functions without *client prefix*.
2. The trace functions with *client prefix* in alphabetically ascending order of the [shortName](#) of the [RteVfbTraceClient](#) (ASCII / ISO 8859-1), if [RteVfbTraceClientPosition](#) is not set.
3. The trace functions with *client prefix* in ascending order of their [RteVfbTraceClientPosition](#), if [RteVfbTraceClientPosition](#) is set.

] ([SRS_Rte_00005](#), [SRS_Rte_00008](#), [SRS_Rte_00192](#))

[SWS_Rte_04592] [In case of multiple clients for one Trace Event the individual stop or return trace functions (i.e. *RTE API Return*, *BSW Scheduler API Return*, *Runnable Entity Termination* and *BSW Schedulable Entity Termination*) shall be called in the following order:

1. The trace functions with *client prefix* in descending order of their [RteVfbTraceClientPosition](#), if [RteVfbTraceClientPosition](#) is set.
2. The trace functions with *client prefix* in alphabetically descending order of the [shortName](#) of the [RteVfbTraceClient](#) (ASCII / ISO 8859-1), if [RteVfbTraceClientPosition](#) is not set.
3. The trace functions without *client prefix*.

] ([SRS_Rte_00005](#), [SRS_Rte_00008](#), [SRS_Rte_00192](#))

The calling order specification ensures a deterministic execution of the multiple clients.

5.11.3 Support for Multiple Instantiation

[SWS_Rte_06031] [The Component Data Structure type for a multiply instantiatable SWC type (see **[SWS_Rte_02311]**) shall be introduced as a forward reference in the *RTE Configuration Header File* when used in a VFB Tracing hook.] ([SRS_Rte_00005](#), [SRS_Rte_00011](#))

The use of a forward reference enables a pointer to the object to be taken (since the size of the data structure does not need to be known).

5.11.4 Contribution to the Basic Software Module Description and the client's configuration

The RTE Generator in Generation Phase shall also update its Basic Software Module Description ([SWS_Rte_05086]) in order to document the possibly traceable functions and their signatures.

[SWS_Rte_05106] [For each generated hook function – including multiple trace clients ([SWS_Rte_05093]) – the RTE generator shall enter a `BswModuleEntry` in its Basic Software Module Description describing the hook function and its signature. The `implementedEntry` element of the `BswModuleDescription` shall be used to capture the information.] (SRS_Rte_00005, SRS_Rte_00192)

A trace client would find the hook functions called by the RTE for it by either searching all `RteVfbTraceHooks` in its `EcucModuleConfigurationValues` (if it configured one) or searching the RTE's Basic Software Module Description for those `BswModuleEntry`s having the client's name as `functionPrototypeEmitter` or by comparing the `BswModuleEntry`'s `shortName` against the hook function pattern provided in its configuration (`RteVfbTraceFunction`).

[SWS_Rte_04593] [If a trace client referenced an `RteVfbTraceHooks` via `RteVfbTraceHooksRef`, the RTE generator shall create an `RteVfbTraceHook` for each hook function generated for that trace client to the container referenced via `RteVfbTraceHooksRef`.] (SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04594] [If the trace hook is of type RTE API Start (i.e. according [SWS_Rte_01238]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `RTE_API_START`
- `RteVfbTraceHookApi.shortName`: set to the `<api>` name part defined in [SWS_Rte_01238]
- `RteVfbTraceHookComponentTypeSymbol.shortName`: set to the `<cts>` name part defined in [SWS_Rte_01238]
- `RteVfbTraceHookComponentTypeSymbol.RteVfbTraceHookSwComponentTypeRef`: referencing the `SwComponentType` from which `<cts>` was derived
- `RteVfbTraceHookAccessPoint.shortName`: set to the `<ap>` name part defined in [SWS_Rte_01238]
- `RteVfbTraceHookAccessPoint.RteVfbTraceHookAccessPointElementRef`: referencing all model elements from which `<ap>` was derived

]([SRS_Rte_00005](#), [SRS_Rte_00192](#))

[SWS_Rte_04595] [If the trace hook is of type RTE API Return (i.e. according [\[SWS_Rte_01239\]](#)), the RTE generator shall configure the created [RteVfbTraceHook](#) the following way:

- [shortName](#): set to the [shortName](#) of the [BswModuleEntry](#) created for the trace hook (i.e. the symbol of the C function)
- [RteVfbTraceHookEntryRef](#): referencing the [BswModuleEntry](#) created for the trace hook.
- [RteVfbTraceHookType](#): set to `RTE_API_RETURN`
- [RteVfbTraceHookApi.shortName](#): set to the `<api>` name part defined in [\[SWS_Rte_01239\]](#)
- [RteVfbTraceHookComponentTypeSymbol.shortName](#): set to the `<cts>` name part defined in [\[SWS_Rte_01239\]](#)
- [RteVfbTraceHookComponentTypeSymbol.RteVfbTraceHookSwComponentTypeRef](#): referencing the [SwComponentType](#) from which `<cts>` was derived
- [RteVfbTraceHookAccessPoint.shortName](#): set to the `<ap>` name part defined in [\[SWS_Rte_01239\]](#)
- [RteVfbTraceHookAccessPoint.RteVfbTraceHookAccessPointElementRef](#): referencing all model elements from which `<ap>` was derived

]([SRS_Rte_00005](#), [SRS_Rte_00192](#))

[SWS_Rte_04596] [If the trace hook is of type BSW Scheduler API Start (i.e. according [\[SWS_Rte_04531\]](#)), the RTE generator shall configure the created [RteVfbTraceHook](#) the following way:

- [shortName](#): set to the [shortName](#) of the [BswModuleEntry](#) created for the trace hook (i.e. the symbol of the C function)
- [RteVfbTraceHookEntryRef](#): referencing the [BswModuleEntry](#) created for the trace hook.
- [RteVfbTraceHookType](#): set to `SCHM_API_START`
- [RteVfbTraceHookApi.shortName](#): set to the `<api>` name part defined in [\[SWS_Rte_04531\]](#)
- [RteVfbTraceHookBswSchedulerNamePrefix.shortName](#): set to the `<bsnp>` name part defined in [\[SWS_Rte_04531\]](#)
- [RteVfbTraceHookBswSchedulerNamePrefix.RteVfbTraceHookBswImplementationRef](#): referencing the [BswImplementation](#) from which `<bsnp>` was derived

- `RteVfbTraceHookVendorId.shortName`: set to the `<vi>` name part defined in [SWS_Rte_04531], if it is not omitted there
- `RteVfbTraceHookVendorApiInfix.shortName`: set to the `<ai>` name part defined in [SWS_Rte_04531], if it is not omitted there
- `RteVfbTraceHookName.shortName`: set to the `<name>` name part defined in [SWS_Rte_04531]
- `RteVfbTraceHookName.RteVfbTraceHookNameElementRef`: referencing all model elements from which `<name>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04597] [If the trace hook is of type BSW Scheduler API Return (i.e. according [SWS_Rte_04532]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `SCHM_API_RETURN`
- `RteVfbTraceHookApi.shortName`: set to the `<api>` name part defined in [SWS_Rte_04532]
- `RteVfbTraceHookBswSchedulerNamePrefix.shortName`: set to the `<bsnp>` name part defined in [SWS_Rte_04532]
- `RteVfbTraceHookBswSchedulerNamePrefix.RteVfbTraceHookBswImplementationRef`: referencing the `BswImplementation` from which `<bsnp>` was derived
- `RteVfbTraceHookVendorId.shortName`: set to the `<vi>` name part defined in [SWS_Rte_04532], if it is not omitted there
- `RteVfbTraceHookVendorApiInfix.shortName`: set to the `<ai>` name part defined in [SWS_Rte_04532], if it is not omitted there
- `RteVfbTraceHookName.shortName`: set to the `<name>` name part defined in [SWS_Rte_04532]
- `RteVfbTraceHookName.RteVfbTraceHookNameElementRef`: referencing all model elements from which `<name>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04598] [If the trace hook is of type Runnable Entity Invocation (i.e. according [SWS_Rte_01248]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `RUNNABLE_ENTITY_INVOCATION`
- `RteVfbTraceHookComponentTypeSymbol.shortName`: set to the `<cts>` name part defined in [SWS_Rte_01248]
- `RteVfbTraceHookComponentTypeSymbol.RteVfbTraceHookSwComponentTypeRef`: referencing the `SwComponentType` from which `<cts>` was derived
- `RteVfbTraceHookExecutableEntityName.shortName`: set to the `<reName>` name part defined in [SWS_Rte_01248]
- `RteVfbTraceHookExecutableEntityName.RteVfbTraceHookExecutableEntityRef`: referencing the `RunnableEntity` from which `<reName>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04599] [If the trace hook is of type Runnable Entity Termination (i.e. according [SWS_Rte_01249]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `RUNNABLE_ENTITY_TERMINATION`
- `RteVfbTraceHookComponentTypeSymbol.shortName`: set to the `<cts>` name part defined in [SWS_Rte_01249]
- `RteVfbTraceHookComponentTypeSymbol.RteVfbTraceHookSwComponentTypeRef`: referencing the `SwComponentType` from which `<cts>` was derived
- `RteVfbTraceHookExecutableEntityName.shortName`: set to the `<reName>` name part defined in [SWS_Rte_01249]
- `RteVfbTraceHookExecutableEntityName.RteVfbTraceHookExecutableEntityRef`: referencing the `RunnableEntity` from which `<reName>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04600] [If the trace hook is of type BSW Schedulable Entity Invocation (i.e. according [SWS_Rte_04533]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `BSW_SCHEDULABLE_ENTITY_INVOCATION`
- `RteVfbTraceHookBswSchedulerNamePrefix.shortName`: set to the `<bsnp>` name part defined in [SWS_Rte_04533]
- `RteVfbTraceHookBswSchedulerNamePrefix.RteVfbTraceHookBswImplementationRef`: referencing the `BswImplementation` from which `<bsnp>` was derived
- `RteVfbTraceHookVendorId.shortName`: set to the `<vi>` name part defined in [SWS_Rte_04533], if it is not omitted there
- `RteVfbTraceHookVendorApiInfix.shortName`: set to the `<ai>` name part defined in [SWS_Rte_04533], if it is not omitted there
- `RteVfbTraceHookExecutableEntityName.shortName`: set to the `<entityName>` name part defined in [SWS_Rte_04533]
- `RteVfbTraceHookExecutableEntityName.RteVfbTraceHookExecutableEntityRef`: referencing the `BswModuleEntity` from which `<entityName>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04601] [If the trace hook is of type BSW Schedulable Entity Termination (i.e. according [SWS_Rte_04534]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `BSW_SCHEDULABLE_ENTITY_TERMINATION`
- `RteVfbTraceHookBswSchedulerNamePrefix.shortName`: set to the `<bsnp>` name part defined in [SWS_Rte_04534]
- `RteVfbTraceHookBswSchedulerNamePrefix.RteVfbTraceHookBswImplementationRef`: referencing the `BswImplementation` from which `<bsnp>` was derived

- `RteVfbTraceHookVendorId.shortName`: set to the `<vi>` name part defined in [SWS_Rte_04534], if it is not omitted there
- `RteVfbTraceHookVendorApiInfix.shortName`: set to the `<ai>` name part defined in [SWS_Rte_04534], if it is not omitted there
- `RteVfbTraceHookExecutableEntityName.shortName`: set to the `<entityName>` name part defined in [SWS_Rte_04534]
- `RteVfbTraceHookExecutableEntityName.RteVfbTraceHookExecutableEntityRef`: referencing the `BswModuleEntity` from which `<entityName>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04602] [If the trace hook is of type RPT Transmission (i.e. according [SWS_Rte_06113]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `RPT_TRANSMISSION`
- `RteVfbTraceHookComponentTypeSymbol.shortName`: set to the `<cts>` name part defined in [SWS_Rte_06113]
- `RteVfbTraceHookComponentTypeSymbol.RteVfbTraceHookSwComponentTypeRef`: referencing the `SwComponentType` from which `<cts>` was derived
- `RteVfbTraceHookVariable.shortName`: set to the `<var>` name part defined in [SWS_Rte_06113]
- `RteVfbTraceHookVariable.RteVfbTraceHookVariableElementRef`: referencing all model elements from which `<var>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04603] [If the trace hook is of type RPT Reception (i.e. according [SWS_Rte_06114]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `RPT_RECEPTION`

- `RteVfbTraceHookComponentTypeSymbol.shortName`: set to the `<cts>` name part defined in [SWS_Rte_06114]
- `RteVfbTraceHookComponentTypeSymbol.RteVfbTraceHookSwComponentTypeRef`: referencing the `SwComponentType` from which `<cts>` was derived
- `RteVfbTraceHookVariable.shortName`: set to the `<var>` name part defined in [SWS_Rte_06114]
- `RteVfbTraceHookVariable.RteVfbTraceHookVariableElementRef`: referencing all model elements from which `<var>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04604] [If the trace hook is of type Task Activate (i.e. according [SWS_Rte_01243]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `OS_TASK_ACTIVATION`
- `RteVfbTraceHookOsApplication.shortName`: set to the `<application>` name part defined in [SWS_Rte_01243]
- `RteVfbTraceHookOsApplication.RteVfbTraceHookOsApplicationRef`: referencing the `OsApplication` from which `<application>` was derived
- `RteVfbTraceHookTask.shortName`: set to the `<task>` name part defined in [SWS_Rte_01243]
- `RteVfbTraceHookTask.RteVfbTraceHookTaskRef`: referencing the `OsTask` from which `<task>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04605] [If the trace hook is of type Task Dispatch (i.e. according [SWS_Rte_01244]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `OS_TASK_DISPATCH`

- `RteVfbTraceHookTask.shortName`: set to the `<task>` name part defined in [SWS_Rte_01244]
- `RteVfbTraceHookTask.RteVfbTraceHookTaskRef`: referencing the `Os-Task` from which `<task>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04606] [If the trace hook is of type Task Termination (i.e. according [SWS_Rte_06032]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `OS_TASK_TERMINATION`
- `RteVfbTraceHookTask.shortName`: set to the `<task>` name part defined in [SWS_Rte_06032]
- `RteVfbTraceHookTask.RteVfbTraceHookTaskRef`: referencing the `Os-Task` from which `<task>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04607] [If the trace hook is of type Set OS Event (i.e. according [SWS_Rte_01245]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `OS_SET_EVENT`
- `RteVfbTraceHookOsApplication.shortName`: set to the `<application>` name part defined in [SWS_Rte_01245]
- `RteVfbTraceHookOsApplication.RteVfbTraceHookOsApplicationRef`: referencing the `OsApplication` from which `<application>` was derived
- `RteVfbTraceHookTask.shortName`: set to the `<task>` name part defined in [SWS_Rte_01245]
- `RteVfbTraceHookTask.RteVfbTraceHookTaskRef`: referencing the `Os-Task` from which `<task>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04608] [If the trace hook is of type Wait OS Event (i.e. according [SWS_Rte_01246]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `OS_WAIT_EVENT`
- `RteVfbTraceHookTask.shortName`: set to the `<task>` name part defined in [SWS_Rte_01246]
- `RteVfbTraceHookTask.RteVfbTraceHookTaskRef`: referencing the `Os-Task` from which `<task>` was derived

](*SRS_Rte_00005*, *SRS_Rte_00192*)

[SWS_Rte_04609] [If the trace hook is of type Received OS Event (i.e. according [SWS_Rte_01247]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `OS_RECEIVED_EVENT`
- `RteVfbTraceHookTask.shortName`: set to the `<task>` name part defined in [SWS_Rte_01247]
- `RteVfbTraceHookTask.RteVfbTraceHookTaskRef`: referencing the `Os-Task` from which `<task>` was derived

](*SRS_Rte_00005*, *SRS_Rte_00192*)

[SWS_Rte_04610] [If the trace hook is of type COM Signal Transmission (i.e. according [SWS_Rte_01240]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `COM_SIGNAL_TRANSMISSION`
- `RteVfbTraceHookSignal.shortName`: set to the `<signalName>` name part defined in [SWS_Rte_01240]

- `RteVfbTraceHookSignal.RteVfbTraceHookSignalRef`: referencing the `ComSignal` from which `<signalName>` was derived

]([SRS_Rte_00005](#), [SRS_Rte_00192](#))

[SWS_Rte_04611] [If the trace hook is of type COM Signal Reception (i.e. according [\[SWS_Rte_01241\]](#)), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `COM_SIGNAL_RECEPTION`
- `RteVfbTraceHookSignal.shortName`: set to the `<signalName>` name part defined in [\[SWS_Rte_01241\]](#)
- `RteVfbTraceHookSignal.RteVfbTraceHookSignalRef`: referencing the `ComSignal` from which `<signalName>` was derived

]([SRS_Rte_00005](#), [SRS_Rte_00192](#))

[SWS_Rte_04612] [If the trace hook is of type COM Signal Invalidation (i.e. according [\[SWS_Rte_03814\]](#)), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `COM_SIGNAL_INVALIDATION`
- `RteVfbTraceHookSignal.shortName`: set to the `<signalName>` name part defined in [\[SWS_Rte_03814\]](#)
- `RteVfbTraceHookSignal.RteVfbTraceHookSignalRef`: referencing the `ComSignal` from which `<signalName>` was derived

]([SRS_Rte_00005](#), [SRS_Rte_00192](#))

[SWS_Rte_04613] [If the trace hook is of type COM Signal Group Invalidation (i.e. according [\[SWS_Rte_07639\]](#)), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.

- `RteVfbTraceHookType`: set to `COM_SIGNAL_GROUP_INVALIDATION`
- `RteVfbTraceHookSignalGroup.shortName`: set to the `<signalGroupName>` name part defined in [SWS_Rte_07639]
- `RteVfbTraceHookSignalGroup.RteVfbTraceHookSignalGroupRef`: referencing the `ComSignalGroup` from which `<signalGroupName>` was derived

](SRS_Rte_00005, SRS_Rte_00192)

[SWS_Rte_04614] [If the trace hook is of type COM Callback (i.e. according [SWS_Rte_01242]), the RTE generator shall configure the created `RteVfbTraceHook` the following way:

- `shortName`: set to the `shortName` of the `BswModuleEntry` created for the trace hook (i.e. the symbol of the C function)
- `RteVfbTraceHookEntryRef`: referencing the `BswModuleEntry` created for the trace hook.
- `RteVfbTraceHookType`: set to `COM_SIGNAL_CALLBACK`
- `RteVfbTraceHookComHookEvent.shortName`: set to the `<Event>` name part defined in [SWS_Rte_01242]
- `RteVfbTraceHookSignal.shortName`: set to the `<signalName>` name part defined in [SWS_Rte_01242], in case `<signalName>` refers to a COM signal
- `RteVfbTraceHookSignal.RteVfbTraceHookSignalRef`: referencing the `ComSignal` from which `<signalName>` was derived, in case `<signalName>` refers to a COM signal
- `RteVfbTraceHookSignalGroup.shortName`: set to the `<signalName>` name part defined in [SWS_Rte_01242], in case `<signalName>` refers to a COM signal group
- `RteVfbTraceHookSignalGroup.RteVfbTraceHookSignalGroupRef`: referencing the `ComSignalGroup` from which `<signalName>` was derived, in case `<signalName>` refers to a COM signal group

](SRS_Rte_00005, SRS_Rte_00192)

The trace client then has to provide an implementation for those hooks in the *VFB Tracing Header File* ([SWS_Rte_01236]) and enrich the RTE's BSWMD with the missing implementation information of those hooks.

[SWS_Rte_08902] [The VFB trace client has to complete the RTE's Bsw Module Description for the hook functions implemented by it. This specifically means to provide the `swServiceImplPolicy` of the related `BswModuleEntry`, add a `BswCalledEntity` referencing the related `BswModuleEntry`, add `MemorySections` for each memory section used by the VFB Trace client code and add a `requiredArtifact` for the related Memmap Header file.]()

Please note that the [MemorySections](#) used by the VFB Trace client should have prefix `RTE_` to avoid namespace clashes with other modules and to make clear that from a functional perspective the functions belong to the RTE.

5.11.5 Trace Events

5.11.5.1 RTE API Trace Events

RTE API trace events occur when an AUTOSAR software-component interacts with the generated RTE API. For implicit S/R communication, however, tracing is not supported.

5.11.5.1.1 RTE API Start

Description: RTE API Start is invoked by the RTE when an API call is made by a component.

Signature: **[SWS_Rte_01238]** `[`
`void Rte_[<client>_]<api>Hook_<cts>_<ap>_Start`
`([const Rte_CDS_<cts>*,]<param>)`

Where `<api>` is the RTE API Name (Write, Call, etc.),

`<cts>` is the [component type symbol](#) of the [AtomicSwComponentType](#) and

`<ap>` the access point name (e.g. port and data element or operation name, exclusive area name, etc.).

The parameters of the API shall be the same as the corresponding RTE API. As with the API itself, the instance handle is included if and only if the software component's [supportsMultipleInstantiation](#) attribute is set to true and the RTE API function is per-instance. Thus the instance handle is always omitted for SWCs supporting single instantiation and also for per-SWC functions, such as [Rte_CData](#) for shared [ParameterDataPrototypes](#), for SWCs supporting multiple instantiation. Note that `Rte_Instance` cannot be used directly, as there will be pointers to multiple components' structure types within the single VFB Tracing header file, and `Rte_Instance` would therefore be ambiguous.]([SRS_Rte_00045](#), [SRS_Rte_00003](#), [SRS_Rte_00004](#))

5.11.5.1.2 RTE API Return

Description: RTE API Return is a trace event that is invoked by the RTE just before an API call returns control to a component.

Signature: **[SWS_Rte_01239]** [
void Rte_[<client>_]<api>Hook_<cts>_<ap>_Return
([const Rte_CDS_<cts>*,]<param>)

Where <api> is the RTE API Name (Write, Call, etc.),

<cts> is the [component type symbol](#) of the [AtomicSwComponentType](#) and

<ap> the access point name (e.g. port and data element or operation name, exclusive area name, etc.).

The parameters of the API are the same as the corresponding RTE API and contain the values of OUT and INOUT parameters on exit from the function.

As with the API itself, the instance handle is included if and only if the software component's [supportsMultipleInstantiation](#) attribute is set to true and the RTE API function is per-instance. Thus the instance handle is always omitted for SWCs supporting single instantiation and also for per-SWC functions, such as [Rte_CData](#) for shared [ParameterDataPrototypes](#), for SWCs supporting multiple instantiation. Note that [Rte_Instance](#) cannot be used directly, as there will be pointers to multiple components' structure types within the single VFB Tracing header file, and [Rte_Instance](#) would therefore be ambiguous.]([SRS_Rte_00045](#))

5.11.5.2 BSW Scheduler API Trace Events

BSW Scheduler API trace events occur when an AUTOSAR Basic Software Module interacts with the generated BSW Scheduler API.

5.11.5.2.1 BSW Scheduler API Start

Description: BSW Scheduler API Start is invoked by the BSW Scheduler when an API call is made by a Basic Software Module.

Signature: **[SWS_Rte_04531]** [
void SchM_[<client>_]<api>Hook_<bsnp>_[<vi>_<ai>]_
<name>_Start(<param>)

Where <api> is the BSW Scheduler API Name (Send, Call, etc.),

<bsnp> is the *BSW Scheduler Name Prefix* according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the [vendorId](#) of the BSW module,

<ai> is the [vendorApiInfix](#) of the BSW module and

<name> is the name provided by the API (e.g. [shortName](#) of the [VariableDataPrototype](#) of a sender-receiver connection).

The parameters of the API shall be the same as the corresponding BSW Scheduler API.

The sub part in square brackets [[_<vi>_<ai>](#)] is omitted if no [vendorApiInfix](#) is defined for the Basic Software Module. See ([[SWS_Rte_07528](#)]).

]([SRS_Rte_00003](#), [SRS_Rte_00004](#), [SRS_Rte_00045](#))

5.11.5.2.2 BSW Scheduler API Return

Description: BSW Scheduler API Return is invoked by the BSW Scheduler just before an API call returns control to a Basic Software Module.

Signature: [[SWS_Rte_04532](#)] [
void SchM_[\[<client>_\]](#)[<api>](#)Hook_[<bsnp>_](#)[\[<vi>_<ai>\]](#)_
[<name>_Return\(<param>\)](#)

Where [<api>](#) is the BSW Scheduler API Name (Send, Call, etc.),

[<bsnp>](#) is the *BSW Scheduler Name Prefix* according [[SWS_Rte_07593](#)] and [[SWS_Rte_07594](#)],

[<vi>](#) is the [vendorId](#) of the BSW module,

[<ai>](#) is the [vendorApiInfix](#) of the BSW module and

[<name>](#) is the name provided by the API (e.g. [shortName](#) of the [VariableDataPrototype](#) of a sender-receiver connection).

The parameters of the API shall be the same as the corresponding BSW Scheduler API.

The sub part in square brackets [[_<vi>_<ai>](#)] is omitted if no [vendorApiInfix](#) is defined for the Basic Software Module. See ([[SWS_Rte_07528](#)]).

]([SRS_Rte_00003](#), [SRS_Rte_00004](#), [SRS_Rte_00045](#))

5.11.5.3 COM Trace Events

COM trace events occur when the generated RTE interacts with the AUTOSAR communication service.

5.11.5.3.1 Signal Transmission

Description: A trace event indicating a transmission request of an Inter-ECU signal (or signal in a signal group) by the RTE. Invoked by the RTE just before `Com_SendSignal`, `Com_SendDynSignal`, or `Com_SendSignalGroupArray` is invoked.

Signature: **[SWS_Rte_01240]** [
void Rte_[<client>_]ComHook_<signalName>_SigTx
(<data>)

Where <signalName> is the COM signal name and <data> is a pointer to the signal data to be transmitted.]([SRS_Rte_00045](#), [SRS_Rte_00003](#), [SRS_Rte_00004](#))

5.11.5.3.2 Signal Reception

Description: A trace event indicating a successful attempt to read an Inter-ECU signal (or signal in a signal group) by the RTE. Invoked by the RTE after return from `Com_ReceiveSignal`, `Com_ReceiveDynSignal`, or `Com_ReceiveSignalGroupArray`.

Signature: **[SWS_Rte_01241]** [
void Rte_[<client>_]ComHook_<signalName>_SigRx
(<data>)

Where <signalName> is the COM signal name and <data> is a pointer to the signal data received.]([SRS_Rte_00045](#), [SRS_Rte_00003](#), [SRS_Rte_00004](#))

5.11.5.3.3 Signal Invalidation

Description: A trace event indicating a signal invalidation request of an Inter-ECU signal (or of a signal in a signal group) by the RTE. Invoked by the RTE just before `Com_InvalidateSignal` is invoked.

Signature: **[SWS_Rte_03814]** [
void Rte_[<client>_]ComHook_<signalName>_SigIv
(void)

Where <signalName> is the COM signal or a signal group name.]([SRS_Rte_00045](#), [SRS_Rte_00003](#), [SRS_Rte_00004](#))

5.11.5.3.4 Signal Group Invalidation

Description: A trace event indicating a signal group invalidation request of an Inter-ECU signal group by the RTE. Invoked by the RTE just before `Com_InvalidateSignalGroup` is invoked.

Signature: **[SWS_Rte_07639]** [
`void Rte_[<client>_]ComHook_<signalGroupName>_SigGroupIv`
`(void)`

Where `<signalGroupName>` is the name of the signal group.]
[\(SRS_Rte_00045, SRS_Rte_00003, SRS_Rte_00004\)](#)

5.11.5.3.5 COM Callback

Description: A trace event indicating the start of a COM call-back. Invoked by generated RTE code on entry to the COM call-back.

Signature: **[SWS_Rte_01242]** [
`void Rte_[<client>_]ComHook<Event>_<signalName>`
`(void)`

Where `<signalName>` is the name of the COM signal or signal group and `<Event>` indicates the callback type and can take the values

- “Rx” for a reception indication callback
- “Inv” for an invalidation callback
- “RxTOut” for a reception timeout callback
- “TxTOut” for a transmission timeout callback
- “TAck” for a transmission acknowledgement callback
- “TErr” for a transmission error callback

] [\(SRS_Rte_00045, SRS_Rte_00003, SRS_Rte_00004\)](#)

5.11.5.4 OS Trace Events

OS trace events occur when the generated RTE interacts with the AUTOSAR operating system.

5.11.5.4.1 Task Activate

Description: A trace event that is invoked by the RTE immediately prior to the activation of a task containing runnable entities.

Signature: **[SWS_Rte_01243]** [
void Rte_[<client>_]Task_Activate_<application>_<task>
(void)

Where <application> is the name of the OsApplication activating the task and <task> is the name of the activated task.]([SRS_Rte_00045](#))

5.11.5.4.2 Task Dispatch

Description: A trace event that is invoked immediately an RTE generated task (containing runnable entities) has commenced execution.

Signature: **[SWS_Rte_01244]** [
void Rte_[<client>_]Task_Dispatch_<task>(void)

Where <task> is the name of the task.]([SRS_Rte_00045](#))

5.11.5.4.3 Task Termination

Description: A trace event invoked immediately prior to an RTE generated task (containing runnable entities) terminating execution. The same task termination VFB event is used whether the RTE generated task terminates by either a `TerminateTask` or a `ChainTask` OS Service call.

Signature: **[SWS_Rte_06032]** [
void Rte_[<client>_]Task_Terminate_<task>(void)

Where <task> is the name of the task.]([SRS_Rte_00045](#))

5.11.5.4.4 Set OS Event

Description: A trace event invoked immediately before generated RTE code attempts to set an OS Event.

Signature: **[SWS_Rte_01245]** [
void Rte_[<client>_]Task_SetEvent_<application>_<task>
(EventMaskType ev)

Where `<application>` is the name of the `OsApplication` setting the event and `<task>` is the name of the task for which the event is being set and `ev` the OS event mask. |(SRS_Rte_00045)

5.11.5.4.5 Wait OS Event

Description: Invoked immediately before generated RTE code attempts to wait on an OS Event. This trace event does *not* indicate that the caller has suspended execution since the OS call may immediately return if the event was already set.

Signature: [SWS_Rte_01246] [
void Rte_[<client>_]Task_WaitEvent_<task>
(EventMaskType ev)

Where `<task>` is the name of the task (that is waiting for the event) and `ev` the OS event mask. |(SRS_Rte_00045)

5.11.5.4.6 Received OS Event

Description: Invoked immediately after generated RTE code returns from waiting on an event.

Signature: [SWS_Rte_01247] [
void Rte_[<client>_]Task_WaitEventRet_<task>
(EventMaskType ev)

Where `<task>` is the name of the task (that was waiting for an event) and `ev` the event mask indicating the received event. |(SRS_Rte_00045)

Note that not all of the trace events listed above may be available for a given input configuration. For example if a task is activated by a schedule table, it is activated by the OS rather than by the RTE, hence no trace hook function for task activation can be invoked by the RTE.

5.11.5.5 Runnable Entity Trace Events

Runnable entity trace events occur when a runnable entity is started.

5.11.5.5.1 Runnable Entity Invocation

Description: Event invoked by the RTE just before execution of runnable entry starts via its entry point. This trace event occurs after any copies of data elements are made to support the [Rte_IRead](#) API Call.

Signature: **[SWS_Rte_01248]** [

```
void Rte_[<client>_]Runnable_<cts>_<reName>_Start
    ([const Rte_CDS_<cts>*)
```

Where `<cts>` is the [component type symbol](#) of the [Atomic-SwComponentType](#)

and `reName` the runnable entity name.

The instance handle is included if and only if the software component's [supportsMultipleInstantiation](#) attribute is set to true. Note that `Rte_Instance` cannot be used directly, as there will be pointers to multiple components' structure types within the single VFB Tracing header file, and `Rte_Instance` would therefore be ambiguous.] ([SRS_Rte_00045](#))

5.11.5.5.2 Runnable Entity Termination

purpose: Event invoked by the RTE immediately execution returns to RTE code from a runnable entity. This trace event occurs before any write-back of data elements are made to support the [Rte_IWrite](#) API Call.

Signature: **[SWS_Rte_01249]** [

```
void Rte_[<client>_]Runnable_<cts>_<reName>_Return
    ([const Rte_CDS_<cts>*)
```

Where `<cts>` is the [component type symbol](#) of the [Atomic-SwComponentType](#)

and `reName` the runnable entity name.

The instance handle is included if and only if the software component's [supportsMultipleInstantiation](#) attribute is set to true. Note that `Rte_Instance` cannot be used directly, as there will be pointers to multiple components' structure types within the single VFB Tracing header file, and `Rte_Instance` would therefore be ambiguous.] ([SRS_Rte_00045](#))

5.11.5.6 BSW Schedulable Entities Trace Events

BSW Schedulable entity trace events occur when a BSW Schedulable entity is started.

5.11.5.6.1 BSW Schedulable Entity Invocation

Description: Event invoked by the BSW Scheduler just before execution of BSW Schedulable entry starts via its entry point.

Signature: **[SWS_Rte_04533]** [
void SchM_[<client>_]Schedulable_<bsnp>[_<vi>_<ai>]
_<entityName>_Start
(void)

Where

<bsnp> is the *BSW Scheduler Name Prefix* according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the *vendorId* of the BSW module,

<ai> is the *vendorApiInfix* of the BSW module and

<entityName> is the name of the BSW Schedulable Entity or BSW Callable Entity.

The sub part in square brackets [_<vi>_<ai>] is omitted if no *vendorApiInfix* is defined for the Basic Software Module. See [\(\[SWS_Rte_07528\]\)](#).

]([SRS_Rte_00045](#))

5.11.5.6.2 BSW Schedulable Entity Termination

Description: Event invoked by the BSW Scheduler immediately after execution returns to BSW Scheduler code from a BSW Schedulable Entity.

Signature: **[SWS_Rte_04534]** [
void SchM_[<client>_]Schedulable_<bsnp>[_<vi>_<ai>]
_<entityName>_Return(void)

Where

<bsnp> is the *BSW Scheduler Name Prefix* according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the *vendorId* of the BSW module,

<ai> is the *vendorApiInfix* of the BSW module and

<entityName> is the name of the BSW Schedulable Entity or BSW Callable Entity.

The sub part in square brackets [_<vi>_<ai>] is omitted if no *vendorApiInfix* is defined for the Basic Software Module. See [\(\[SWS_Rte_07528\]\)](#).

]([SRS_Rte_00045](#))

5.11.5.7 RPT Trace Events

RPT trace events occur when a [RP global buffer](#) is sent or received.

5.11.5.7.1 Transmission

Description: Event invoked by the RTE immediately before transmission of an [RP global buffer](#).

The event takes as parameter a **reference** to the [RP global buffer](#) allowing the VFB trace hook to both monitor and influence the value.

Signature: **[SWS_Rte_06113]** [

```
void Rte_[<client>_]RptHook_<cts>_<var>_Transmit
    ([const Rte_CDS_<cts>*], <type>* <buffer> )
```

Where [<cts>](#) is the [component type symbol](#) of the [Atomic-SwComponentType](#), [<var>](#) the identifying name of the [RP global buffer](#), e.g. port and data element names. [<buffer>](#) is a reference to the [RP global buffer](#).

The instance handle is included if and only if the software component's [supportsMultipleInstantiation](#) attribute is set to true. Note that `Rte_Instance` cannot be used directly, as there will be pointers to multiple components' structure types within the single VFB Tracing header file, and `Rte_Instance` would therefore be ambiguous.]([SRS_Rte_00045](#), [SRS_Rte_00244](#))

5.11.5.7.2 Reception

Description: Event invoked by the RTE immediately before the received value is copied from the [RP global buffer](#) to the RTE API's `OUT` parameter or return value. Placing the VFB trace hook at this position ensures that any conditional writes to the [RP global buffer](#) governed by [RP enabler flag](#) will have taken effect.

The event takes as parameter a **reference** to the [RP global buffer](#) allowing the VFB trace hook to both monitor and influence the value.

Signature: **[SWS_Rte_06114]** [

```
void Rte_[<client>_]RptHook_<cts>_<var>_Reception
    ([const Rte_CDS_<cts>*], <type>* <buffer> )
```

Where <cts> is the [component type symbol](#) of the [Atomic-SwComponentType](#), <var> the identifying name of the [RP global buffer](#), e.g. port and data element names. <buffer> is a reference to the [RP global buffer](#).

The instance handle is included if and only if the software component's [supportsMultipleInstantiation](#) attribute is set to true. Note that `Rte_Instance` cannot be used directly, as there will be pointers to multiple components' structure types within the single VFB Tracing header file, and `Rte_Instance` would therefore be ambiguous.] ([SRS_Rte_00045](#), [SRS_Rte_00244](#))

5.11.6 Configuration

The VFB tracing mechanism works by the RTE invoking the tracepoint hook function whenever the tracing event occurs.

The support trace events and their hook function name and signature are defined in Section 5.11.5. There are many potential trace events and it is likely that only a few will be of interest at any one time. Therefore, the RTE generator supports a mechanism to configure which trace events are of interest.

In order to minimize RTE Overheads, trace events that are not enabled should have no run-time effect on the generated system. This is achieved by the RTE not emitting function calls to hook functions that have not been configured as being of interest. A trace function is configured being of interest if its name starts with one of the strings defined in parameter [RteVfbTraceFunction](#) of the respective trace client.

[SWS_Rte_08000] [When [RteVfbTraceEnabled](#) is configured to `TRUE`, the RTE shall call all configured VFB Trace hooks (see [ECUC_Rte_09017]).] ([SRS_Rte_00005](#), [SRS_Rte_00008](#))

Note that there is no way to configure interesting tracing hooks for the trace client without prefix. So if enabled (see [[SWS_Rte_05091](#)]), all trace hooks will be provided for the trace client without prefix.

5.11.7 Interaction with Object-code Software-Components

VFB tracing is only available during the “RTE Generation” or “Basic Software Scheduler Generation” phase [[SWS_Rte_01319](#)] and therefore hook functions never appear in an application header or in a Module Interlink Header file created during “RTE Contract” resp. “Basic Software Scheduler Contract” phase. However, object-code software-components and / or Basic Software Modules are compiled against the “RTE Contract” resp. “Basic Software Scheduler Contract” phase headers and can therefore only trace

events that are inserted into the generated RTE. In particular they cannot trace events that require invocation of hook functions to be inserted into the API mapping such as the [Rte_Pim](#) API. However, many trace events are applicable to object-code software-components including trace events related to the explicit communication API, to task activity and for runnable entity start and stop.

This approach means that the external interactions of the object-code software-component can be monitored without requiring modification of the delivered object-code and without revealing the internal activity of the software-component. The approach is therefore considered to be consistent with the desire for IP protection that prompts delivery of a software-component as object-code. Finally, tracing can easily be disabled for a production build without invalidating tests of the object-code software-component.

6 Basic Software Scheduler Reference

6.1 Scope

This chapter presents the *Basic Software Scheduler* API from the perspective of *AUTOSAR Basic Software Module* – these API is not applicable for *AUTOSAR software-components*.

Section 6.2 presents basic principles of the API including naming conventions and supported programming languages. Section 6.3 describes the header files used by the *Basic Software Scheduler* and the files created by an RTE generator. The data types used by the API are described in Section 6.4 and Sections 6.5 and 6.6 provide a reference to the *Basic Software Scheduler* API itself including the definition of *Basic Software Module Entities*.

6.2 API Principles

6.2.1 Basic Software Scheduler Namespace

The *Basic Software Scheduler* is interleaved with the scheduling part of the *RTE*. Further on it is generated by the *RTE Generator* together with the *RTE* so *Basic Software Scheduler* and *RTE* can not be separated if both are generated. Therefore the *Basic Software Scheduler* uses the namespace of the *RTE* for internal symbols, variables and functions, see [SWS_Rte_01171].

The only exceptions are defines, data types and functions belonging to the interface of the *Basic Software Scheduler*. These are explicitly mentioned in the specification.

[SWS_Rte_07284] [All Basic Software Scheduler symbols (e.g. function names, data types, etc.) belonging to the *Basic Software Schedulers* interfaces are required to use the `SchM_` prefix.] (*SRS_BSW_00307*, *SRS_BSW_00300*, *SRS_Rte_00055*)

In case of *Basic Software Modules* supporting multiple instances of the same *Basic Software Module* the name space of the `BswSchedulableEntitys` and the *Basic Software Scheduler* API related to one instance of a *Basic Software Module* is extended by the `vendorId` and the `vendorApiInfix`. See document [12] [SRS_BSW_00347]. In the following chapters this optional part is denoted by usage of squared brackets [`_<vi>_<ai>`].

[SWS_Rte_07528] [If the attribute `vendorApiInfix` exists for a *Basic Software Module*, the RTE generator shall insert the `vendorId` (`<vi>`) and the `vendorApiInfix` (`<ai>`) with leading underscores where it is denoted by [`_<vi>_<ai>`].] (*SRS_BSW_00347*)

6.2.2 BSW Scheduler Name Prefix and Section Name Prefix

Since the Basic Software Module Description supports the description of BSW Module Clusters one *Basic Software Module Description* can contain the content of several BSW Modules. In order to fulfill the Standardized Interfaces with the cluster interface different ICC3 *Module abbreviations* [9] inside one cluster can occur. For the Basic Software Scheduler the *Module abbreviation* is used as *BSW Scheduler Name Prefix* in the SchM API. Nevertheless the `shortName` of the `BswModuleDescription` can as well describe the `BSW Scheduler Name Prefix` and `Section Name Prefix` in order to provide one common prefix in case of ICC3 modules.

In the Meta Model *Module abbreviations* relevant for the Schedule Manager API are explicitly expressed with the meta class `BswSchedulerNamePrefix`. Further information can be found in document [9].

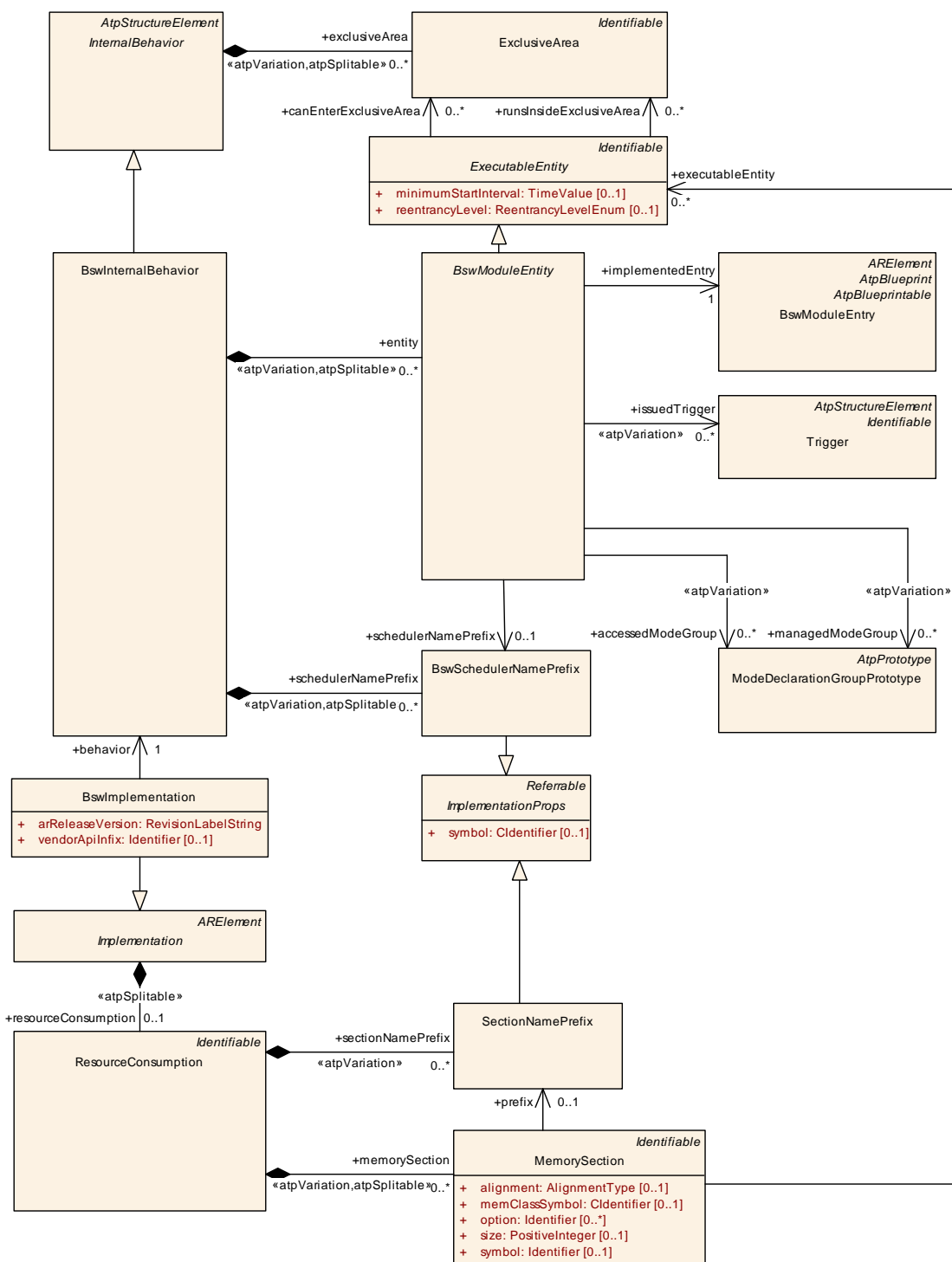


Figure 6.1: BswSchedulerNamePrefix and SectionNamePrefix

In several requirements of this specification the *Module Prefix* is required and determined as follows:

[SWS_Rte_07593] The BSW Scheduler Name Prefix <bsnp> of the calling BSW module shall be derived from the BswModuleDescription shortName if no BswSchedulerNamePrefix is defined for the BswModuleEntity using the related Basic Software Scheduler API. (*SRS Rte 00148, SRS Rte 00149*)

[SWS_Rte_07594] [The `Bsw Scheduler Name Prefix` <bsnp> shall be the value of the `symbol` attribute of the `BswSchedulerNamePrefix` of the `BswModuleEntity` if a `BswSchedulerNamePrefix` is defined for the `BswModuleEntity` using the related Basic Software Scheduler API.]([SRS_Rte_00148](#), [SRS_Rte_00149](#))

Please note that no matter if the <bsnp> is derived via `BswModuleDescription.shortName` (see [\[SWS_Rte_07593\]](#)) or via `BswSchedulerNamePrefix.symbol` (see [\[SWS_Rte_07594\]](#)) [\[TPS_BSWMDT_04008\]](#) always applies. That means, except for the potential vendor infix, the `BswModuleEntry.shortName` is always equal to the C function name. And therefore the `BswModuleEntry.shortName` is always prefixed by the <bsnp>. For regular BSWMs this also means that the <bsnp> will always be equal to the `BswModuleDescription.shortName`, if a `BswSchedulerNamePrefix.symbol` exists or not. Only for BSWMs being ICC2 clusters the `BswModuleDescription.shortName` will typically be different to the prefix of the `BswModuleEntry.shortName` because the `BswModuleEntry`s they implement are originally defined in different BSWMs. The definition of a `BswSchedulerNamePrefix` is then necessary to define where the prefix of the C symbol of the `BswModuleEntry` ends and the <name> part starts (see figure [6.2](#)).

Further on the *Memory Mapping* inside one cluster can either keep or abolish the ICC3 borders. For some cases (e.g. *Entry Point Prototype*) the RTE has to know the used prefixes for the *Memory Allocation Keywords* as well.

In the Meta Model these prefixes are expressed with the meta class `SectionNamePrefix`. Further information can be found in document [\[9\]](#).

[SWS_Rte_07595] [The `Section Name Prefix` <snp> shall be the module abbreviation (in uppercase letters) of the BSW module derived from the `BswModuleDescription`'s `shortName` if no `SectionNamePrefix` is defined for the `BswModuleEntity` implementing the related `BswModuleEntry`.]([SRS_Rte_00148](#), [SRS_Rte_00149](#))

[SWS_Rte_07596] [The `Section Name Prefix` <snp> shall be the symbol of the `SectionNamePrefix` of the `MemorySection` associated to the `BswModuleEntity` implementing the related `BswModuleEntry` if a `SectionNamePrefix` is defined for the `BswModuleEntity` implementing the related `BswModuleEntry`.]([SRS_Rte_00148](#), [SRS_Rte_00149](#))

For instance the following input configuration

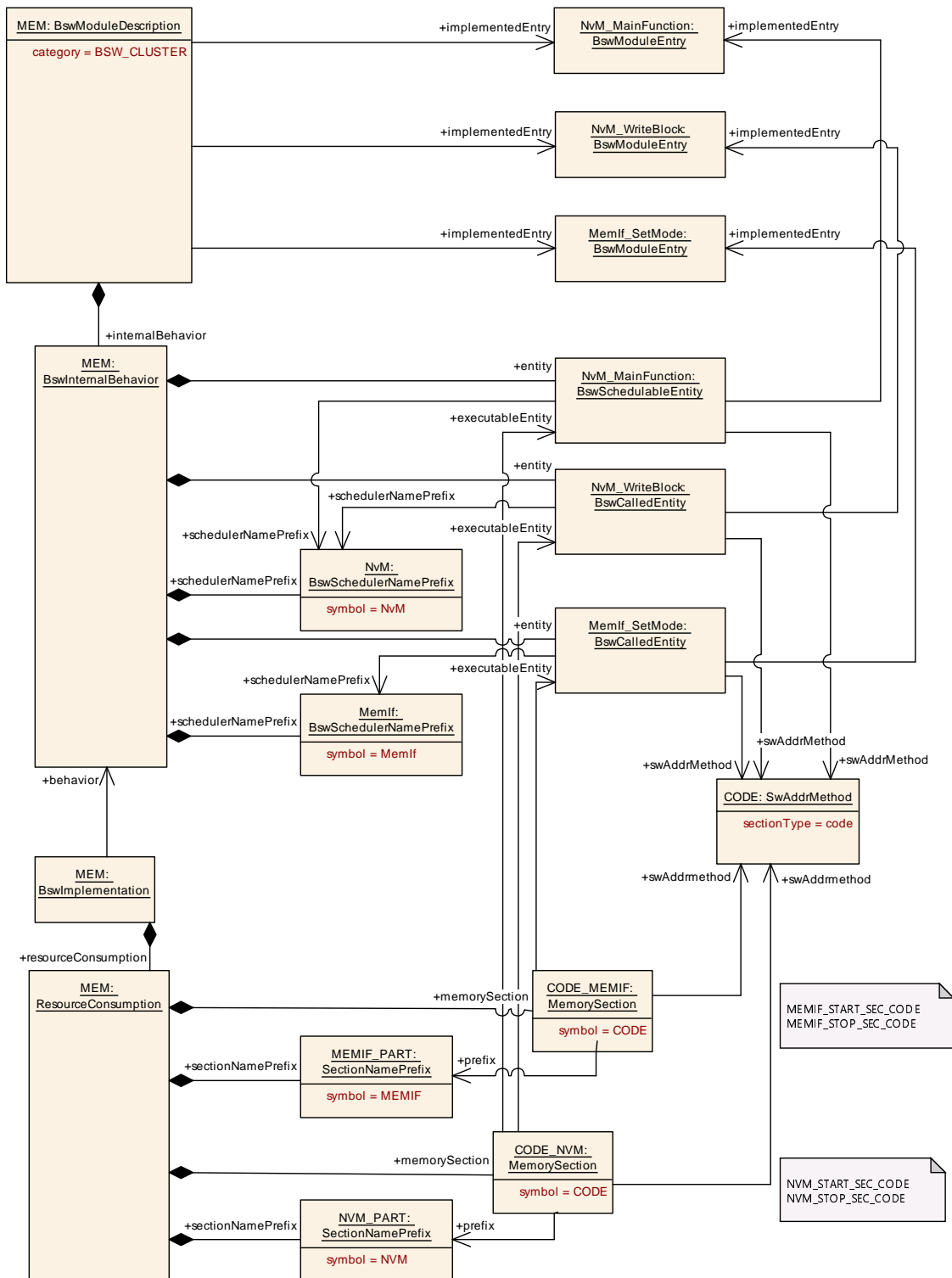


Figure 6.2: Example of ICC2 cluster

would result in the generation of the *Entry Point Prototype* according [SWS_Rte_07195] as:

```
1 #define NVM_START_SEC_CODE
2 #include "MEM_MemMap.h"
3
```

```

4  FUNC(void, NVM_CODE) NvM_MainFunction (void);
5
6  #define NVM_STOP_SEC_CODE
7  #include "MEM_MemMap.h"

```

6.2.3 BSW Scheduler API options

[SWS_Rte_06811] [If the attribute `enableTakeAddress` is set to `TRUE` for a `providedData`, `requiredData`, `perInstanceParameter`, `providedModeGroup`, `requiredModeGroup`, `releasedTrigger`, `requiredClientServerEntry`, `BswInternalTriggeringPoint` or `arTypedPerInstanceMemory` the RTE generator shall provide an API implementation of the related SchM APIs for which it is valid to take the address of an API function at compile time.]()

In C it is valid to take the address of a function but not of a function-like macro. If the `enableTakeAddress` attribute is not set or set to `FALSE` for a particular SchM API, the RTE generator may provide 'C' functions or function like macro depending from the implementation.

6.3 Basic Software Scheduler modules

[SWS_Rte_07288] [Every file of the *Basic Software Scheduler* shall be named with the prefix `SchM_.`] (*SRS_BSW_00300*)

6.3.1 Module Interlink Types Header

The *Module Interlink Types Header* defines specific types related to this basic software module derived either from the input configuration or from the RTE / Basic Software Scheduler implementation.

[SWS_Rte_07503] [The RTE generator shall create a *Module Interlink Types Header File* for each `BswSchedulerNamePrefix` in the `BswInternalBehavior` of each `BswImplementation` referencing such `BswInternalBehavior` defined in the input.] (*SRS_BSW_00415*)

For instance an input configuration with two `BswImplementations` (typical with different API infix) referencing a `BswInternalBehavior` with three `BswSchedulerNamePrefixes` would result in the generation of six Module Interlink Types Header Files.

6.3.1.1 File Name

[SWS_Rte_07295] [The name of the *Module Interlink Types Header File* shall be formed in the following way:

SchM_<bsnp>_[<vi>_<ai>]Type.h

Where here

<bsnp> is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594],

<vi> is the *vendorId* of the BSW module and

<ai> is the *vendorApiInfix* of the BSW module.

The sub part in squared brackets [<vi>_<ai>] is omitted if no *vendorApiInfix* is defined for the *Basic Software Module*. See [SWS_Rte_07528].] (SRS_BSW_00415, SRS_BSW_00300, SRS_BSW_00347)

Example 6.1

The following declaration in the input XML:

```
<AR-PACKAGE>
  <SHORT-NAME>CanDriver</SHORT-NAME>
  <ELEMENTS>
    <BSW-MODULE-DESCRIPTION>
      <SHORT-NAME>Can</SHORT-NAME>
      <INTERNAL-BEHAVIORS>
        <BSW-INTERNAL-BEHAVIOR>
          <SHORT-NAME>YesWeCan</SHORT-NAME>
        </BSW-INTERNAL-BEHAVIOR>
      </INTERNAL-BEHAVIORS>
    </BSW-MODULE-DESCRIPTION>
    <BSW-IMPLEMENTATION>
      <SHORT-NAME>MyCanDrv</SHORT-NAME>
      <VENDOR-ID>25</VENDOR-ID>
      <BEHAVIOR-REF DEST="BSW-INTERNAL-BEHAVIOR">/CanDriver/Can/
        YesWeCan</BEHAVIOR-REF>
      <VENDOR-API-INFIX>Dev0815</VENDOR-API-INFIX>
    </BSW-IMPLEMENTATION>
  </ELEMENTS>
</AR-PACKAGE>
```

should result in the *Module Interlink Types Header* SchM_Can_25_Dev0815Type.h being generated.

The concatenation of the basic software module prefix (which has to be equally with the short name of the basic software module description) and the vendor API infix is required to support the separation of several basic software module instances. In difference to the multiple instantiation concept of software components, where the same

component code is used for all component instances, basic software modules are multiple instantiated by creation of own code per instance in a different name space.

6.3.1.2 Scope

[SWS_Rte_07297] [The *Module Interlink Types Header* shall be valid for both C and C++ source.] ([SRS_Rte_00126](#), [SRS_Rte_00138](#))

Requirement [\[SWS_Rte_07297\]](#) is met by ensuring that all definitions within the *Application Types Header File* are defined using C linkage if a C++ compiler is used.

[SWS_Rte_07298] [All definitions within in the *Module Interlink Types Header File* shall be preceded by the following fragment:

```
1  #ifdef __cplusplus
2  extern "C" {
3  #endif /* __cplusplus */
```

] ([SRS_Rte_00126](#), [SRS_Rte_00138](#))

[SWS_Rte_07299] [All definitions within the *Module Interlink Types Header* shall be suffixed by the following fragment:

```
1  #ifdef __cplusplus
2  } /* extern "C" */
3  #endif /* __cplusplus */
```

] ([SRS_Rte_00126](#), [SRS_Rte_00138](#))

6.3.1.3 File Contents

[SWS_Rte_07500] [The *Module Interlink Types Header* shall include the *RTE Types Header File*.] ([SRS_BSW_00415](#))

The name of the *RTE Types Header File* is defined in Section [5.3.4](#).

6.3.1.4 Basic Software Scheduler Modes

The *Module Interlink Types Header File* shall contain identifiers for the [ModeDeclarations](#) and type definitions for [ModeDeclarationGroups](#) as defined in Chapter [6.4.2](#)

6.3.2 Module Interlink Header

The *Module Interlink Header* defines the *Basic Software Scheduler* API and any associated data structures that are required by the *Basic Software Scheduler* implementation. But the *Module Interlink Header* file is not allowed to create objects in memory.

[SWS_Rte_07501] [The RTE generator shall create a *Module Interlink Header File* for each *BswSchedulerNamePrefix* in the *BswInternalBehavior* of each *BswImplementation* referencing such *BswInternalBehavior* defined in the input.] (*SRS_BSW_00415*)

[SWS_Rte_CONSTR_09059] Usage of *Basic Software Scheduler* API prerequisites the include of the *Module Interlink Header File* [Each BSW module implementation shall include its *Module Interlink Header File* if it uses *Basic Software Scheduler* API or if it implements *BswSchedulableEntity*s.]()

[SWS_Rte_07502] [The *Module Interlink Header File* shall not contain code that creates objects in memory.] (*SRS_BSW_00308*)

6.3.2.1 File Name

[SWS_Rte_07504] [

The name of the *Module Interlink Header File* shall be formed in the following way:

```
1 SchM_<bsnp>[_<vi>_<ai>].h
```

Where here

<bsnp> is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594],

<vi> is the *vendorId* of the BSW module and

<ai> is the *vendorApiInfix* of the BSW module.

The sub part in squared brackets [_<vi>_<ai>] is omitted if no *vendorApiInfix* is defined for the *Basic Software Module*.] (*SRS_BSW_00415*, *SRS_BSW_00300*, *SRS_BSW_00347*)

Example 6.2

The following declaration in the input XML:

```
<AR-PACKAGE>
  <SHORT-NAME>CanDriver</SHORT-NAME>
  <ELEMENTS>
    <BSW-MODULE-DESCRIPTION>
      <SHORT-NAME>Can</SHORT-NAME>
      <INTERNAL-BEHAVIORS>
        <BSW-INTERNAL-BEHAVIOR>
          <SHORT-NAME>YesWeCan</SHORT-NAME>
        </BSW-INTERNAL-BEHAVIOR>
      </INTERNAL-BEHAVIORS>
    </BSW-MODULE-DESCRIPTION>
```

```

<BSW-IMPLEMENTATION>
  <SHORT-NAME>MyCanDrv</SHORT-NAME>
  <VENDOR-ID>25</VENDOR-ID>
  <BEHAVIOR-REF DEST="BSW-INTERNAL-BEHAVIOR">/CanDriver/Can/
    YesWeCan</BEHAVIOR-REF>
  <VENDOR-API-INFIX>Dev0815</VENDOR-API-INFIX>
</BSW-IMPLEMENTATION>
</ELEMENTS>
</AR-PACKAGE>

```

should result in the *Module Interlink Header* `SchM_Can_25_Dev0815.h` being generated.

The concatenation of the basic software module prefix (which has to be equally with the short name of the basic software module description) and the `vendorApiInfix` is required to support the separation of several basic software module instances. In difference to the multiple instantiation concept of software components, where the same component code is used for all component instances, basic software modules are multiple instantiated by creation of own code per instance in a different name space.

6.3.2.2 Scope

[SWS_Rte_07505] [The *Module Interlink Header* for a component shall contain declarations relevant for that instance of a basic software module.] ([SRS_BSW_00415](#))

Requirement [\[SWS_Rte_07505\]](#) means that compile time checks ensure that a *Module Interlink Header File* that uses the *Module Interlink Header File* only accesses the generated data types to which it has been configured. The use of data types which are not used by the basic software module, will fail with a compiler error [\[SRS_Rte_00017\]](#).

6.3.2.3 File Contents

[SWS_Rte_07506] [The *Module Interlink Header File* shall include the *Module Interlink Types Header File*.] ([SRS_BSW_00415](#))

The name of the *Module Interlink Types Header File* is defined in Section [6.3.1](#).

[SWS_Rte_07507] [The *Module Interlink Header* shall be valid for both C and C++ source.] ([SRS_Rte_00126](#), [SRS_Rte_00138](#))

Requirement [\[SWS_Rte_07507\]](#) is met by ensuring that all definitions within the *Application Types Header File* are defined using C linkage if a C++ compiler is used.

[SWS_Rte_07508] [All definitions within in the *Module Interlink Header File* shall be preceded by the following fragment:

```

1  #ifdef __cplusplus
2  extern "C" {

```

```
3 #endif /* __cplusplus */
```

]([SRS_Rte_00126](#), [SRS_Rte_00138](#))

[SWS_Rte_07509] [All definitions within the *Module Interlink Header File* shall be suffixed by the following fragment:

```
1 #ifdef __cplusplus
2 } /* extern "C" */
3 #endif /* __cplusplus */
```

]([SRS_Rte_00126](#), [SRS_Rte_00138](#))

6.3.2.3.1 Entry Point Prototype

The *Module Interlink Header File* also includes a prototype for each [BswSchedulableEntity](#)s entry point ([\[SWS_Rte_04542\]](#)).

6.3.2.3.2 Basic Software Scheduler - Basic Software Module Interface

The *Module Interlink Header File* defines the “interface” between a *Basic Software Module* and the *Basic Software Scheduler*. The interface consists of the *Basic Software Scheduler* API for the *Basic Software Module* and the prototypes for [BswSchedulableEntity](#)s entry point. The definition of the *Basic Software Scheduler* API requires in case of macro implementation that both relevant data structures and API calls are defined. In case of interfaces implemented as functions, the prototypes for the *Basic Software Scheduler* API of the particular *Basic Software Module* instance is sufficient. The data structures are dependent from the implementation and configuration of the *Basic Software Scheduler* and are not standardized. If data structures are required these shall be accessible via the *Module Interlink Header File* as well.

The RTE generator is required [\[SWS_Rte_07505\]](#) to limit the contents of the *Module Interlink Header* file to only that information that is relevant to that instance of a basic software module. This requirement includes the definition of the API.

[SWS_Rte_07510] [Only *Basic Software Scheduler* API calls that are valid for the particular instance of a basic software module shall be defined within the modules *Module Interlink Header File*.]([SRS_BSW_00415](#), [SRS_Rte_00017](#))

Requirement [\[SWS_Rte_07510\]](#) ensures that attempts to invoke invalid API calls will be rejected as a compile-time error [\[SRS_Rte_00017\]](#).

[SWS_Rte_06534] [The RTE Generator shall wrap each *Basic Software Scheduler* API definition of a variant existent API according table [4.34](#) if the variability shall be implemented.

```
1 #if (<condition> [||<condition>])
2
```

```

3 <Basic Software Scheduler API Definition>
4
5 #endif

```

where `condition` are the condition value macro(s) of the [VariationPoints](#) relevant for the conditional existence of the RTE API (see table 4.34), `Basic Software Scheduler API Definition` is the code according an invariant *Basic Software Scheduler API* definition (see also [\[SWS_Rte_07510\]](#), [\[SWS_Rte_07250\]](#), [\[SWS_Rte_07253\]](#), [\[SWS_Rte_07255\]](#), [\[SWS_Rte_07260\]](#), [\[SWS_Rte_07556\]](#), [\[SWS_Rte_07263\]](#), [\[SWS_Rte_07266\]](#))]([SRS_Rte_00229](#))

The Basic Software Scheduler API for basic software modules is defined in [6.5](#)

[SWS_Rte_07511] [The *Basic Software Scheduler API* of the particular *Basic Software Module* instance shall be implemented as functions if the basic software module is delivered as object code.]([SRS_BSW_00342](#))

In case of basic software modules delivered as source code the definitions of the *Basic Software Scheduler API* contained in the *Module Interlink Header File* can be optimized during the “RTE Generation” phase when the mapping of the [BswSchedulableEntity](#)s to OS Tasks is known.

6.3.2.3.3 Provide activating Bsw event

The provide activating event feature is enabled if the executable entity has at least one [activationReason](#) defined.

[SWS_Rte_08056] [If the provide activating event feature is enabled, the RTE generator in contract phase shall generate the executable entity signature according to [\[SWS_Rte_07282\]](#) and [\[SWS_Rte_08071\]](#).]([SRS_Rte_00238](#))

[SWS_Rte_08057] [If the provide activating event feature is enabled, the RTE generator in contract phase shall generate the type `SchM_ActivatingEvent_<name>` (activation vector), where `<name>` is the [symbol](#) describing the executable entity’s entry point, to store the activation bits. Based on the highest value of [ExecutableEntityActivationReason.bitPosition](#) for this executable entity the type shall be either `uint8`, `uint16`, or `uint32` so that the highest value of [bitPosition](#) fits into the data type.]([SRS_Rte_00238](#))

Note that it is considered an invalid configuration if [ExecutableEntityActivationReason.bitPosition](#) has a value higher than 31 (see [\[constr_1226\]](#) in software component template [\[2\]](#)).

[SWS_Rte_08058] [If the provide activating event feature is enabled, the RTE generator in contract phase shall generate for each [ExecutableEntityActivationReason](#) of one executable entity a definition to provide the specific bit position in the `Rte_ActivatingEvent_<name>` data type:

```
#define SchM_ActivatingEvent_<name>_<activation> xxU
```

The value of `xx` is defined by the `bitPosition` $xx = 2^{\text{bitPosition}}$.] ([SRS_Rte_00238](#))
For further details see section [4.2.3.3](#) Provide activating RTE event.

6.3.2.3.4 RunnableEntity mapped to BswModuleEntity

In the case that a `RunnableEntity` is mapped to a `BswSchedulableEntity` the RTE Generator only emits the *Entry Point Prototype* ([6.3.2.3.1](#)) for the `BswSchedulableEntity` (see [[SWS_Rte_01132](#)]). Since `RunnableEntity` and `BswModuleEntity` define a overlapping set of attributes it is technically possible to have redundancy in the AUTOSAR models between the BSW Module Description and the Software Component Description.

[SWS_Rte_06732] [The RTE generator shall reject configurations violating the [constr_4071].] ([SRS_Rte_00018](#))

Within the scope of a `SwcBswRunnableMapping` both `RTEEvents` and `BswEvents` are applicable. Therefore the `ExecutableEntityActivationReasons` of the `RunnableEntity` and the mapped `BswModuleEntity` have to be overlayed.

[SWS_Rte_08071] [The signature of a `RunnableEntity` and a `BswModuleEntity` with a `SwcBswRunnableMapping` shall contain all `ExecutableEntityActivationReasons` that are defined for each entity.] ([SRS_Rte_00238](#))

Note: Multiple definition of identical `activationReasons` with respect to `shortName` and `bitPosition` yields to a valid configuration since both `RunnableEntity`s and `BswModuleEntity`s may provide separate `activationReasons`.

6.3.2.3.5 Condition Value Macros

[SWS_Rte_08790] [For each `VariationPointProxy` which `bindingTime` = `Pre-CompileTime` the *Module Interlink Header File* shall contain a definition

```
#define SchM_SysCon_<name>
    SchM_SysCon_<bsnp>[_<vi>_<ai>]_<ki>_<name>
```

Where

`<bsnp>` is the *BSW Scheduler Name Prefix* according [[SWS_Rte_07593](#)] and [[SWS_Rte_07594](#)],

`<vi>` is the `vendorId` of the BSW module,

`<ai>` is the `vendorApiInfix` of the BSW module,

`<ki>` is the *kind infix* according table [4.34](#),

`<name>` is the short name of the element which is subject to variability in table [4.34](#) defining the *Basic Software Scheduler* API name infix.

The sub part in squared brackets [_{<vi>}_{<ai>}] is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See [SWS_Rte_07528].] (SRS_Rte_00229, SRS_BSW_00347)

6.4 API Data Types

Besides the API functions for accessing *Basic Software Scheduler* services, the API also contains *Basic Software Scheduler* specific data types.

6.4.1 Predefined Error Codes for Std_ReturnType

The specification in [31] specifies a standard API return type `Std_ReturnType`. The `Std_ReturnType` defines the "status" and "error values" returned by API functions. It is defined as a `uint8` type. The value "0" is reserved for "No error occurred".

Symbolic name	Value	Comments
SCHM_E_OK	0	[SWS_Rte_07289]
SCHM_E_LIMIT	130	[SWS_Rte_07290]
SCHM_E_NO_DATA	131	[SWS_Rte_07562]
SCHM_E_TRANSMIT_ACK	132	[SWS_Rte_07563]
SCHM_E_IN_EXCLUSIVE_AREA	135	[SWS_Rte_02747]
SCHM_E_TIMEOUT	129	[SWS_Rte_07054]
SCHM_E_LOST_DATA	64	[SWS_Rte_02312]

Table 6.1: Basic Software Scheduler Error and Status values

The underlying type for `Std_ReturnType` is defined as a `uint8` for reasons of compatibility. Consequently, `#define` is used to declare the error values:

```

1 typedef uint8 Std_ReturnType; /* defined in Std_Types.h */
2
3 #define SCHM_E_OK 0U

```

[SWS_Rte_07291] [The errors as defined in table 6.1 shall be defined in the *RTE Header File*.] (SRS_Rte_00051)

An `Std_ReturnType` value can be directly compared (for equality) with the above pre-defined error identifiers.

6.4.1.1 SCHM_E_OK

[SWS_Rte_07289] [

Symbolic name: SCHM_E_OK

Value: 0

Comments: No error occurred.] (SRS_BSW_00327)

6.4.1.2 SCHM_E_LIMIT

[SWS_Rte_07290] [

Symbolic name: SCHM_E_LIMIT

Value: 130

Comments: An internal *Basic Software Scheduler* limit has been exceeded. Request could not be handled. OUT buffers are not modified.

Note: The value has to be identical with [SWS_Rte_01317]] ([SRS_BSW_00327](#))

6.4.1.3 SCHM_E_NO_DATA

[SWS_Rte_07562] [

Symbolic name: SCHM_E_NO_DATA

Value: 131

Comments: An explicit read API call returned no data. (This is no error.)

Note: The value has to be identical with [SWS_Rte_01061]] ([SRS_BSW_00327](#))

6.4.1.4 SCHM_E_TRANSMIT_ACK

[SWS_Rte_07563] [

Symbolic name: SCHM_E_TRANSMIT_ACK

Value: 132

Comments: Transmission acknowledgement received.

Note: The value has to be identical with [SWS_Rte_01065]] ([SRS_BSW_00327](#))

6.4.1.5 SCHM_E_IN_EXCLUSIVE_AREA

[SWS_Rte_02747] [

Symbolic name: SCHM_E_IN_EXCLUSIVE_AREA

Value: 135

Comments: The error is returned by a blocking API and indicates that the schedulable entity could not enter a wait state, because one [ExecutableEntity](#) of the current task's call stack has entered an [ExclusiveArea](#).

Note: There are no blocking SchM APIs and therefore this value cannot be returned. It is defined here for future use and for consistency with [SWS_Rte_02739]. Both error values have to be identical.] ([SRS_BSW_00327](#))

6.4.1.6 SCHM_E_TIMEOUT

[SWS_Rte_07054] [

Symbolic name: SCHM_E_TIMEOUT

Value: 129

Comments: The configured timeout exceeds before the intended result was ready.

Note: The value has to be identical with [SWS_Rte_01064]] (SRS_BSW_00327)

6.4.1.7 SCHM_E_LOST_DATA

[SWS_Rte_02312] [

Symbolic name: SCHM_E_LOST_DATA

Value: 64

Comments: An API call for reading received data with event semantics indicates that some incoming data has been lost due to an overflow of the receive queue or due to an error of the underlying communication stack.

Note: The value has to be identical with [SWS_Rte_02571]] (SRS_BSW_00327, SRS_Rte_00107, SRS_Rte_00110, SRS_Rte_00094)

6.4.2 Basic Software Modes

[SWS_Rte_07293] [For each [ModeDeclarationGroup](#) of category "ALPHABETIC_ORDER", the *Module Interlink Types Header File* shall contain a definition

```
1 #ifndef RTE_TRANSITION_<prefix><ModeDeclarationGroup>
2 #define RTE_TRANSITION_<prefix><ModeDeclarationGroup> \
3     <n>U
4 #endif
```

where `<ModeDeclarationGroup>` is the short name of the [ModeDeclarationGroup](#)¹,

`<prefix>` is the optional [prefix](#) attribute defined by the [IncludedModeDeclarationGroupSet](#) referring the [ModeDeclarationGroup](#) and

`<n>` is the number of modes declared within the group.] (SRS_Rte_00213)

[SWS_Rte_08600] [For each [ModeDeclarationGroup](#) of category "EXPLICIT_ORDER", the *Module Interlink Types Header File* shall contain a definition

```
1 #ifndef RTE_TRANSITION_<prefix><ModeDeclarationGroup>
2 #define RTE_TRANSITION_<prefix><ModeDeclarationGroup> \
3     <onTransitionValue>U
4 #endif
```

¹No additional capitalization is applied to the names.

where `<ModeDeclarationGroup>` is the short name of the [ModeDeclarationGroup](#)²,

`<prefix>` is the optional [prefix](#) attribute defined by the [IncludedModeDeclarationGroupSet](#) referring the [ModeDeclarationGroup](#) and

`<onTransitionValue>` is the [onTransitionValue](#) of the *ModeDeclarationGroup*.]([SRS_Rte_00213](#))

[SWS_Rte_07294] [For each mode of a [ModeDeclarationGroup](#) of category "ALPHABETIC_ORDER", the *Module Interlink Types Header File* shall contain a definition

```
1 #ifndef RTE_MODE_<prefix><ModeDeclarationGroup>_<ModeDeclaration>
2 #define RTE_MODE_<prefix><ModeDeclarationGroup>_<ModeDeclaration> \
3     <index>U
4 #endif
```

where `<ModeDeclarationGroup>` is the short name of the [ModeDeclarationGroup](#),

`<prefix>` is the optional [prefix](#) attribute defined by the [IncludedModeDeclarationGroupSet](#) referring the [ModeDeclarationGroup](#)

`<ModeDeclaration>` is the short name of a [ModeDeclaration](#)³,

and `<index>` is the index of the [ModeDeclarations](#) in alphabetic ordering (ASCII / ISO 8859-1 code in ascending order) of the short names within the [ModeDeclarationGroup](#).

The lowest index shall be '0' and therefore the range of assigned values is 0..`<n>` where `<n>` is the number of modes declared within the group]([SRS_Rte_00213](#))

[SWS_Rte_08601] [For each mode of a [ModeDeclarationGroup](#) of category "EXPLICIT_ORDER", the *Module Interlink Types Header File* shall contain a definition

```
1 #ifndef RTE_MODE_<prefix><ModeDeclarationGroup>_<ModeDeclaration>
2 #define RTE_MODE_<prefix><ModeDeclarationGroup>_<ModeDeclaration> \
3     <value>U
4 #endif
```

where `<ModeDeclarationGroup>` is the short name of the [ModeDeclarationGroup](#),

`<prefix>` is the optional [prefix](#) attribute defined by the [IncludedModeDeclarationGroupSet](#) referring the [ModeDeclarationGroup](#)

`<ModeDeclaration>` is the short name of a [ModeDeclaration](#)⁴,

and `<value>` is the *value* specified at the [ModeDeclaration](#).]([SRS_Rte_00213](#))

²No additional capitalization is applied to the names.

³No additional capitalization is applied to the names.

⁴No additional capitalization is applied to the names.

6.4.3 Enumeration Data Types

Enumeration is not a plain primitive `ImplementationDataType`. Rather a range of integers can be used as a structural description. The mapping of integers on "labels" in the enumeration is actually modeled in the SwC-T with the semantics class `CompuMethod` of a `SwDataDefProps` [2]. Enumeration data types are modeled as `ImplementationDataTypes` having a `SwDataDefProps` referencing a `CompuMethod` that contains only `CompuScales` with point ranges (i. e. lower and upper limit of a `CompuScale` are identical).

[SWS_Rte_03983] [The *The Module Interlink Types Header File* shall include the definitions of all constants of `ImplementationDataTypes` and `ApplicationDataTypes` for each `ImplementationDataType/ApplicationDataTypes` used (See [SWS_Rte_08803] for the meaning of the term "used") by this Basic Software module.

This includes constants for `CompuMethods` referenced by `ImplementationDataTypeElements` of `ImplementationDataTypes` directly referenced by the Basic Software module and constants for `CompuMethods` of `ImplementationDataTypes` which are referenced indirectly via `ImplementationDataTypes / ImplementationDataTypeElements` of category `TYPE_REFERENCE`.] (*SRS_Rte_00252*)

[SWS_Rte_03983] is applicable regardless if the `AutosarDataType` is referenced in `DataPrototypes` defined in the `InternalBehavior` of the Basic Software module or `AutosarDataTypes` which are only referenced by the `IncludedDataTypeSet`.

This requirement ensures the availability of `AutosarDataType` constants for the internal use in Basic Software modules, for example enumeration constants.

The name of those constants bases on the `CompuScale` symbolic name as defined in [TPS_SWCT_01569].

[SWS_Rte_03984] [For each `CompuScale` which has a point range and is located in the `compuInternalToPhys` container of a `CompuMethod` referenced by an `ImplementationDataType` or `ApplicationPrimitiveDataType` according [SWS_Rte_03983] with category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or `BITFIELD_TEXTTABLE`, the *Module Interlink Types Header File* shall contain a definition

```
1 #ifndef <prefix><EnumLiteral>
2 #define <prefix><EnumLiteral> <value><suffix>
3 #endif /* <prefix><EnumLiteral> */
```

where the name of the enumeration literal `<EnumLiteral>` is derived according to the following rule:

```
if (attribute symbol of CompuScale is available and not empty) {
    <EnumLiteral> := C identifier specified in symbol attribute of CompuScale
} else {
```

```

if (string specified in the VT element of the CompuConst of the CompuScale
    is a valid C identifier) {
    <EnumLiteral> :=
        string specified in the VT element of the CompuConst of the CompuScale
} else {
    if (attribute shortLabel of CompuScale is available and not empty) {
        <EnumLiteral> :=
            string specified in shortLabel attribute of CompuScale
    }
}
}

```

<prefix> is the optional `literalPrefix` attribute defined by the `IncludedDataTypeSet` referring the `AutosarDataType` using the `CompuMethod`.

<value> is the value representing the `CompuScale`'s point range.

<suffix> shall be set according to [SWS_Rte_03619].] (SRS_Rte_00252)

Please note that the `prefix` can either be defined that the `IncludedDataTypeSet` with a `literalPrefix` attribute references the `ApplicationDataType` or it references the `ImplementationDataType`.

[SWS_Rte_03984] implies that the RTE does add prefix to the names of the enumeration constants on explicit demand only. This is necessary in order to handle enumeration constants supplied by Basic Software modules which all use their own prefix convention. Such Enumeration constant names have to be unique in the whole AUTOSAR system.

[SWS_Rte_03985] [In the case that the same `ImplementationDataType` or `ApplicationPrimitiveDataType` is referenced via different `IncludedDataTypeSets` with different `literalPrefix` attributes, the definition according to [SWS_Rte_03984] has to be provided once for each different `literalPrefix`.] (SRS_Rte_00252)

[SWS_Rte_03986] [If the input of the RTE generator contains a `CompuMethod` with category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or BITFIELD_TEXTTABLE that contains a `CompuScale` with a point range, and

- neither the attribute `symbol` of the `CompuScale` is available and not empty,
- nor the string specified in the VT element of the `CompuConst` of the `CompuScale` is a valid C identifier,
- nor the attribute `shortLabel` of `CompuScale` is available and not empty,

the RTE generator shall reject this input as an invalid configuration.] (SRS_Rte_00018)

[SWS_Rte_03987] [The RTE shall reject configurations where the same Basic Software module uses `ImplementationDataTypes` and `ApplicationPrimitiveDataTypes` referencing two or more `CompuMethods` with category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or

BITFIELD_TEXTTABLE that both contain a [CompuScale](#) with a different point range and an identical [CompuScale](#) symbolic names as an invalid configuration. The only exception is that the usage of the [ImplementationDataTypes](#) and [ApplicationPrimitiveDataTypes](#) are defined with non identical <literalPrefix>es.] ([SRS_Rte_00018](#))

[SWS_Rte_03988] [The RTE generator shall reject configurations violating the [constr_1133].] ([SRS_Rte_00018](#))

This rejects configurations where an [ImplementationDataType](#) or an [ApplicationPrimitiveDataType](#) references a [CompuMethod](#) which is of category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or BITFIELD_TEXTTABLE and has [CompuScales](#) with identical [CompuScale](#) symbolic names but different [CompuScale.lowerLimit](#) or [CompuScale.upperLimit](#).

Note that there might exist additional [CompuScales](#) with non-point ranges inside a [CompuMethod](#) of category "TEXTTABLE", "SCALE_LINEAR_AND_TEXTTABLE", "SCALE_RATIONAL_AND_TEXTTABLE", or BITFIELD_TEXTTABLE , but for those no enumeration literals are generated by the RTE generator.

The RTE generator does not support the use of C enums for [DataPrototypes](#) used in Basic Software.

[SWS_Rte_03989] [The RTE generator shall reject configurations violating the [constr_1244], so where a [DataPrototype](#) that is used in an Basic Software module has set the [swDataDefProps.additionalNativeTypeQualifier](#) attribute set to enum.] ([SRS_Rte_00018](#))

[SWS_Rte_08803] The meaning of the term "used" with respect to [Autosar-DataTypes](#) [An [AutosarDataType](#) is used if it meets any one of the following conditions:

- it is referenced by a [DataPrototype](#) in the [BswInternalBehavior](#), or
- it is referenced by a [VariationPointProxy](#) in the [BswInternalBehavior](#), or
- it is referenced by a [DataPrototype](#) referenced by a [providedData](#) or [requiredData](#), or
- it is referenced by an [IncludedDataTypeSet](#) in the [BswInternalBehavior](#), or
- it is the [ImplementationDataType](#) mapped to an [ApplicationDataType](#) (i.e. via the [DataTypeMappingSet](#)) that is used in one of the above ways, or
- it is an [ImplementationDataTypeElement](#) of a complex [Implementation-DataType](#) that is used in one of the above ways, or

- it is referenced as the target type of an `ImplementationDataType` or `ImplementationDataTypeElement` of category `TYPE_REFERENCE` that is used in one of the above ways, or
- it is an `ApplicationDataType` referenced as the type of a sub-element of a complex `ApplicationDataType` that is used in one of the above ways.

]()

Please note that in contrast to the `TYPE_REFERENCE` case, when an `ImplementationDataType` of category `DATA_REFERENCE` is "used" the target `ImplementationDataType` it references is not considered used, unless it is independently used in its own right.

6.4.4 Range Data Types

For the `ApplicationPrimitiveDataType` a Range might be specified by referencing a data constraint (`dataConstr`) giving the `lowerLimit` and the `upperLimit`. To allow a Basic Software Module the access to these values two definitions for these values shall be generated.

[SWS_Rte_03990] [The *The Module Interlink Types Header File* shall include the definitions of all `lowerLimit` and `upperLimit` constants of each `ApplicationPrimitiveDataType` used by this Basic Software Module once per `ApplicationPrimitiveDataType` if the `ApplicationPrimitiveDataType` is not referenced via different `IncludedDataTypeSets`.] ([SRS_Rte_00252](#))

[SWS_Rte_03991] [The *Module Interlink Types Header File* shall include the definitions of all `lowerLimit` and `upperLimit` constants of each `ApplicationPrimitiveDataType` used by this Basic Software Module for each combination of different `literalPrefix` and `ApplicationPrimitiveDataType` when the same `ImplementationDataType` or `ApplicationPrimitiveDataType` is referenced via different `IncludedDataTypeSets`.] ([SRS_Rte_00252](#))

[SWS_Rte_03992] [The `lowerLimit` and `upperLimit` constants for *ApplicationPrimitiveDataType* referencing a `DataConstr` shall be generated by RTE generator in the *Module Interlink Types Header File* as:

```
1 #define <prefix><DataType>_LowerLimit <lowerValue><suffix>
2 #define <prefix><DataType>_UpperLimit <upperValue><suffix>
```

where `<DataType>` is the name of the `ApplicationPrimitiveDataType` used by the Basic Software Module.

`<prefix>` is the optional `literalPrefix` attribute defined by the `IncludedDataTypeSet` referring the `AutosarDataType` to which the `DataConstr` belongs.

`<lowerValue>` and `<upperValue>` are the values `lowerLimit` and `upperLimit` of the `dataConstr` referenced by the `ApplicationPrimitiveDataType` onto which the corresponding `CompuMethod` has been applied (see [[SWS_Rte_07038](#)]). The values

in the macro definitions shall always reflect the closed interval, regardless of the interval type specified by the `dataConstr`.

`<suffix>` shall be set according to [SWS_Rte_03619]. (SRS_Rte_00252)

Please note that [SWS_Rte_07196] is not applicable for [SWS_Rte_03992]. Further on it's possible that a `DataPrototype` using an `ApplicationPrimitiveDataType` might reference additional `dataConstr` (see [SWS_Rte_07196]). In this case the `upperLimit` and `lowerLimit` definitions according [SWS_Rte_03992] do not reflect the real applicable range of the `DataPrototype`. No macros are generated for `DataPrototype` specific data constraints.

Please note that the `prefix` can either be defined that the `IncludedDataTypeSet` with a `literalPrefix` attribute references the `ApplicationDataType` or it references the `ImplementationDataType`.

Rationale: `ApplicationPrimitiveDataType` is taken as the basis for the generation of limits (as opposed to take the corresponding `ImplementationDataType`) because the limits defined on the `ImplementationDataType` may be wider than the limits of the `ApplicationPrimitiveDataType` ((see subsection "Data Types for Single Values" in the AUTOSAR SW-C Template [2]).

[SWS_Rte_03993] [For AUTOSAR data types which have an `invalidValue` specified, the Module Interlink Types Header File shall contain the definition

```
1 #define InvalidValue_<prefix><DataType> <invalidValue><suffix>
```

where

`<prefix>` is the optional `literalPrefix` attribute defined by the `Included-DataTypeSet` referring the `AutosarDataType`

`<DataType>` is the short name of the data type.

`<invalidValue>` is the value defined as `invalidValue` for the data type.

`<suffix>` shall be set according to [SWS_Rte_03619]. (SRS_Rte_00252)

[SWS_Rte_03994] [The *Module Interlink Types Header File* shall include the definitions of all `invalidValue` constants used by this Basic Software Module for each combination of different `literalPrefix` and `ApplicationPrimitiveDataType` when the same `ImplementationDataType` or `ApplicationPrimitiveDataType` is referenced via different `IncludedDataTypeSets`.] (SRS_Rte_00252)

6.4.5 Data Types with bitfield conversions

`AutosarDataTypes` associated with a `CompuMethod` of category `BIT-FIELD_TEXTTABLE` support the concatenation of a value set inside a single scalar variable. Thereby single bits may get an individual (boolean) meaning or a set of bits is used to carry an enumeration. Please note that those data types are not

mapped to C bit fields rather than to scalars (e.g. uint8). Thereby the RTE Generator provides a set of definitions for the "Bit Mask", "Bit Start Position" and the "Number of Bits" in order to support the usage of the AUTOSAR Bit Handling Routines [32] for those kind of data types. For some operations on a set of bits (the set may contain only 1 bit) the AUTOSAR bitfield library requires a single contiguous bit field which means that all bits set to 1 in the `CompuScale.mask` attribute value are adjoining, e.g. 0b00010000 or 0b00111100.

[SWS_Rte_03995] [For each unique `CompuScale.shortLabel` / `CompuScale.mask` value pair for a `CompuScale` which is located in the `compuInternalToPhys` container of a `CompuMethod` referenced by an `ImplementationDataType` or `ApplicationPrimitiveDataType` according [SWS_Rte_03984] with category `BITFIELD_TEXTTABLE` the *Module Interlink Types Header File* shall contain a definition for the bit field mask

```
1 #ifndef <prefix><BflMaskLabel>_BflMask
2 #define <prefix><BflMaskLabel>_BflMask <mask>U
3 #endif /* <prefix><BflMaskLabel>_BflMask */
```

where

<BflMaskLabel> is the value of the attribute `CompuScale.shortLabel`

<mask> is the value of the attribute `mask`

<prefix> is the optional `literalPrefix` attribute defined by the `Included-DataTypeSet` referring the `AutosarDataType` using the `CompuMethod`.|([SRS_Rte_00252](#))

[SWS_Rte_03996] [For each unique `CompuScale.shortLabel` / `CompuScale.mask` value pair for a `CompuScale` with a single contiguous bit field which is located in the `compuInternalToPhys` container of a `CompuMethod` referenced by an `ImplementationDataType` or `ApplicationPrimitiveDataType` according [SWS_Rte_03984] with category `BITFIELD_TEXTTABLE` the *Module Interlink Types Header File* shall contain a definition for the bit start position

```
1 #ifndef <prefix><BflStartPnLabel>_BflPn
2 #define <prefix><BflStartPnLabel>_BflPn <BflStartPnNumber>U
3 #endif /* <prefix><BflStartPnLabel>_BflPn */
```

where

<BitStartPnLabel> is the value of the attribute `CompuScale.shortLabel`

<BflStartPnNumber> is the number of the first bit in the attribute value `CompuScale.mask` which is set to 1. Thereby the bit counting starts from 0 (LSB) to n (MSB).

<prefix> is the optional `literalPrefix` attribute defined by the `Included-DataTypeSet` referring the `AutosarDataType` using the `CompuMethod`.|([SRS_Rte_00252](#))

[SWS_Rte_03997] [For each unique `CompuScale.shortLabel` / `CompuScale.mask` value pair for a `CompuScale` with a single contiguous bit field which is located in the `compuInternalToPhys` container of a `CompuMethod` referenced by an `ImplementationDataType` or `ApplicationPrimitiveDataType` according

[SWS_Rte_03984] with category `BITFIELD_TEXTTABLE` the *Module Interlink Types Header File* shall contain a definition for the bit field length

```
1 #ifndef <prefix><BflLengthLabel>_BflLn
2 #define <prefix><BflLengthLabel>_BflLn <BflLength>U
3 #endif /* <prefix><BflLengthLabel>_BflLn */
```

where

`<BflLengthLabel>` is the value of the attribute `shortLabel`.

`<BflLength>` is the number of contiguous bits set to 1 in the attribute value `CompuScale.mask`.

`<prefix>` is the optional `literalPrefix` attribute defined by the `Included-DataTypeSet` referring the `AutosarDataType` using the `CompuMethod`.] (*SRS_Rte_00252*)

Please note the example in section [F.3](#).

[SWS_Rte_07415] [The requirements [SWS_Rte_03995], [SWS_Rte_03996], and [SWS_Rte_03997] are only applied to `CompuScales` where the attribute `shortLabel` is defined.] (*SRS_Rte_00252*)

6.5 API Reference

This chapter defines the “interface” between a particular instance of a *Basic Software Module* and the *Basic Software Scheduler*. The wild-card `<bsnp>` is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594].

6.5.1 SchM_Enter

Purpose: `SchM_Enter` function enters an exclusive area of an *Basic Software Module*.

Signature: [SWS_Rte_07250] [

```
void SchM_Enter_<bsnp>[_<vi>_<ai>][_<me>_]<name>()
```

Where here

`<bsnp>` is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594],

`<vi>` is the `vendorId` of the calling BSW module,

`<ai>` `vendorApiInfix` of the calling BSW module,

`<me>` is the `shortName` of the `BswModuleEntity` and

`<name>` is the exclusive area name. The sub part in squared brackets `[<me>_]` is emitted if the attribute `BswExclusiveAreaPol- 114` 763 of 1410

squared brackets [_{<vi>}_{<ai>}] is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See [SWS_Rte_07528].] ([SRS_Rte_00222](#), [SRS_BSW_00347](#), [SRS_Rte_00046](#))

Existence: [SWS_Rte_07251] [A `SchM_Enter` API shall be created for each `ExclusiveArea` that is declared in the `BswInternalBehavior` and which has an `canEnterExclusiveArea` association.] ([SRS_Rte_00222](#), [SRS_Rte_00046](#))

Description: The `SchM_Enter` API call is invoked by an AUTOSAR BSW module to define the start of an exclusive area.

Return Value: None.

Notes: The *Basic Software Scheduler* is not required to support nested invocations of `SchM_Enter` for the same exclusive area.

[SWS_Rte_07252] [The *Basic Software Scheduler* shall permit calls to `SchM_Enter` and `SchM_Exit` to be nested as long as different exclusive areas are exited in the reverse order they were entered.] ([SRS_Rte_00222](#), [SRS_Rte_00046](#))

[SWS_Rte_CONSTR_09046] `SchM_Enter` and `SchM_Exit` API may only be used by `BswModuleEntitys` describing its usage [The `SchM_Enter` and `SchM_Exit` API may only be used by `BswModuleEntitys` that contain a corresponding `canEnterExclusiveArea` association]()

[SWS_Rte_CONSTR_09047] **Nested call of `SchM_Enter` and `SchM_Exit` API is restricted** [The `SchM_Enter` and `SchM_Exit` API may only be called nested if different exclusive areas are invoked; in this case exclusive areas shall exited in the reverse order they were entered.]()

[SWS_Rte_07578] [The *Basic Software Scheduler* shall support calls of `SchM_Enter` and `SchM_Exit` after initialization of the OS but before the *Basic Software Scheduler* is initialized.] ([SRS_Rte_00222](#), [SRS_Rte_00046](#))

[SWS_Rte_07579] [The *Basic Software Scheduler* shall support calls of `SchM_Enter` and `SchM_Exit` in the context of os tasks, category 1 and category 2 interrupts.] ([SRS_Rte_00222](#), [SRS_Rte_00046](#))

Note: the possible implementation mechanism for such an exclusive area is limited in this case to mechanism available for the related kind of context. For instance `SuspendAllInterrupts` and `ResumeAllInterrupts` service of the OS are available for all kind of context but `GetResource` and `ReleaseResource` is only available for tasks and category 2 interrupts.

Within the *AUTOSAR OS* an attempt to lock a resource cannot fail because the lock is already held. The lock attempt can only fail due to configuration errors (e.g. caller not declared as accessing the resource) or invalid handle. Therefore the return type from this function is `void`.

Mutual exclusion of tasks requesting the same exclusive area shall be ensured across partition and core boundaries.

6.5.2 SchM_Exit

Purpose: `SchM_Exit` function leaves an exclusive area of an *Basic Software Module*.

Signature: **[SWS_Rte_07253]** [
`void`
`SchM_Exit_<bsnp>[_<vi>_<ai>][_<me>_] <name>()`

Where

`<bsnp>` is the *BSW Scheduler Name Prefix* according **[SWS_Rte_07593]** and **[SWS_Rte_07594]**,

`<vi>` is the `vendorId` of the calling BSW module,

`<ai>` `vendorApiInfix` of the calling BSW module,

`<me>` is the `shortName` of the `BswModuleEntity` and

`<name>` is the exclusive area name. The sub part in squared brackets `[_<me>_]` is emitted if the attribute `BswExclusiveAreaPolicy.apiPrinciple` is set to "perExecutable". The sub part in squared brackets `[_<vi>_<ai>]` is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See **[SWS_Rte_07528]**.] (**SRS_Rte_00222**, **SRS_BSW_00347**, **SRS_Rte_00046**)

Existence: **[SWS_Rte_07254]** [A `SchM_Exit` API shall be created for each `ExclusiveArea` that is declared in the `BswInternalBehavior` and which has an `canEnterExclusiveArea` association..] (**SRS_Rte_00222**, **SRS_Rte_00046**)

Description: The `SchM_Exit` API call is invoked by an AUTOSAR BSW module to define the end of an exclusive area.

Return Value: None.

Notes: The *Basic Software Scheduler* is not required to support nested invocations of `SchM_Exit` for the same exclusive area.

Requirement [SWS_Rte_07252] permits calls to `SchM_Exit` and `SchM_Exit` to be nested as long as different exclusive areas are exited in the reverse order they were entered.

[SWS_Rte_CONSTR_09048] `SchM_Exit` API may only be used by `BswModuleEntity`s that describe its usage [The `SchM_Exit` API may only be used by `BswModuleEntity`s that contain a corresponding `canEnterExclusiveArea` association]()

6.5.3 SchM_Call

Purpose: Invokes a Client-Server operation between BSW modules, possibly crossing partition boundaries.

Signature: [SWS_Rte_08733] [
Std_ReturnType SchM_Call_<bsnp>[_<vi>_<ai>]_<name>(
[OUT <typeOfReturnValue> returnValue]
[IN|IN/OUT|OUT]<data_1>...
[IN|IN/OUT|OUT] <data_n>)

where there is a BSW module providing an entry which is the base for a generated function `<typeOfReturnValue>`
`<bsnp>[_<vi>_<ai>]_<name> (<data_1>...<data_n>)`

with `<typeOfReturnValue>` is the `returnType` of the referenced `BswModuleEntry`. If the `returnType` of the referenced `BswModuleEntry` is of type `void` or execution is asynchronous, this part should be omitted.

`<bsnp>` is the BSW Scheduler Name Prefix of the BSW module providing the entry according to [SWS_Rte_07593] and [SWS_Rte_07594],

`<vi>` is the `vendorId` of the calling BSW module,

`<ai>` is the `vendorApiInfix` of the calling BSW module,

`<name>` is the `shortName` of the `BswModuleClientServerEntry` defined with the role of `requiredClientServerEntry`.

The sub part in square brackets `[_<vi>_<ai>]` is omitted if no `vendorApiInfix` is defined for the Basic Software Module. See [SWS_Rte_07528].] (SRS_Rte_00243)

Existence: [SWS_Rte_08734] [A synchronous `SchM_Call` API shall be generated if a `callPoint` association to a `BswSynchronousServerCallPoint` exists and the `BswSynchronousServerCallPoint` references a `BswModuleClientServerEntry` as `calledEntry` and this `BswModuleClientServerEntry` is referenced by the

BswModuleDescription as a requiredClientServerEntry.]
(SRS_Rte_00243)

[SWS_Rte_08735] [An asynchronous SchM_Call API shall be generated if a callPoint association to a BswAsynchronousServerCallPoint exists and the BswAsynchronousServerCallPoint references a BswModuleClientServerEntry as calledEntry and this BswModuleClientServerEntry is referenced by the BswModuleDescription as a requiredClientServerEntry.](SRS_Rte_00243)

A configuration that includes both synchronous and asynchronous Call Points is invalid.

[SWS_Rte_CONSTR_09079] SchM_Call API may only be used by the BswModuleEntity that describe its usage [The SchM_Call API may only be used within the BswModuleEntity that references the corresponding BswSynchronousServerCallPoint respectively BswAsynchronousServerCallPoint using a callPoint association.](/)

Description: Function to initiate Client-Server communication between BSW modules. The SchM_Call API is used for both synchronous and asynchronous calls.

When the BswModuleClientServerEntry is called the SchM shall invoke the referenced BswModuleEntry providing the C-function with the signature <bpns>[_<vi>_<ai>]_name(<data_1>...(<data_n>) on the partition of the task assigned to the respective BswOperationInvokedEvent, or on the local partition if the BswOperationInvokedEvent is not mapped to a task.

[SWS_Rte_08736] [The OUT parameter returnValue shall only exist if the returnType of BswModuleEntry is not void and the SchM_Call is synchronous.](SRS_Rte_00243)

[SWS_Rte_08737] [The datatype of the OUT parameter returnValue shall be equal to returnType of the called BswModuleEntry.](SRS_Rte_00243)

[SWS_Rte_08738] [The return value of the called BswModuleEntry shall be returned inside the OUT parameter returnValue.](SRS_Rte_00243)

[SWS_Rte_08739] [The SchM shall ensure that the BswModuleEntity implementing a server operation has completed the processing of a request before it begins processing the next request, if call

serialization is required by the server operation, i.e the `isReentrant` attribute of the corresponding `BswModuleClientServerEntry` which is referenced as `providedClientServerEntry` is set to `false` and more than one `BswModuleClientServerEntry` in the role `requiredClientServerEntry` references this server. If the `SchM_Call` crosses partition borders, the call is mapped to `IOCSend_<id>()` or uses trusted functions if [SWS_Rte_08903] applies.] (SRS_Rte_00243)

The pointers to all parameters passed by reference must remain valid until the API call returns.

Return Value: [SWS_Rte_08740] [The return value shall be used to indicate infrastructure errors detected by the RTE during execution of the `SchM_Call` call.] ()

- [SWS_Rte_08741] [SCHM_E_OK - The API call completed successfully.] ()
- [SWS_Rte_08742] [SCHM_E_LIMIT - There are multiple outstanding asynchronous calls of the same `BswModuleEntry`. The invocation shall be discarded, the buffers of the return parameters shall not be modified.] ()
- [SWS_Rte_04555] [SCHM_E_TIMEOUT – if the call is ignored according to [SWS_Rte_04552]] ()

6.5.4 SchM_Result

Purpose: Get the result of an asynchronous call of a `BswModuleEntry`.

Signature: [SWS_Rte_08743] [

```
Std_ReturnType
SchM_Result_<bsnp>[_<vi>_<ai>]_<name>(
    [OUT <typeOfReturnValue> returnValue]
    [IN/OUT|OUT] <data_1> ...
    [IN/OUT|OUT] <data_n>)
```

where there is a BSW module providing an entry which is the base for a generated function `<bsnp>[_<vi>_<ai>]_<name>(<data_1>...<data_n>)`

with `<bsnp>` is the BSW Scheduler Name Prefix of the BSW module sending the callback according to [SWS_Rte_07593] and [SWS_Rte_07594],

`<vi>` is the `vendorId` of the calling BSW module,

`<ai>` is the `vendorApiInfix` of the calling BSW module,

<name> is the shortName of the BswModuleClientServerEntry defined with the role of requiredClientServerEntry.

The sub part in squared brackets [_<vi>_<ai>] is omitted if no *vendorApiInfix* is defined for the *Basic Software Module*. See [SWS_Rte_07528]. (SRS_Rte_00243)

[SWS_Rte_08420] [The OUT parameter `returnValue` shall exist if the `returnType` of `BswModuleEntry` is different from `void`.] (SRS_Rte_00243)

[SWS_Rte_08421] [The datatype of the OUT parameter `return-Value` shall be equal to `returnType` of the called `BswModuleEntry`.] (SRS_Rte_00243)

[SWS_Rte_08422] [The return value of the called `BswModuleEntry` shall be returned inside the OUT parameter `returnValue`.] (SRS_Rte_00243)

Existence: **[SWS_Rte_08744]** [A non-blocking `SchM_Result` API shall be generated if a `callPoint` association to a `BswAsynchronousServerCallResultPoint` exists.] (SRS_Rte_00243)

[SWS_Rte_CONSTR_09076] **SchM_Result API may only be used by the BswModuleEntity that describe its usage** [The `SchM_Result` API may only be used within the `BswModuleEntity` that references the corresponding `BswAsynchronousServerCallResultPoint` using a `callPoint` association.] ()

Description: The `SchM_Result` is used to collect the result of an asynchronous call of a `BswModuleEntry` invoked by `SchM_Call_<bsnp>[_<vi>_<ai>]_name(<data_1>...<data_n>)`.

Using `SchM_Result` it is possible get back the result of call.

The `SchM_Result` API includes zero or more IN/OUT and OUT parameters to pass back results.

The pointers to all parameters passed by reference must remain valid until the API call returns.

If the `SchM_Result` crosses partition borders, the callback is mapped to `IOCSend_<id>()`.

Return Value: The return value is used to indicate errors from either the `SchM_Result` call itself or communication errors detected before the API call was made.

- **[SWS_Rte_08745]** [SCHM_E_OK - The API call completed successfully.] ()

- **[SWS_Rte_08746]** [SCHM_E_NO_DATA - The [BswModuleEntry](#)'s result is not available but no other error occurred within the API call or the [BswModuleEntry](#) was not called using [SchM_Call](#). The buffers for the IN/OUT and OUT parameters shall not be modified.] ()
- **[SWS_Rte_04556]** [SCHM_E_TIMEOUT – if the call is ignored according to [\[SWS_Rte_04552\]](#)] ()

The SCHM_E_NO_DATA return value is not considered to be an error but rather indicate correct operation of the API call. When SCHM_E_NO_DATA occurs, a BSW module is free to invoke [SchM_Result](#) again and thus repeat the attempt to read the result.

6.5.5 SchM_Send

Purpose: Initiate an "explicit" sender-receiver transmission of data elements with "event" semantic (queued) between BSW modules.

Signature: **[SWS_Rte_08747]** [
Std_ReturnType
SchM_Send_<bsnp>[_<vi>_<ai>]_<name> (IN <data>)

with <bsnp> is the BSW Scheduler Name Prefix of the BSW module providing the data according to [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the [vendorId](#) of the BSW module providing the data,

<ai> is the [vendorApiInfix](#) of the BSW module providing the data,

<name> is the [shortName](#) of the [VariableDataPrototype](#) of this sender-receiver connection.

The sub part in square brackets [_<vi>_<ai>] is omitted if no [vendorApiInfix](#) is defined for the *Basic Software Module*. See [\[SWS_Rte_07528\]](#).] ([SRS_Rte_00243](#))

Existence: **[SWS_Rte_08748]** [The existence of a [dataSendPoint](#) association to a [providedData VariableDataPrototype](#) shall result in the generation of a [SchM_Send](#) API for the provided [VariableDataPrototype](#).] ([SRS_Rte_00243](#))

[SWS_Rte_CONSTR_09077] **SchM_Send API may only be used by the BswModuleEntity that describes its usage** [The [SchM_Send](#) API may only be used within the [BswModuleEntity](#) that references the [VariableDataPrototype](#) using a [dataSendPoint](#).] ()

Description: When a BSW module writes data to a sender-receiver connection on a system with the BSW running on multiple partitions, it shall invoke `SchM_Send_<bsnp>[_<vi>_<ai>]_<name>(<data>)`. The `SchM_Send` API call initiates a sender-receiver communication where the transmission occurs at the point the API call is made (cf. explicit transmission). The `SchM_Send` API call includes the IN parameter `<data>` to pass the data element to write. The IN parameter `<data>` is passed by value or reference according to the `ImplementationDataType` as described in the section 5.2.6.5. If the IN parameter `<data>` is passed by reference, the pointer must remain valid until the API call returns.

Return Value: The return value is used to indicate errors detected by the SchM during execution of the `SchM_Send`.

- **[SWS_Rte_08749]** [SCHM_E_OK - data passed to communication service successfully.]()
- **[SWS_Rte_08750]** [SCHM_E_LIMIT - an 'event' has been discarded due to a full queue by one of the partition local receivers.]()

Notes: The `SchM_Send` API is used to transmit data with "events" semantics which means that they are getting queued.

[SWS_Rte_08751] [In case of inter partition communication, the `SchM_Send` API call shall cause an immediate transmission request.]([SRS_Rte_00243](#))

For inter-partition communication the IOC can be used for transmitting the data to the other partition.

[SWS_Rte_08752] [If the `VariableDataPrototype` in the `providedData` role is connected to multiple `VariableDataPrototypes` in the role `requiredData`, then the SchM shall ensure that writes to all receivers are independent.]([SRS_Rte_00243](#))

This ensures that an error detected by the SchM when writing to one receiver does not prevent the transmission of this message to other BSW modules.

[SWS_Rte_08753] [In case of intra partition communication, the `SchM_Send` API call shall return after copying the data to RTE local memory or using IOC buffers.]([SRS_Rte_00243](#))

6.5.6 SchM_Receive

Purpose: Performs an "explicit" sender-receiver reception of data elements with "event" semantic (queued) between BSW modules.

- Signature:** **[SWS_Rte_08754]** [
Std_ReturnType
SchM_Receive_<bsnp>[_<vi>_<ai>]_<name>(OUT <data>)

with <bsnp> is the BSW Scheduler Name Prefix of the BSW module reading the data according to [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the [vendorId](#) of the BSW module reading the data,

<ai> is the [vendorApiInfix](#) of the BSW module reading the data,

<name> is the `shortName` of the [VariableDataPrototype](#) of this sender-receiver connection.

The sub part in square brackets [_<vi>_<ai>] is omitted if no [vendorApiInfix](#) is defined for the *Basic Software Module*. See [\[SWS_Rte_07528\]](#).] ([SRS_Rte_00243](#))
- Existence:** **[SWS_Rte_08755]** [The existence of a [dataReceivePoint](#) association to a [requiredData VariableDataPrototype](#) shall result in the generation of a [SchM_Receive](#) API for the required [VariableDataPrototype](#).] ([SRS_Rte_00243](#))
- [SWS_Rte_CONSTR_09078]** **SchM_Receive API may only be used by the BswModuleEntity that describes its usage** [The [SchM_Receive](#) API may only be used within the [BswModuleEntity](#) that references the [VariableDataPrototype](#) using a [dataReceivePoint](#).] ()
- Description:** When a BSW module handles a [BswDataReceivedEvent](#) on a system with the BSW running on multiple partitions, it shall invoke [SchM_Receive_<bsnp>\[_<vi>_<ai>\]_<name>\(<data>\)](#). For a sender-receiver connection crossing partition boundaries, the SchM shall then read the data from a shared buffer, where it has been put by [SchM_Send](#).
- The [SchM_Receive](#) API call includes the OUT parameter <data> to pass back the received data element.
- The pointers to the OUT parameters must remain valid until the API call returns.
- Return Value:** The return value is used to indicate errors detected by the SchM during execution of the [SchM_Receive](#) or errors detected by the communication system.
- **[SWS_Rte_08757]** [[SCHM_E_OK](#) - data read successfully.] ()
 - **[SWS_Rte_08758]** [[SCHM_E_NO_DATA](#) - no "events" (means queued data) were received and no other error occurred when the read was attempted.] ()

[SWS_Rte_02313] [SCHM_E_LOST_DATA - Indicates that some incoming data has been lost due to an overflow of the receive queue or due to an error of the underlying communication layers. This is not an error of the data returned in the parameters. This Overlayed Error can be combined with any other error.] ([SRS_Rte_00107](#), [SRS_Rte_00110](#), [SRS_Rte_00094](#))

[SWS_Rte_08756] [In case return value is SCHM_E_NO_DATA the OUT parameters shall remain unchanged.] ([SRS_Rte_00243](#))

The SCHM_E_NO_DATA return value is not considered to be an error but rather indicates correct operation of the API call.

6.5.7 SchM_Switch

Purpose: Initiate a mode switch. The [SchM_Switch](#) API call is used for sending of a [mode switch notification](#) by a *Basic Software Module*.

Signature: **[SWS_Rte_07255]** [
Std_ReturnType
SchM_Switch_<bsnp>[_<vi>_<ai>]_<name>(
IN <mode>)

Where here

<bsnp> is the *BSW Scheduler Name Prefix* according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the [vendorId](#) of the calling BSW module,

<ai> [vendorApiInfix](#) of the calling BSW module and

<name> is the provided ([providedModeGroup](#)) [ModeDeclarationGroupPrototype](#) name.

The sub part in squared brackets [_<vi>_<ai>] is omitted if no [vendorApiInfix](#) is defined for the *Basic Software Module*. See [\[SWS_Rte_07528\]](#).] ([SRS_Rte_00215](#), [SRS_BSW_00347](#))

Existence: **[SWS_Rte_07256]** [The existence of a [managedModeGroup](#) association to a [providedModeGroup ModeDeclarationGroupPrototype](#) shall result in the generation of a [SchM_Switch](#) API.] ([SRS_Rte_00215](#))

[SWS_Rte_CONSTR_09049] [SchM_Switch](#) API may only be used by [BswModuleEntitys](#) that describe its usage [The [SchM_Switch](#) API may only be used by [BswModuleEntitys](#) that contain a corresponding [managedModeGroup](#) association]()

Description: The `SchM_Switch` triggers a mode switch for all connected required (`requiredModeGroup`) `ModeDeclarationGroupPrototypes`.

The `SchM_Switch` API call includes exactly one IN parameter for the next mode `<mode>`. The IN parameter `<mode>` is passed by value according to the `ImplementationDataType` on which the `ModeDeclarationGroup` is mapped. The type name shall be equal to the `ImplementationDataType` symbol.

Return Value: The return value is used to indicate errors detected by the *Basic Software Scheduler* during execution of the `SchM_Switch` call.

- **[SWS_Rte_07258]** [SCHM_E_OK – data passed to service successfully.] ([SRS_Rte_00213](#), [SRS_Rte_00214](#), [SRS_Rte_00094](#))
- **[SWS_Rte_07259]** [SCHM_E_LIMIT – a mode switch has been discarded due to a full queue.] ([SRS_Rte_00213](#), [SRS_Rte_00214](#), [SRS_Rte_00143](#))

Notes: `SchM_Switch` is restricted to ECU local communication.

If a mode instance is currently involved in a transition then the `SchM_Switch` API will attempt to queue the request and return [\[SWS_Rte_02667\]](#). However if no transition is in progress for the mode instance, the mode disables and the activations of *on-entry*, *on-transition*, and *on-exit* runnables for this mode instance are executed before the `SchM_Switch` API returns [\[SWS_Rte_02665\]](#).

Note that the mode switch might be discarded when the queue is full and a mode transition is in progress, see [\[SWS_Rte_02675\]](#).

[SWS_Rte_07286] [If the mode switched acknowledgment is enabled, the RTE shall notify the mode manager when the mode switch is completed.] ([SRS_Rte_00213](#), [SRS_Rte_00214](#), [SRS_Rte_00122](#))

6.5.8 SchM_Mode

There exist two versions of the `SchM_Mode` APIs. Depending on the attribute `enhancedModeApi` in the *basic software module description* there shall be provided different versions of this API (see also [6.5.9](#)).

Purpose: Provides the currently active mode of a (`requiredModeGroup` or `providedModeGroup`) `ModeDeclarationGroupPrototype`.

Signature: **[SWS_Rte_07260]** [
`<return>`
`SchM_Mode_<bsnp>[_<vi>_<ai>]_<name>()`

Where here

<bsnp> is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594],

<vi> is the *vendorId* of the calling BSW module,

<ai> *vendorApiInfix* of the calling BSW module and

<name> is the (*requiredModeGroup* or *providedModeGroup*) *ModeDeclarationGroupPrototype* name.

The sub part in squared brackets [*_<vi>_<ai>*] is omitted if no *vendorApiInfix* is defined for the *Basic Software Module*. See [SWS_Rte_07528].] (*SRS_Rte_00213*, *SRS_BSW_00347*)

Existence: [SWS_Rte_07261] [If a *accessedModeGroup* association to a *providedModeGroup* or *requiredModeGroup* *ModeDeclarationGroupPrototype* exists and if the attribute *enhancedModeApi* of the *BswModeSenderPolicy* resp. *BswModeReceiverPolicy* is set to *false* a *SchM_Mode* API according to [SWS_Rte_07260] shall be generated.] (*SRS_Rte_00215*)

Note: This ensures the availability of the *SchM_Mode* API for the *mode manager* and *mode user*

[SWS_Rte_CONSTR_09050] ***SchM_Mode* API may only be used by *BswModuleEntity*s that describe its usage** [The *SchM_Mode* API may only be used by *BswModuleEntity*s that contain a corresponding *managedModeGroup* association or *accessedModeGroup* association] ()

Description: The *SchM_Mode* API tells the *Basic Software Module* which mode of a required or provided *ModeDeclarationGroupPrototype* is currently active. This is the information that the *RTE* uses for the *ModeDisablingDependency*s. A new mode will not be indicated immediately after the reception of a *mode switch notification* from a *mode manager*, see section 4.4.4. During mode transitions, i.e. during the execution of runnables that are triggered on exiting one mode or on entering the next mode, overlapping mode disabling of two modes are active. In this case, the *SchM_Mode* API will return *RTE_TRANSITION_<ModeDeclarationGroup>*.

The *SchM_Mode* will return the same mode for all required or provided *ModeDeclarationGroupPrototypes* that are connected. (see [SWS_Rte_02630]).

Return Value: The return type of *SchM_Mode* is dependent on the *ImplementationDataType* of the *ModeDeclarationGroup*. It shall return the value of the *ModeDeclarationGroupPrototype*. The type name shall be equal to the *ImplementationDataType* symbol.

[SWS_Rte_07262] [The [SchM_Mode](#) API shall return the following values:

- during mode transitions:
RTE_TRANSITION_<ModeDeclarationGroup>,

where <ModeDeclarationGroup> is the short name of the ModeDeclarationGroup.
- else:
RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>,

where <ModeDeclarationGroup> is the short name of the [ModeDeclarationGroup](#) and <ModeDeclaration> is the short name of the currently active [ModeDeclaration](#)

]([SRS_Rte_00144](#))

Notes: None.

6.5.9 Enhanced SchM_Mode

Purpose: Provides the currently active mode of a ([requiredModeGroup](#) or [providedModeGroup](#)) [ModeDeclarationGroupPrototype](#). If the corresponding [mode machine instance](#) is in transition additionally the values of the previous and the next mode are provided.

Signature: **[SWS_Rte_07694]** [
 <return>
 SchM_Mode_<bsnp>[_<vi>_<ai>]_<name>(
 OUT <previousmode>,
 OUT <nextmode>)
)

Where here

<bsnp> is the *BSW Scheduler Name Prefix* according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the [vendorId](#) of the calling BSW module,

<ai> [vendorApiInfix](#) of the calling BSW module and

<name> is the ([requiredModeGroup](#) or [providedModeGroup](#)) [ModeDeclarationGroupPrototype](#) name.

The sub part in squared brackets [_<vi>_<ai>] is omitted if no [vendorApiInfix](#) is defined for the *Basic Software Module*. See [\[SWS_Rte_07528\]](#).]([SRS_Rte_00213](#), [SRS_BSW_00347](#))

Existence: [SWS_Rte_08507] [The existence of a `accessedModeGroup` association to a `providedModeGroup` or `requiredModeGroup` `ModeDeclarationGroupPrototype` given that the attribute `enhancedModeApi` of the `BswModeSenderPolicy` resp. `BswModeReceiverPolicy` is set to `true` a `SchM_Mode` API according to [SWS_Rte_07694] shall be generated.] (SRS_Rte_00215)

Note: This ensures the availability of the `SchM_Mode` API for the `mode manager` and `mode user`

[SWS_Rte_CONSTR_09051] **`SchM_Mode` API may only be used by `BswModuleEntity`s that describe its usage** [The `SchM_Mode` API may only be used by `BswModuleEntity`s that contain a corresponding `managedModeGroup` association or `accessedModeGroup` association] ()

Description: The `SchM_Mode` API tells the *Basic Software Module* which mode of a required or provided `ModeDeclarationGroupPrototype` is currently active. This is the information that the *RTE* uses for the `ModeDisablingDependency`s. A new mode will not be indicated immediately after the reception of a `mode switch notification` from a `mode manager`, see section 4.4.4. During mode transitions, i.e. during the execution of runnables that are triggered on exiting one mode or on entering the next mode, overlapping mode disabling of two modes are active. In this case, the `SchM_Mode` API will return `RTE_TRANSITION_<ModeDeclarationGroup>`. The parameter `<previousmode>` then contains the mode currently being left. The parameter `<nextmode>` contains the mode being entered.

The `SchM_Mode` will return the same mode for all required or provided `ModeDeclarationGroupPrototypes` that are connected. (see [SWS_Rte_02630]).

Return Value: The return type of `SchM_Mode` is dependent on the `ImplementationDataType` of the `ModeDeclarationGroup`. It shall return the value of the `ModeDeclarationGroupPrototype`. The type name shall be equal to the `ImplementationDataType` symbol.

[SWS_Rte_08509] [During transitions `SchM_Mode` API shall return the following values:

- the return value shall be
`RTE_TRANSITION_<ModeDeclarationGroup>`
- `<previousmode>` shall contain the
`RTE_MODE_<ModeDeclarationGroup>_<ModeDeclaration>`
of the mode being left,

- `<nextmode>` shall contain the
RTE_MODE_`<ModeDeclarationGroup>`_`<ModeDeclaration>`
of the mode being entered,

where `<ModeDeclarationGroup>` is the short name of the `ModeDeclarationGroup`.

]([SRS_Rte_00144](#))

[SWS_Rte_08510] [If the `mode machine instance` is in a defined mode `SchM_Mode` shall return the following values:

- the return value shall contain the value of the
RTE_MODE_`<ModeDeclarationGroup>`_`<ModeDeclaration>`,
- `<previousmode>` shall contain the value of the
RTE_MODE_`<ModeDeclarationGroup>`_`<ModeDeclaration>`,
- `<nextmode>` shall contain the the value of
RTE_MODE_`<ModeDeclarationGroup>`_`<ModeDeclaration>`,

where `<ModeDeclarationGroup>` is the short name of the `ModeDeclarationGroup` and `<ModeDeclaration>` is the short name of the currently active `ModeDeclaration`.

]([SRS_Rte_00144](#))

Notes: None.

6.5.10 SchM_SwitchAck

Purpose: Provide access to acknowledgment notifications for mode communication.

Signature: **[SWS_Rte_07556]** [
Std_ReturnType
SchM_SwitchAck_`<bsnp>`[_`<vi>`_`<ai>`]`<name>` ()

Where here

`<bsnp>` is the *BSW Scheduler Name Prefix* according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

`<vi>` is the `vendorId` of the calling BSW module,

`<ai>` `vendorApiInfix` of the calling BSW module and

`<name>` is the provided (`provideModeGroup`) `ModeDeclarationGroupPrototype` name.

The sub part in squared brackets [`<vi><ai>`] is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See [SWS_Rte_07528].](SRS_BSW_00310, SRS_Rte_00213)

Existence: [SWS_Rte_07557] [Acknowledgement is enabled for a provided (`providedModeGroup`) `ModeDeclarationGroupPrototype` by the presence of an `ackRequest` attribute of the `BswModeSenderPolicy`.](SRS_Rte_00213, SRS_Rte_00122)

[SWS_Rte_07558] [A non-blocking `SchM_SwitchAck` API shall be generated for a provided (`providedModeGroup`) `ModeDeclarationGroupPrototype` if acknowledgement is enabled and a `managedModeGroup` association references the `providedModeGroup ModeDeclarationGroupPrototype`.](SRS_Rte_00213, SRS_Rte_00122)

[SWS_Rte_CONSTR_09052] `SchM_SwitchAck` API may only be used by `BswModuleEntitys` that describe its usage [The `SchM_SwitchAck` API may only be used by `BswModuleEntitys` that contain a corresponding `managedModeGroup` association]()

Description: The `SchM_SwitchAck` API takes no parameters – the return value is used to indicate the acknowledgement status to the caller.

Return Value: The return value is used to indicate the “status” status and errors detected by the *Basic Software Scheduler* during execution of the `Rte_SwitchAck` call.

- [SWS_Rte_07560] [`SCHM_E_NO_DATA` – (non-blocking read) no error is occurred when the `SchM_SwitchAck` read was attempted.](SRS_Rte_00213, SRS_Rte_00122)
- [SWS_Rte_07561] [`SCHM_E_TRANSMIT_ACK` – For communication of mode switches, this indicates, that the `BswScheduleableEntitys` on the transition have been executed and the mode disablings have been switched to the new mode (see [SWS_Rte_02587]).](SRS_Rte_00213, SRS_Rte_00122)
- [SWS_Rte_07055] [`SCHM_E_TIMEOUT` The configured timeout exceeds before the mode transition was completed.
OR:
Any `mode users` partition is stopped or restarting or has been restarted while the mode switch was requested.](SRS_Rte_00213, SRS_Rte_00122)

The `SCHM_E_TRANSMIT_ACK` return value is not considered to be an error but rather indicates correct operation of the API call.

When `SCHM_E_NO_DATA` occurs, a *Basic Software Module* is free to reinvoke `SchM_SwitchAck` and thus repeat the attempt to read the mode switch acknowledgment status.

The `SCHM_E_TIMEOUT` return value can denote a stopped or restarting partition even for the `SchM_SwitchAck` API in case of a `common mode machine instance`.

Notes: If multiple transmissions on the same provided (`providedModeGroup`) `ModeDeclarationGroupPrototype` are outstanding it is not possible to determine which is acknowledged first. If this is important, transmissions should be serialized with the next occurring only when the previous transmission has been acknowledged or has timed out.

6.5.11 SchM_Trigger

Purpose: Triggers the activation of connected `BswSchedulableEntitys` of the same or other *Basic Software Modules*.

Signature: **[SWS_Rte_07263]** [signature if `swImplPolicy` of the `Trigger` is not set to `queued`:

```
void
SchM_Trigger_<bsnp>[_<vi>_<ai>]_<name>()
```

signature if `swImplPolicy` of the `Trigger` is set to `queued`:

```
Std_ReturnType
SchM_Trigger_<bsnp>[_<vi>_<ai>]_<name>()
```

Where here

<bsnp> is the *BSW Scheduler Name Prefix* according **[SWS_Rte_07593]** and **[SWS_Rte_07594]**,

<vi> is the `vendorId` of the calling BSW module,

<ai> `vendorApiInfix` of the calling BSW module and

<name> is the released (`releasedTrigger`) `Trigger` name.

The sub part in squared brackets `[_<vi>_<ai>]` is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See **[SWS_Rte_07528]**.] (**SRS_Rte_00218**, **SRS_BSW_00347**)

Existence: **[SWS_Rte_07264]** [The existence of a `issuedTrigger` association to the released (`releasedTrigger`) `Trigger` shall result in the generation of a `SchM_Trigger` API.] (**SRS_Rte_00218**)

[SWS_Rte_CONSTR_09053] `SchM_Trigger` API may only be used by the `BswModuleEntitys` that describe its usage [The `SchM_Trigger` API may only be used by the `BswModuleEntity` that contains the corresponding `issuedTrigger` association.]()

Description: The `SchM_Trigger` triggers an execution for all `BswSchedulableEntity`s whose `BswExternalTriggerOccurredEvent` is associated to connected required `Trigger`.

Return Value: None if `swImplPolicy` of the `Trigger` is not set to `queued`.

[SWS_Rte_06722] [The `SchM_Trigger` API shall return the following values:

- `SCHM_E_OK` if the trigger was successfully queued
- `SCHM_E_LIMIT` if the trigger was not queued because the maximum queue size is already reached.

if `swImplPolicy` of the `Trigger` is set to `queued`.] ([SRS_Rte_00235](#))

Notes: `SchM_Trigger` is restricted to ECU local communication.

6.5.12 SchM_ActMainFunction

Purpose: Triggers the activation of the `BswSchedulableEntity` which is associated with an `activationPoint` of the same or *Basic Software Module*.

Signature: **[SWS_Rte_07266]** [signature if `swImplPolicy` of the `Trigger` is not set to `queued`:

```
void
SchM_ActMainFunction_<bsnp>[_<vi>_<ai>]_<name>()
```

signature if `swImplPolicy` of the `Trigger` is set to `queued`:

```
Std_ReturnType
SchM_ActMainFunction_<bsnp>[_<vi>_<ai>]_<name>()
```

Where here

<bsnp> is the *BSW Scheduler Name Prefix* according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the `vendorId` of the calling BSW module,

<ai> `vendorApiInfix` of the calling BSW module and

<name> is the associated `BswInternalTriggeringPoint` short name.

The sub part in squared brackets `[_<vi>_<ai>]` is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See [\[SWS_Rte_07528\]](#).] ([SRS_Rte_00218](#), [SRS_BSW_00347](#))

- Existence:** [SWS_Rte_07267] [The existence of an `activationPoint` shall result in the generation of a `SchM_ActMainFunction` API.] ([SRS_Rte_00218](#))
- [SWS_Rte_CONSTR_09054] `SchM_ActMainFunction` API may only be used by the `BswModuleEntity`s that describe its usage [The `SchM_ActMainFunction` API may only be used by the `BswModuleEntity` that contains the corresponding `activationPoint` association.]()
- Description:** The `SchM_ActMainFunction` triggers an execution for all `BswSchedulableEntity`s whose `BswInternalTriggerOccurredEvent` is associated by `activationPoint`.
- Return Value:** None if `swImplPolicy` of the `Trigger` is not set to `queued`.
- [SWS_Rte_06723] [The `SchM_ActMainFunction` API shall return the following values:
- `SCHM_E_OK` if the trigger was successfully queued
 - `SCHM_E_LIMIT` if the trigger was not queued because the maximum queue size is already reached.
- if `swImplPolicy` of the `Trigger` is set to `queued`.] ([SRS_Rte_00235](#))
- Notes:** `SchM_ActMainFunction` is restricted to ECU local communication.

6.5.13 SchM_CData

- Purpose:** Provide access to the calibration parameter of a *Basic Software Module* defined internally. The `ParameterDataPrototype` in the role `perInstanceParameter` is used to define *Basic Software Module* internal calibration parameters. Internal because the `ParameterDataPrototype` cannot be reused outside the *Basic Software Module*. Access is read-only. Each instance has an own data value associated with it.
- Signature:** [SWS_Rte_07093] [
`<return> SchM_CData_<bsnp>[_<vi>_<ai>]_<name>()`
 Where here
`<bsnp>` is the *BSW Scheduler Name Prefix* according [SWS_Rte_07593] and [SWS_Rte_07594],
`<vi>` is the `vendorId` of the calling BSW module,
`<ai>` `vendorApiInfix` of the calling BSW module and

<name> is the [shortName](#) of the [ParameterDataPrototype](#).

The sub part in squared brackets [[_<vi>_<ai>](#)] is omitted if no [vendorApiInfix](#) is defined for the *Basic Software Module*. See [[SWS_Rte_07528](#)]. ([SRS_BSW_00347](#), [SRS_Rte_00155](#))

Existence: [[SWS_Rte_07094](#)] [An [SchM_CData](#) API shall be created for each defined [ParameterDataPrototype](#) in the role [perInstanceParameter](#)] ([SRS_Rte_00155](#))

Description: The [SchM_CData](#) API provides access to the defined calibration parameter within a *Basic Software Module*. The actual data values for a *Basic Software Module* instance may be set after component compilation.

Return Value: The [SchM_CData](#) return value provide access to the data value of the [ParameterDataPrototype](#) in the role [perInstanceParameter](#).

The return type of [SchM_CData](#) is dependent on the [ImplementationDataType](#) of the [ParameterDataPrototype](#) and can either be a value or a pointer to the location where the value can be accessed. Thus the component does not need to use type casting to convert access to the [ParameterDataPrototype](#) data.

For details of the <return> value definition see section [5.2.6.6](#).

[[SWS_Rte_07095](#)] [The return value of the corresponding [SchM_CData](#) API shall provide access to the calibration parameter value specific to the instance of the *Basic Software Module*.] ([SRS_Rte_00155](#))

Notes: None.

6.5.14 SchM_Pim

Purpose: Provide access to the defined per-instance memory (section) of a Basic Software Module.

Signature: [[SWS_Rte_06203](#)] [
 <return> [SchM_Pim_<bsnp>\[_<vi>_<ai>\]_<name>\(\)](#)

with <bsnp> is the BSW Scheduler Name Prefix of the BSW module reading the data according to [[SWS_Rte_07593](#)] and [[SWS_Rte_07594](#)],

<vi> is the [vendorId](#) of the BSW module reading the data,

<ai> is the [vendorApiInfix](#) of the BSW module reading the data,

<name> is the [shortName](#) of the [VariableDataPrototype](#) defined in the role [arTypedPerInstanceMemory](#).

The sub part in square brackets [`<vi><ai>`] is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See [SWS_Rte_07528].] (SRS_BSW_00347, SRS_Rte_00075)

Existence: [SWS_Rte_06204] [A `SchM_Pim` API shall be created for each defined `VariableDataPrototype` in the role `arTypedPerInstanceMemory` within the Basic Software Module description.] (SRS_Rte_00075)

Description: The `SchM_Pim` API provides access to the `arTypedPerInstanceMemory` defined in the context of a `BswInternalBehavior` of a Basic Software Module description.

Return Value: [SWS_Rte_06205] [The API returns a typed reference (in C a typed pointer) to the `arTypedPerInstanceMemory`.] (SRS_Rte_00051, SRS_Rte_00075)

Notes: For an `arTypedPerInstanceMemory` the `<return reference>` is defined by the associated `AutosarDataType` (see [SWS_Rte_07161]). For details of the `<return reference>` definition see section 5.2.6.7.

6.6 Bsw Module Entity Reference

An AUTOSAR Basic Software Module defines one or more “BSW module entities”. A BSW Module Entity is a piece of code with a single entry point and an associate set of attributes. In contrast to runnable entities which are exclusively scheduled by the RTE only a subset of the BSW module entities, the `BswSchedulableEntity`s and `BswCalledEntity`s are called by the *Basic Software Scheduler*. Others might implement ‘C’ function interfaces which are directly called by other BSW modules or interrupts which are called by OS / interrupt controller.

A *Basic Software Module Description* provides definitions for each `BswModuleEntity` within the BSW Module. The *Basic Software Scheduler* triggers the execution of `BswSchedulableEntity`s and `BswCalledEntity`s in response to different `BswEvents`.

The `BswCalledEntity`s are triggered by `BswOperationInvokedEvents`, the `BswSchedulableEntity`s by `BswScheduleEvents`.

For BSW modules implemented using C or C++ the entry point of a `BswSchedulableEntity` is implemented by a function with global scope defined within a BSW Modules source code. The following sections consider the function signature and prototype.

6.6.1 Signature

The definition of all [BswSchedulableEntity](#)s, whatever the [BswScheduleEvent](#) that triggers their execution, follows the same basic form.

Purpose: Trigger a [BswSchedulableEntity](#) if the related [BswScheduleEvent](#) defined within the [BswModuleDescription](#) is raised.

Signature: **[SWS_Rte_07282]** [
 FUNC(void, <memclass>) <bsnp>[_<vi>_<ai>]_<name>(
 [IN SchM_ActivatingEvent_<name> <activation>])
]([SRS_BSW_00347](#), [SRS_Rte_00211](#), [SRS_Rte_00213](#), [SRS_Rte_00216](#), [SRS_Rte_00238](#))

The usage of `SchM_ActivatingEvent` is optional and defined in [\[SWS_Rte_08056\]](#).

For [BswCalledEntity](#)s the signature contains the parameters and return type. It can be seen in [\[SWS_Rte_08765\]](#).

Purpose: Trigger a [BswCalledEntity](#) if the related [BswOperationInvokedEvent](#) defined within the [BswModuleDescription](#) is raised.

Signature: **[SWS_Rte_08765]** [
 FUNC(<returnType>, <memclass>)
 <bsnp>[_<vi>_<ai>]_<name>(
 [IN|IN/OUT|OUT] <parameter_1>...
 [IN|IN/OUT|OUT] <parameter_n>)
]([SRS_BSW_00347](#), [SRS_Rte_00241](#), [SRS_Rte_00243](#))

There is currently no possibility to obtain the activating [BswOperationInvokedEvent](#) of a [BswCalledEntity](#).

Where here for both of them

<bsnp> is the [BSW Scheduler Name Prefix](#) according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<vi> is the [vendorId](#) of the BSW module,

<ai> is the [vendorApiInfix](#) of the BSW module

<name> is the substring after "<bsnp>_" of the [BswModuleEntry shortName](#) referred as `implementedEntry`.

<memclass> is the [Compiler Abstraction Memory Class](#) according [\[SWS_Rte_06739\]](#) and [\[SWS_Rte_06740\]](#).

<returnType> is the return type defined in the [SwServiceArg](#) in the role [returnType](#) of the [BswModuleEntry](#) which is referenced by the [BswModuleClientServerEntry](#) in the role [encapsulatedEntry](#). If no type is defined, the <returnType> is of type `void`.

<parameter_x> are the arguments defined in the `SwServiceArgs` in the role `argument` of the `BswModuleEntry` which is referenced by the `BswModule-ClientServerEntry` in the role `encapsulatedEntry`. For each argument the type has to be given according to [SWS_Rte_08766].

The sub part in square brackets [`_<vi>_<ai>`] is omitted if no `vendorApiInfix` is defined for the *Basic Software Module*. See [SWS_Rte_07528].

[SWS_Rte_08766] [The datatype of the argument is depending on `SwServiceArgs`.

For category of `SwServiceArg` of type `TYPE_REFERENCE`:

If the `ImplementationDataType` in the role `implementationDataType` of the `SwDataDefProps` of the `SwServiceArg` resolves to a primitive and the `direction` of the `SwServiceArg` is `IN`, the datatype of the argument is defined by the `ImplementationDataType` (possibly referred over a chain of `ImplementationDataTypes` of category `TYPE_REFERENCE`) in the role `implementationDataType` of the `SwDataDefProps` of the `SwServiceArg` which represents the argument.

If the `ImplementationDataType` in the role `implementationDataType` of the `SwDataDefProps` of the `SwServiceArg` resolves to a pointer type where the final pointer target is a primitive or composite and the `direction` of the `SwServiceArg` is `IN`, `INOUT` or `OUT`, the datatype of the argument is defined by the `SwPointerTargetProps` element referred by the `ImplementationDataType` of category `DATA_REFERENCE` (possibly referred over a chain of `ImplementationDataTypes` of category `TYPE_REFERENCE`).

For category of `SwServiceArg` of type `DATA_REFERENCE`:

If the `SwPointerTargetProps` in the role `swPointerTargetProps` of the `SwDataDefProps` of the `SwServiceArg` resolves to a primitive or composite and the `direction` of the `SwServiceArg` is `IN`, `INOUT` or `OUT`, the datatype of the argument is defined by the `SwPointerTargetProps` in the `SwDataDefProps` of the `SwServiceArg` which represents the argument (which may include resolving a chain of `ImplementationDataTypes` if the target category of the `SwPointerTargetProps` is `TYPE_REFERENCE`).

For category of `SwServiceArg` of type `FUNCTION_REFERENCE`:

This case is not supported.

] ([SRS_Rte_00243](#))

[SWS_Rte_CONSTR_09058] **`BswSchedulableEntity` is not allowed to have service arguments or return value** [The Basic Software Scheduler requires that the `BswModuleEntry` has no service arguments (unless `SchM_ActivatingEvent` is enabled) and no return value.] ()

[SWS_Rte_06739] [`<memclass>` shall be defined as `<snp>[_<vi>_<ai>]_<memClassSymbol>` if a `MemorySection.memClassSymbol` and an associated `MemorySection` is defined and where

<snp> is the `Section Name Prefix` according [SWS_Rte_07595] and [SWS_Rte_07596],

<vi> is the `vendorId` of the BSW module,

<ai> is the `vendorApiInfix` of the BSW module, and

<memClassSymbol> is the value of the attribute `memClassSymbol` the of the `MemorySection` associated via `executableEntity` reference to the `BswModuleEntity` implementing the related `BswModuleEntry`.]()

[SWS_Rte_06740] [`<memclass>` shall be defined as `<snp>[_<vi>_<ai>]_<sadm>` if no `MemorySection.memclassSymbol` is applicable (see [SWS_Rte_06739]) and where

<snp> is the `Section Name Prefix` according [SWS_Rte_07595] and [SWS_Rte_07596],

<vi> is the `vendorId` of the BSW module,

<ai> is the `vendorApiInfix` of the BSW module, and

<sadm> is the `shortName` of the referred `swAddrMethod`.]()

6.6.2 Entry Point Prototype

The entry point defined in the Basic Software Modules source *must* be compatible with the called function when the `BswSchedulableEntity` or `BswCalledEntity` is triggered by the *Basic Software Scheduler* and therefore the RTE generator is required to emit a prototype for the function.

[SWS_Rte_04542] [The RTE generator shall emit an *Entry Point Prototype* for each `BswSchedulableEntity`s implementedEntry in the *Module Interlink Header* file. See chapter 6.3.2 according [SWS_Rte_07282].](SRS_Rte_00211, SRS_Rte_00213, SRS_Rte_00216)

[SWS_Rte_04543] [The RTE generator shall emit an *Entry Point Prototype* for each `BswCalledEntity`s implementedEntry in the *Module Interlink Header* file, if the value of the attribute `functionPrototypeEmitter` is set to "RTE" . See chapter 6.3.2 according [SWS_Rte_08765].](SRS_Rte_00211, SRS_Rte_00213, SRS_Rte_00216)

[SWS_Rte_07195] [The RTE Generator shall wrap each `BswSchedulableEntity`'s *Entry Point Prototype* in the *Module Interlink Header* with the *Memory Mapping* and *Compiler Abstraction* macros.

```

1  #define <snp>[_<vi>_<ai>]_START_SEC_<sadm>
2  #include "<MemMap_filename.h>"
3
4  FUNC(void, <memclass>) <bsnp>[_<vi>_<ai>]_<name>
5      ([IN SchM_ActivatingEvent_<name> <activation>]);
6

```

```

7 #define <snp>[_<vi>_<ai>]_STOP_SEC_<sadm>
8 #include "<MemMap_filename.h>"

```

The RTE Generator shall wrap each [BswCalledEntity](#)'s *Entry Point Prototype* in the *Module Interlink Header* with the *Memory Mapping* and *Compiler Abstraction* macros.

```

1 #define <snp>[_<vi>_<ai>]_START_SEC_<sadm>
2 #include "<MemMap_filename.h>"
3
4 FUNC(<returnType>, <memclass>) <bsnp>[_<vi>_<ai>]_<name> (
5     [IN|IN/OUT|OUT] <parameter_1> ... [IN|IN/OUT|OUT] <parameter_n>);
6
7 #define <snp>[_<vi>_<ai>]_STOP_SEC_<sadm>
8 #include "<MemMap_filename.h>"

```

Where here for both of them

<bsnp> is the [BSW Scheduler Name Prefix](#) according [\[SWS_Rte_07593\]](#) and [\[SWS_Rte_07594\]](#),

<snp> is the [Section Name Prefix](#) according [\[SWS_Rte_07595\]](#) and [\[SWS_Rte_07596\]](#),

<vi> is the [vendorId](#) of the BSW module,

<ai> is the [vendorApiInfix](#) of the BSW module,

<name> is the substring after "<bsnp>_" of the [BswModuleEntry shortName](#) referred as [implementedEntry](#) and

<returnType> is the return type defined in the [SwServiceArg](#) in the role [returnType](#) of the [BswModuleEntry](#) which is referenced by the [BswModule-ClientServerEntry](#) in the role [encapsulatedEntry](#). If no type is defined, the <returnType> is of type void.

<parameter_x> are the arguments defined in the [SwServiceArgs](#) in the role [argument](#) of the [BswModuleEntry](#) which is referenced by the [BswModule-ClientServerEntry](#) in the role [encapsulatedEntry](#). For each argument the type has to be give according to [\[SWS_Rte_08766\]](#).

<sadm> is the [shortName](#) of the referred [swAddrMethod](#).

<memclass> is the [Compiler Abstraction Memory Class](#) according [\[SWS_Rte_06739\]](#) and [\[SWS_Rte_06740\]](#)

<MemMap_filename.h> is the *Applicable Memory Mapping Header File Name* according [\[SWS_Rte_07830\]](#), [\[SWS_Rte_07831\]](#) and [\[SWS_Rte_07832\]](#).

The sub part in square brackets [_<vi>_<ai>] is omitted if no [vendorApiInfix](#) is defined for the *Basic Software Module*. See [\[SWS_Rte_07528\]](#).

The usage of [SchM_ActivatingEvent](#) is optional for [BswSchedulableEntity](#) and defined in [\[SWS_Rte_08056\]](#). It does currently not exist for [BswCalledEntity](#)s.

The Memory Mapping macros could wrap several *Entry Point Prototype* if these referring the same `swAddrMethod`. If the `BswSchedulableEntity` or the `BswCalledEntity` does not refer a `swAddrMethod` the `<sadm>` is set to `CODE`.] ([SRS_Rte_00148](#), [SRS_Rte_00149](#), [SRS_Rte_00238](#))

[SWS_Rte_07830] [The RTE Generator shall emit the *Applicable Memory Mapping Header File Name* `<MemMap_filename.h>` as `<Msn>[_<vi>_<ai>]_MemMap.h` if the `BswImplementation` does not contain a `DependencyOnArtifact` in the role `requiredArtifact` where the `DependencyOnArtifact.category` is set to `MEMMAP`. `<Msn>` is the `shortName` (case sensitive) of the `BswModuleDescription`.] ([SRS_Rte_00148](#))

[SWS_Rte_07831] [The RTE generator shall emit the *Applicable Memory Mapping Header File Name* `<MemMap_filename.h>` identical to the attribute value `requiredArtifact.artifactDescriptor.shortLabel` if the `BswImplementation` does contain exactly one `DependencyOnArtifact` in the role `requiredArtifact` where the `DependencyOnArtifact.category` is set to `MEMMAP`.] ([SRS_Rte_00148](#))

[SWS_Rte_07832] [The RTE Generator shall emit the *Applicable Memory Mapping Header File Name* `<MemMap_filename.h>` identical to the attribute value `requiredArtifact.artifactDescriptor.shortLabel` of the `DependencyOnArtifact` in the role `requiredArtifact` where the `DependencyOnArtifact.category` is set to `MEMMAP` and which is associated with the `SectionNamePrefix` implemented in of the `MemorySection` associated to the `BswModuleEntity`.] ([SRS_Rte_00148](#))

Please note the example 6.2 of *Entry Point Prototype*.

[SWS_Rte_06533] [The RTE Generator shall wrap each *Entry Point Prototype* in the *Module Interlink Header* file of a variant existent `BswSchedulableEntity` or `BswCalledEntity` if the variability shall be implemented.

```

1  #if (<condition>)
2
3  <Entry Point Prototype>
4
5  #endif

```

where `condition` is the *Condition Value Macro* of the `VariationPoint` relevant for the variant existence of the `BswSchedulableEntity` or `BswCalledEntity` (see table 4.36), *Entry Point Prototype* is the code according an invariant *Entry Point Prototype* (see also [[SWS_Rte_07282](#)], [[SWS_Rte_04542](#)]).] ([SRS_Rte_00229](#))

6.6.3 Reentrancy

The `BswSchedulableEntity`s and `BswCalledEntity`s are declared within a BSW Module. The *Basic Software Module Scheduler* ensures that concurrent activation of the same `BswSchedulableEntity` or `BswCalledEntity` is only allowed if the

implemented entry points attribute `"isReentrant"` is set to `"true"` (see Section 4.2.7).

Consistency rule:

[SWS_Rte_07588] [The RTE Generator shall reject configurations where a `BswSchedulableEntity` whose referenced `BswModuleEntry` in the role `implementedEntry` has its `isReentrant` attribute set to `false`, and this `BswSchedulableEntity` is mapped to different tasks which can pre-empt each other.]([SRS_Rte_00018](#))

6.6.4 Provide activating Bsw event

[SWS_Rte_08059] [If the provide activating Bsw event feature is enabled, the RTE shall collect the activating Bsw events, which have the `activationReasonRepresentation` reference defined, in the context of the OS task the executable entity is mapped to in an activation vector at the corresponding bit position as defined in [\[SWS_Rte_08058\]](#).]([SRS_Rte_00238](#))

[SWS_Rte_08060] [If the provide activating Bsw event feature is enabled, the RTE shall provide the collected activating Bsw events (activation vector) to the executable entity API when the executable entity is "started". The activation vector shall be reset immediately after it has been provided.]([SRS_Rte_00238](#))

Provision of the activating Bsw event is currently not available for `BswCalledEntities`.

Since it is possible that there is a time gap between the activation and the execution (start) of an executable entity the subsequent activations are summed up and provided with the start of the executable entity.

Activations during the execution of an executable entity are collected for the next start of that runnable entity.

6.7 Basic Software Scheduler Lifecycle API Reference

6.7.1 SchM_Init

□ [

Service Name	SchM_Init
Syntax	<pre>void SchM_Init (const SchM_ConfigType* ConfigPtr)</pre>





Service ID [hex]	0x00	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	ConfigPtr	Pointer to configuration set in Variant Post-Build.
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	SchM_Init is intended to allocate and initialize system resources used by the Basic Software Scheduler part of the RTE for the core on which it is called.	
Available via	SchM.h	

]()

[SchM_Init](#) is intended to allocate and initialize system resources used by the *Basic Software Scheduler* part of the RTE for the core on which it is called.

[SWS_Rte_07270] [

```
void SchM_Init(const SchM_ConfigType * ConfigPtr)
```

]([SRS_BSW_00101](#), [SRS_Rte_00116](#))

[SWS_Rte_07271] [The [SchM_Init](#) API is always created.]([SRS_BSW_00101](#))

[SWS_Rte_07273] [[SchM_Init](#) shall return within finite execution time – it must not enter an infinite loop.]([SRS_BSW_00101](#))

[SchM_Init](#) may be implemented as a function or a macro.

[SchM_Init](#) is declared in the lifecycle header file `Rte_Main.h`.

6.7.2 SchM_Start

[] [

Service Name	SchM_Start
Syntax	<pre>void SchM_Start (void)</pre>
Service ID [hex]	0x70
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None





Description	Basic Software Scheduler initialized. Shall be called before BswM_Init().
Available via	SchM.h

](()

[SchM_Start](#) is intended to initialize the *Basic Software Scheduler*. It shall be called before BswM_Init().

[SWS_Rte_04546] [
void SchM_Start(void)

]([SRS_BSW_00101](#))

[SWS_Rte_04547] [The [SchM_Start](#) API is always created.]([SRS_BSW_00101](#))

[SWS_Rte_04548] [[SchM_Start](#) shall return within finite execution time – it must not enter an infinite loop.]([SRS_BSW_00101](#))

[SchM_Start](#) may be implemented as a function or a macro.

[SchM_Start](#) is declared in the lifecycle header file Rte_Main.h.

6.7.3 SchM_StartTiming

[] [

Service Name	SchM_StartTiming
Syntax	<pre>void SchM_StartTiming (void)</pre>
Service ID [hex]	0x76
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Start periodical events for BSW/SWCs. SchM_Init() has to be called before.
Available via	SchM.h

](()

[SchM_StartTiming](#) starts the *Basic Software Scheduler* part of the RTE.

[SchM_Start](#) starts periodical events for BSW/SWCs. SchM_Init() has to be called before.

[SWS_Rte_04549] [
void SchM_StartTiming(void)

]([SRS_BSW_00101](#))

[SWS_Rte_04550] [The [SchM_StartTiming](#) API is always created.]([SRS_BSW_00101](#))

[SWS_Rte_04551] [[SchM_StartTiming](#) shall return within finite execution time – it must not enter an infinite loop.]([SRS_BSW_00101](#))

[SchM_StartTiming](#) may be implemented as a function or a macro.

[SchM_StartTiming](#) is declared in the lifecycle header file `Rte_Main.h`.

[SWS_Rte_CONSTR_09055] [SchM_Init](#), [SchM_Start](#), [SchM_StartTiming](#) shall be called only once [[SchM_Init](#), [SchM_Start](#), [SchM_StartTiming](#) shall be called only once by the *EcuStateManager* on each core after the basic software modules required by the *Basic Software Scheduler* part of the RTE are initialized.]([SRS_BSW_00101](#))

These modules include:

- OS

6.7.4 SchM_Deinit

[

Service Name	SchM_Deinit
Syntax	<pre>void SchM_Deinit (void)</pre>
Service ID [hex]	0x01
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	SchM_Deinit is used to finalize Basic Software Scheduler part of the RTE of the core on which it is called. This service releases all system resources allocated by the Basic Software Scheduler part on that core.
Available via	SchM.h

]([SRS_BSW_00336](#))

[SchM_Deinit](#) finalizes the *Basic Software Scheduler* part of the RTE on the core it is called.

[SWS_Rte_07274] [`void SchM_Deinit(void)`

]([SRS_BSW_00336](#))

[SWS_Rte_07275] [The [SchM_Deinit](#) API is always created.]([SRS_BSW_00336](#))

[SWS_Rte_CONSTR_09057] **SchM_Deinit shall be called before shut down of BSW** [SchM_Deinit shall be called by the *EcuStateManager* before the basic software modules required by *Basic Software Scheduler* part are shut down.]()

These modules include:

- OS

[SWS_Rte_CONSTR_09056] **SchM_Deinit API may only be used after the was RTE finalized** [The [SchM_Deinit](#) API may only be used after the RTE finalized (after termination of the [Rte_Stop](#))]()

[SWS_Rte_07277] [SchM_Deinit shall return within finite execution time.]([SRS_BSW_00336](#))

[SchM_Deinit](#) may be implemented as a function or a macro.

[SchM_Deinit](#) is declared in the lifecycle header file `Rte_Main.h`.

6.7.5 SchM_GetVersionInfo

[]

Service Name	SchM_GetVersionInfo	
Syntax	<pre>void SchM_GetVersionInfo (Std_VersionInfoType* versioninfo)</pre>	
Service ID [hex]	0x02	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	versioninfo	Pointer to the memory location holding the version information of the module
Return value	None	
Description	Returns the version information of the Basic Software Scheduler.	
Available via	SchM.h	

]()

[SWS_Rte_07278] [
void SchM_GetVersionInfo(Std_VersionInfoType * versioninfo)
]([SRS_BSW_00407](#))

[SWS_Rte_07279] [The [SchM_GetVersionInfo](#) API is only created if [RteSchMVersionInfoApi](#) is set to true.]([SRS_BSW_00407](#))

[SWS_Rte_07280] [[SchM_GetVersionInfo](#) shall return the version information of the RTE module which includes the *Basic Software Scheduler*. The version information includes:

- Module Id
- Vendor Id
- Vendor specific version numbers

]([SRS_BSW_00407](#))

[SWS_Rte_07281] [The parameter `versioninfo` of the [SchM_GetVersionInfo](#) shall point to the memory location holding the version information of the *Basic Software Scheduler*.]([SRS_BSW_00407](#))

[SchM_GetVersionInfo](#) may be implemented as a function or a macro.

[SchM_GetVersionInfo](#) is declared in the lifecycle header file `Rte_Main.h`.

The existence of the API [SchM_GetVersionInfo](#) depends on the parameter [RteSchMVersionInfoApi](#).

Vendor specific version numbers shall represent build version which depends from the RTE generator version and the input configuration. It is not in the scope if this specification to standardize the way how the version numbers are created in detail because these are the vendor specific version numbers.

7 RTE Implementation Plug-Ins Reference

Please note, that the requirements concerning [RTE Implementation Plug-Ins](#) in this chapter are set to draft to support a simple revise of requirements in case of defects. Nevertheless, all addressed concept elements were fully elaborated and incorporated in the AUTOSAR specifications.

It's expected, that all draft requirements in this section will be set to valid in the next minor release.

7.1 Introduction

For a standard RTE Generator, the possibilities to determine the system dynamics are very limited (task priorities, internal OsResources ...). A real ECU SW will have more constraints, e.g. tasks that only run in different system states, tasks that follow the execution of other tasks (i.e. chains of tasks). Without this knowledge an RTE will on one side use more protection of internal variables and on the other side perform more data buffering than necessary. This will lead to higher CPU resource consumption than necessary. AUTOSAR provides some ideas and requirements regarding buffering of implicitly accessed data, but mostly leaves the optimization up to the RTE vendor. For the RTE vendor, the buffer optimization is one of the most challenging jobs when implementing an RTE Generator. And it does again not have all the knowledge about the system dynamics nor about the optimization goals (AUTOSAR only provides optimization switches MEMORY and RUNTIME). The idea of [RTE Implementation Plug-In](#) is to move the jobs of protection and buffering optimizations from the RTE vendor to some domain specific tool which has a more detailed knowledge about optimization goals and system dynamics.

With the introduction of `Software Clusters` in the AUTOSAR Classic Platform additionally the `Cross Cluster Communication` is realized by means of [RTE Implementation Plug-Ins](#).

The interface between the RTE and the domain specific tooling will mostly be a C code interface. Further on in this document this domain specific tooling with the RTE extending C-code will be called [RTE Implementation Plug-In](#). Those [RTE Implementation Plug-Ins](#) can exist in two specializations characterizing the different communication scope:

- [Local Software Cluster Communication Plug-Ins](#)
- [Cross Software Cluster Communication Plug-Ins](#)

7.1.1 RTE Implementation Plug-Ins in the AUTOSAR Architecture

From the AUTOSAR software layered architecture point of view the [RTE Implementation Plug-Ins](#) are a part of the RTE. This means the "Core" RTE provided by the RTE Generator plus the [RTE Implementation Plug-Ins](#) implement the overall RTE. Nevertheless the interface between the "Core" RTE and the [RTE Implementation Plug-Ins](#) is standardized in order to support, that the RTE Generator and the [RTE Implementation Plug-Ins](#) can be provided by different vendors.

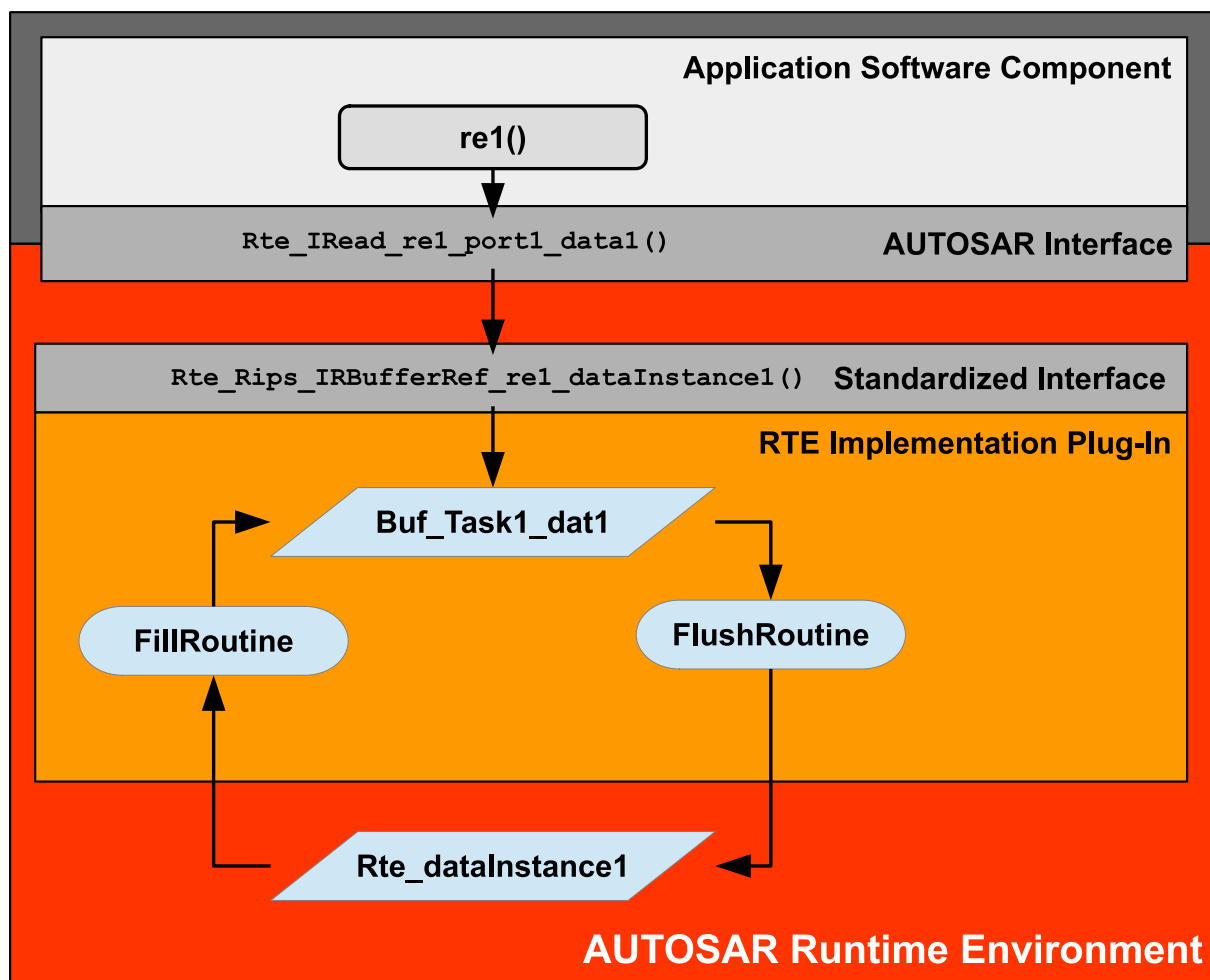


Figure 7.1: Example of implicit communication via RTE Implementation Plug-In

The Figure 7.1 shows the principle of implicit communication implementation via an [RTE Implementation Plug-In](#). Based on the Software Component Description the RTE provides the `Rte_IRead` API. This `Rte_IRead` API uses the `Rte_Rips_IRBufferRef` API from the [RTE Implementation Plug-In](#) to get the address of the [implicit communication buffer](#) `Buf_Task1_dat1`. The [RTE Implementation Plug-In](#) provides the fill- and flush routines and the [implicit communication buffer](#) instance. Via interface conventions it knows as well the [global copy](#) `Rte_dataInstance1` which is related to the [Data Communication Graph](#). This supports the creation of the according copy code for the fill- and flush routines.

7.1.2 Multiple RTE Implementation Plug-Ins handling one Communication Graph

It's possible that a Communication Graph is handled by at most two different RTE Implementation Plug-Ins with a different communication scope. This enables e.g. that for one communication graph a Local Software Cluster Communication Plug-In implements optimized implicit buffering or LET compliant buffering and additionally a Cross Software Cluster Communication Plug-In implements the communication from / to other Software Clusters. Nevertheless the association via the RIPS FlatInstanceDescriptors has to be done in a consistent manner. This consistency restrictions are defined by following constraints:

[SWS_Rte_CONSTR_80019]{DRAFT} associatedRtePlugin shall only reference a Local Software Cluster Communication Plug-In [FlatInstanceDescriptor.rtePluginProps.associatedRtePlugin shall only reference a RteRipsPluginProps EcucContainerValue where the parameter value RteRipsPluginCommunicationScope is set to RTE_RIPS_LOCAL_SW_CLUSTER_COM or is omitted.](SRS_Rte_00304, SRS_Rte_00318)

[SWS_Rte_CONSTR_80030]{DRAFT} associatedCrossSwClusterComRtePlugin shall only reference a Cross Software Cluster Communication Plug-In [FlatInstanceDescriptor.rtePluginProps.associatedCrossSwClusterComRtePlugin shall only reference a RteRipsPluginProps EcucContainerValue where the parameter value RteRipsPluginCommunicationScope is set to RTE_RIPS_CROSS_SW_CLUSTER_COM.](SRS_Rte_00304, SRS_Rte_00318)

Please note that for specific types of communication the usage might be restricted to the assignment of either a Local Software Cluster Communication Plug-In or a Cross Software Cluster Communication Plug-In. For other types of communication the parallel assignment of a Local Software Cluster Communication Plug-In AND a Cross Software Cluster Communication Plug-In might be supported. Such details are defined in the according chapters of the RTE Implementation Plug-Ins support.

[SWS_Rte_CONSTR_80201]{DRAFT} Communication Graph is handled by at most one Local Software Cluster Communication Plug-In and one Cross Software Cluster Communication Plug-In. [A Communication Graph is handled by at most one Local Software Cluster Communication Plug-In and at most one Cross Software Cluster Communication Plug-In. But it's possible, that both RTE Implementation Plug-Inss are enabled together.](SRS_Rte_00304, SRS_Rte_00318)

Rationale: Incase of an arbitrary number of RTE Implementation Plug-Ins the interaction between RTE and the RTE Implementation Plug-Ins is unspecified.

[SWS_Rte_CONSTR_80202]{DRAFT} **Cross Software Cluster Communication Plug-In is only applicable in the Cluster Generation Phase** [A `FlatInstanceDescriptor` shall only be associated to `Cross Software Cluster Communication Plug-In` in the Cluster Generation Phase.]([SRS_Rte_00300](#), [SRS_Rte_00301](#))

Rationale: A `Cross Software Cluster Communication Plug-In` is not supported in a non-cluster ECU SW.

7.2 Interface between RTE Implementation Plug-Ins and RTE

7.2.1 File Structure

The following subsection describes the content of the `RTE Implementation Plug-In` specific files and the additional requirements on the standardized Header Files of the RTE.

The shown file structure is the one relevant for *Generation Phase* or *Cluster Generation Phase*. `RTE Implementation Plug-Ins` do not have any influence on the RTE Contract Phase or Basic Software Scheduler Contract Phase.

The general coding rules mandate to have exactly one declaration for each C symbol definition and that this declaration is visible to the definition as well as the users of the C symbol. Furthermore the file structure represents only the idea and some kind of best practice. The RTE as well as the `RTE Implementation Plug-Ins` are free to adapt this structure to their needs. However, the essence of the interface between the two has to be maintained. That is,

- which file of one domain (RTE or `RTE Implementation Plug-In`) exports which declaration or definition into the other domain and
- which files (or better their contents) have to be expected to be visible in other files at the same time (risk of double declarations, double inclusion protection taking effect etc.).

The term 'export' in that sense means that the exported definition or declaration shall be visible in the file including the exporting header. It does not matter if that header performs the declarations or definitions itself or if they are performed by another header included into this one.

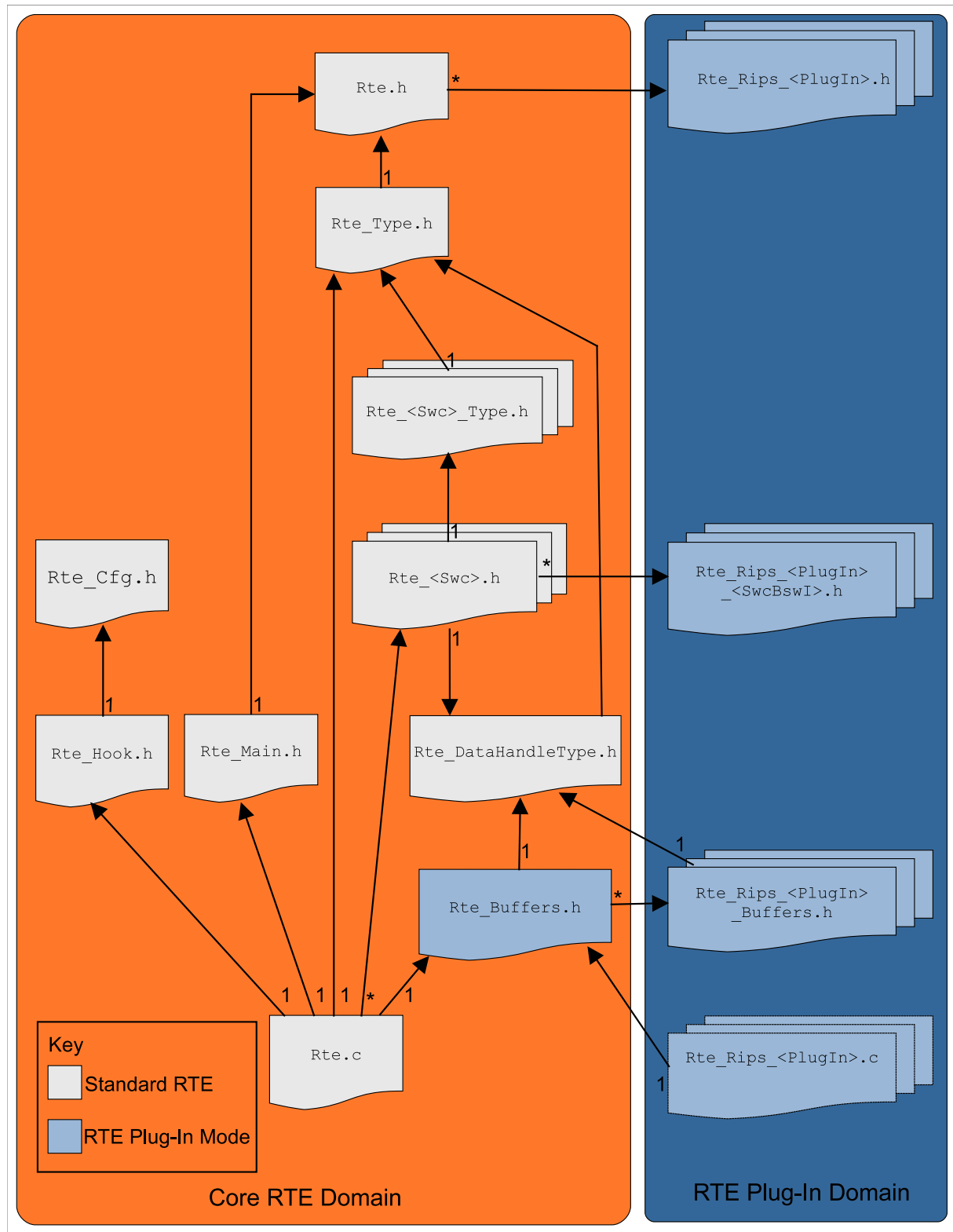


Figure 7.2: Include Structure of RTE Implementation Plug-Ins for RTE

7.2.1.1 RTE Global Buffer Declaration File

The RTE Global Buffer Declaration File makes all global copies of data instantiated by the RTE visible to the RTE Implementation Plug-In Services and the RTE Implementation Plug-In C-code. As the RTE Implementation Plug-In only knows their name by the related RIPS FlatInstanceDescriptor, it might be necessary to have an according mapping in case the resulting global copy name differs from this one. The RTE therefore has to map the name derived from the RIPS FlatInstanceDescriptor domain to the real C name implemented by the RTE. An example of a RTE Global Buffer Declaration File containing a plain declaration and a declaration with mapping can be seen below in Example 7.1.

Example 7.1

```
1  #ifndef RTE_BUFFERS_H
2  #define RTE_BUFFERS_H
3
4  #include "Rte_DataHandleType.h"
5  #include "Rte_Rips_myPlugin1_Buffers.h"
6  #include "Rte_Rips_myPlugin2_Buffers.h"
7
8  extern uint32 Rte_someInternalNameForData;
9
10 #define Rte_Rips_GlobalCopy_myMappedData Rte_someInternalNameForData
11
12 #endif /* RTE_BUFFERS_H */
```

[SWS_Rte_80000] [The RTE Global Buffer Declaration File shall have the name `Rte_Buffers.h`.] ([SRS_Rte_00306](#))

[SWS_Rte_80001] [The RTE Generator shall create the RTE Global Buffer Declaration File when the RTE Implementation Plug-In mode is enabled.] ([SRS_Rte_00306](#))

[SWS_Rte_80002] [The RTE Global Buffer Declaration File shall include the RTE Data Handle Types Header File.] ([SRS_Rte_00306](#))

[SWS_Rte_80003] [The RTE Global Buffer Declaration File shall include all RIPS Buffer Declaration Files of all participating RTE Implementation Plug-Ins.] ([SRS_Rte_00306](#))

[SWS_Rte_80005] [The RTE Global Buffer Declaration File shall export the declarations of all global copies for implicit communication instantiated by the RTE, where the Data Communication Graph is associated with a RTE Implementation Plug-In.] ([SRS_Rte_00306](#))

Please note: The data structures for queues inside an RTE are considered as specific for each RTE implementation. Since there is never the use case to buffer queued communication there is no need to make them accessible for the [RTE Implementation Plug-In](#) code.

[SWS_Rte_80006] [For each [global copy](#) of a [Data Communication Graph](#) associated to an [RTE Implementation Plug-In](#) and implemented by the RTE where the C symbol is different to the [shortName](#) of the respective [RIPS FlatInstanceDescriptor](#) prefixed by `Rte_Rips_GlobalCopy_`, the [RTE Global Buffer Declaration File](#) shall export a mapping from the [shortName](#) of the [RIPS FlatInstanceDescriptor](#) prefixed by `Rte_Rips_GlobalCopy_` to the according C symbol of the [global copy](#).] ([SRS_Rte_00306](#))

[SWS_Rte_80131]{DRAFT} [For each parameter instance of a [Parameter Communication Graph](#) associated to an [RTE Implementation Plug-In](#) where the C symbol (decided by the RTE) is different to the [shortName](#) of the respective [RIPS FlatInstanceDescriptor](#) prefixed by `Rte_Rips_PrmInst_`, the [RTE Global Buffer Declaration File](#) shall export a mapping from the [shortName](#) of the [RIPS FlatInstanceDescriptor](#) prefixed by `Rte_Rips_PrmInst_` to the according C symbol of the [parameter instance](#).] ([SRS_Rte_00306](#), [SRS_Rte_00319](#))

Example 7.2

```

1  #ifndef RTE_BUFFERS_H
2  #define RTE_BUFFERS_H
3
4  extern uint32 Rte_someInternalNameForData;
5  extern uint16 Rte_someInternalNameForParameter;
6
7  /*SWS_Rte_80006*/
8  #define Rte_Rips_GlobalCopy_myMappedData Rte_someInternalNameForData
9  /*SWS_Rte_80131*/
10 #define Rte_Rips_PrmInst_myParameter Rte_someInternalNameForParameter
11
12 #endif /* RTE_BUFFERS_H */

```

[SWS_Rte_80007] [The RTE shall be implemented in a way that the mappings resulting from [\[SWS_Rte_80006\]](#) and [\[SWS_Rte_80131\]](#) shall not have any effect on the AUTOSAR RTE code, specifically `Rte.c`, as they might cause unintended replacements there. In particular this means that they shall not change the C symbol of the global copies.] ([SRS_Rte_00306](#))

Note: [\[SWS_Rte_80007\]](#) can be simply implemented by the fact that the RTE code does not use any symbols starting with `Rte_Rips_GlobalCopy_` or `Rte_Rips_PrmInst_`.

7.2.1.2 RIPS Buffer Declaration Files

The [RIPS Buffer Declaration File](#) makes all global copies of data instantiated by the [RTE Implementation Plug-In](#) visible to the RTE.

[SWS_Rte_70000] [The [RIPS Buffer Declaration File](#) shall have the name `Rte_Rips_<PlugIn>_Buffers.h`, where `<PlugIn>` is the name of the related [RTE Implementation Plug-In](#) defined by the container `RteRipsPluginProps`.] ([SRS_Rte_00306](#))

[SWS_Rte_70001] [The [RTE Implementation Plug-In](#) shall create the [RIPS Buffer Declaration File](#).] ([SRS_Rte_00306](#))

Note: Each participating [RTE Implementation Plug-In](#) creates a separate [RIPS Buffer Declaration File](#).

[SWS_Rte_70002] [The [RIPS Buffer Declaration File](#) shall include the [RTE Data Handle Types Header File](#) (`Rte_DataHandleType.h`).] ([SRS_Rte_00306](#))

[SWS_Rte_70003] [The [RIPS Buffer Declaration File](#) shall export the declarations of the [implicit communication buffers](#) for the RIPS relevant data handled by this [RTE Implementation Plug-In](#).] ([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_70004] [The [RIPS Buffer Declaration File](#) shall export the type definitions of the [implicit communication buffers](#) for RIPS relevant data handled by this [RTE Implementation Plug-In](#).] ([SRS_Rte_00306](#), [SRS_Rte_00301](#))

7.2.1.3 RTE Implementation Plug-In Header File

[SWS_Rte_70005] [The [RTE Implementation Plug-In Header File](#) shall have the name `Rte_Rips_<PlugIn>.h`, where `<PlugIn>` is the name of the related [RTE Implementation Plug-In](#) defined by the container `RteRipsPluginProps`.] ([SRS_Rte_00306](#))

[SWS_Rte_70006] [The [RTE Implementation Plug-In](#) shall create the [RTE Implementation Plug-In Header File](#).] ([SRS_Rte_00306](#))

Note: Each participating [RTE Implementation Plug-In](#) creates a separate [RTE Implementation Plug-In Header File](#).

[SWS_Rte_70007] [The [RTE Implementation Plug-In Header File](#) shall export the `Rte_Rips_Enter` and `Rte_Rips_Exit` Services related to `ExclusiveAreas` used as `runsInsideExclusiveArea`.] ([SRS_Rte_00306](#), [SRS_Rte_00302](#))

[SWS_Rte_70098] [The RTE Implementation Plug-In Header File shall export the `Rte_Rips_EnterModeQueue` and `Rte_Rips_ExitModeQueue` Services related to mode machine instances and distributed shared mode queues.]([SRS_Rte_00306](#), [SRS_Rte_00310](#), [SRS_Rte_00315](#))

[SWS_Rte_70029] [The RTE Implementation Plug-In Header File shall export the declarations of the lifecycle APIs of the RTE Implementation Plug-In.]([SRS_Rte_00306](#))

Please note: The lifecycle APIs of RTE Implementation Plug-Ins are defined in section [7.2.4.15](#).

[SWS_Rte_70046] [The RTE Implementation Plug-In Header File shall export the declarations of the `Rte_Rips_FillFlushRoutines` of the RTE Implementation Plug-In.]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_82009]{DRAFT} [The RTE Implementation Plug-In Header File shall export the declarations of the `Rte_Rips_InvocationHandlers` of the RTE Implementation Plug-In.]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_82010]{DRAFT} [The RTE Implementation Plug-In Header File shall export the declarations of the `Rte_Rips_DataIsUpdated_EventActivations` of the RTE Implementation Plug-In.]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_80026] [The RTE shall include the RTE Implementation Plug-In Header File where it needs the contained definitions and declarations.]([SRS_Rte_00306](#))

Note: Due to the relationship to the lifecycle API a reasonable include might be the `Rte.h` file as shown in [7.2](#).

7.2.1.4 RIPS SWC-BSW-Instance Header File

[SWS_Rte_70031] [The RIPS SWC-BSW-Instance Header File shall be named `Rte_Rips_<PlugIn>_<SwcBswI>.h`, where `<PlugIn>` is the name of the related RTE Implementation Plug-In defined by the container `RteRipsPluginProps` and `<SwcBswI>` is the SWC-BSW-Instance name according to [\[SWS_Rte_70035\]](#)]([SRS_Rte_00306](#))

[SWS_Rte_70032] [The RIPS SWC-BSW-Instance Header File shall be generated by the RTE Implementation Plug-In for each Software Component or BSW Module which either has

- an `ExclusiveArea` with enabled RTE Implementation Plug-In support mapped to this RTE Implementation Plug-In (see [\[SWS_Rte_80024\]](#)), OR

- an access to a [Data Communication Graph](#) with enabled [RTE Implementation Plug-In](#) support mapped to this [RTE Implementation Plug-In](#),
OR
- an access to a [Parameter Communication Graph](#) with enabled [RTE Implementation Plug-In](#) support mapped to this [RTE Implementation Plug-In](#),
OR
- an access to a [mode machine instance](#) with enabled [RTE Implementation Plug-In](#) support mapped to this [RTE Implementation Plug-In](#),
OR
- an access to a [mode machine instance](#) belonging to a [distributed shared mode queue](#) with enabled [RTE Implementation Plug-In](#) support mapped to this [RTE Implementation Plug-In](#),
OR
- an access to a [Trigger Communication Graph](#) with enabled [RTE Implementation Plug-In](#) support mapped to this [RTE Implementation Plug-In](#), OR
- an access to a [Client Server Communication Graph](#) with enabled [RTE Implementation Plug-In](#) support mapped to this [RTE Implementation Plug-In](#).

]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00301](#), [SRS_Rte_00302](#), [SRS_Rte_00310](#), [SRS_Rte_00312](#), [SRS_Rte_00315](#))

[SWS_Rte_70033] [The [RIPS SWC-BSW-Instance Header File](#) shall include the [RTE Global Buffer Declaration File](#).]([SRS_Rte_00306](#))

[SWS_Rte_70039] [The [RIPS SWC-BSW-Instance Header File](#) shall export the definitions of the

- [Rte_Rips_Enter/Rte_Rips_Exit](#) Services for [ExclusiveAreas](#) with a [canEnterExclusiveArea](#) association
- [Rte_Rips_StartRead](#), [Rte_Rips_StopRead](#), [Rte_Rips_StartWrite](#), and [Rte_Rips_StopWrite](#) Services for explicit access protection
- [Rte_Rips_Read](#), [Rte_Rips_Write](#), [Rte_Rips_DRead](#), [Rte_Rips_Feedback](#) and [Rte_Rips_DataIsUpdated](#) for Services for explicit data accesses
- [Rte_Rips_IRead](#), [Rte_Rips_IWrite](#), [Rte_Rips_IRBufferRef](#), [Rte_Rips_IWBufferRef](#) and [Rte_Rips_Feedback](#) Services for implicit accesses
- [Rte_Rips_Invoke](#) and [Rte_Rips_ReturnResult](#) for clients and trigger sources

- [Rte_Rips_Prm](#) for calibration parameter accesses
- [Rte_Rips_Switch](#) for cross cluster mode communication
- [Rte_Rips_Trigger](#) for cross cluster trigger communication

handled by this [RTE Implementation Plug-In](#) for this component instance / *Basic Software Module instance*.] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00301](#), [SRS_Rte_00302](#), [SRS_Rte_00310](#), [SRS_Rte_00312](#), [SRS_Rte_00315](#))

7.2.1.5 RTE Implementation Plug-In Implementation File

[SWS_Rte_70008] [The [RTE Implementation Plug-In](#) shall name the [RTE Implementation Plug-In Implementation Files](#) in a way that name collisions with file names of AUTOSAR Basic Software Modules and Software Components are avoided.] ([SRS_Rte_00306](#))

Please note that the file structure of the [RTE Implementation Plug-In](#) is not strictly standardized. Nevertheless [\[SWS_Rte_70009\]](#) defines a recommendation for the case the [RTE Implementation Plug-In](#) needs only one source file. For sure the given name pattern can also be extended to support more than one file, e.g. one source file per ASIL level.

[SWS_Rte_70009] [If the [RTE Implementation Plug-In](#) uses a single source file, the [RTE Implementation Plug-In Implementation File](#) should have the name `Rte_Rips_<PlugIn>.c`, where `<PlugIn>` is the name of the related [RTE Implementation Plug-In](#) defined by the container `RteRipsPluginProps`.] ([SRS_Rte_00306](#))

[SWS_Rte_70010] [The [RTE Implementation Plug-In](#) shall create the [RTE Implementation Plug-In Implementation Files](#).] ([SRS_Rte_00306](#))

Note: Each participating [RTE Implementation Plug-In](#) creates a separate set of [RTE Implementation Plug-In Implementation Files](#).

[SWS_Rte_70011] [The [RTE Implementation Plug-In Implementation Files](#) shall include the [RTE Global Buffer Declaration File](#).] ([SRS_Rte_00306](#))

[SWS_Rte_70012] [The [RTE Implementation Plug-In Implementation Files](#) shall include the [RTE Implementation Plug-In Header File](#).] ([SRS_Rte_00306](#))

[SWS_Rte_70013] [The [RTE Implementation Plug-In Implementation Files](#) shall contain the definition of the [implicit communication buffers](#) for RIPS relevant data handled by this RIPS plug-in.] ([SRS_Rte_00306](#), [SRS_Rte_00301](#))

The RIPS Implementation File shall contain the definition of the [implicit communication buffers](#) for RIPS relevant data handled by this RIPS plug-in, the implementation of the fill- and flush-Runnables and all further memory consuming C objects that might be necessary by the RIPS implementation of this plug-in.

7.2.1.6 RTE Header File

This subsection describes the additional requirements on the [RTE Header File](#) of the RTE when the [RTE Implementation Plug-In](#) mode is enabled.

[SWS_Rte_80008] [The [RTE Header File](#) (`Rte.h`) shall include the [RTE Implementation Plug-In Header Files](#) of all participating [RTE Implementation Plug-Ins](#).] ([SRS_Rte_00306](#))

7.2.1.7 Application Header File

This subsection describes the additional requirements on the [Application Header File](#) of the RTE when the [RTE Implementation Plug-In](#) mode is enabled.

[SWS_Rte_80027] [The [Application Header File](#) of a Software Component shall include the [RIPS SWC-BSW-Instance Header File](#) of all [RTE Implementation Plug-Ins](#) applicable for this component instance, if they exist (refer to [\[SWS_Rte_70032\]](#)).] ([SRS_Rte_00306](#))

7.2.1.8 Module Interlink Header

This subsection describes the additional requirements on the [Module Interlink Header](#) of the Basic Software Scheduler when the [RTE Implementation Plug-In](#) mode is enabled.

[SWS_Rte_80028] [The [Module Interlink Header](#) of a BSW Module shall include the [RIPS SWC-BSW-Instance Header File](#) of all [RTE Implementation Plug-Ins](#) applicable for this *Basic Software Module instance*, if they exist (refer to [\[SWS_Rte_70032\]](#)).] ([SRS_Rte_00306](#))

7.2.1.9 RTE Data Handle Types Header File

This subsection describes the additional requirements on the [RTE Data Handle Types Header File](#) of the RTE when the [RTE Implementation Plug-In](#) mode is enabled.

[SWS_Rte_80079] [In case the RTE implements a [global copy](#) of some RIPS relevant [Data Communication Graphs](#) or [Parameter Communication Graphs](#),

the [RTE Data Handle Types Header File](#) shall contain a wrapper type definition for each [global copy](#)

```
typedef <type of global copy> Rte_Rips_GlobalCopy_<CGI>_Type;
```

where <CGI> is the name of the [Communication Graph](#) Instance defined by the [shortName](#) of the [RIPS FlatInstanceDescriptor](#) referencing the [Communication Graph](#).] ([SRS_Rte_00306](#), [SRS_Rte_00301](#), [SRS_Rte_00302](#))

[SWS_Rte_82011]{DRAFT} [In case the RTE implements a [parameter instance](#) of some RIPS relevant [Parameter Communication Graphs](#), the [RTE Data Handle Types Header File](#) shall contain a wrapper type definition for each [parameter instance](#)

```
typedef <type of parameter instance> Rte_Rips_PrmInst_<CGI>_Type;
```

where <CGI> is the name of the [Communication Graph](#) Instance defined by the [shortName](#) of the [RIPS FlatInstanceDescriptor](#) referencing the [Communication Graph](#).] ([SRS_Rte_00306](#), [SRS_Rte_00301](#), [SRS_Rte_00302](#))

This wrapper type is intended for [RTE Implementation Plug-Ins](#) with type independent buffering strategy. In this case the buffering decisions are driven by the timing behavior and interference of readers and writers. For instance LET based buffering. In this case the [RTE Implementation Plug-Ins](#) can omit the gathering of types from the AUTOSAR model.

[SWS_Rte_80009] [The [RTE Data Handle Types Header File](#) ([Rte_DataHandleType.h](#)) shall include the [RTE Types Header File](#) independent whether this is directly needed or not.] ([SRS_Rte_00306](#))

7.2.2 API principles

7.2.2.1 API name pattern

The [RTE Implementation Plug-In Services](#) are defined according to the following principles.

The RTE APIs towards the Software Components or Basic Software Modules are defined amongst the AUTOSAR Meta Model (e.g. providing an explicit write access to a specific data element in a specific port of a [SwComponentType](#)). In contrast the interface towards the [RTE Implementation Plug-Ins](#) is on one hand strictly use case oriented resp. instance based. Use case oriented means that for the same use case (e.g. starting the protection of an [ExclusiveArea](#)) which may exist in Software Components or Basic Software Modules the same kind of [RTE Implementation Plug-In Service](#) is defined and provided for use by the RTE code.

Instance based means that the name of a [RTE Implementation Plug-In Service](#) reflects the specific activity on a specific entity in the ECU SW implemented by

a specific [RTE Implementation Plug-In](#), e.g. determining the location in memory where data values from a communication graph can be read from for a specific [RunnableEntity](#) of a specific Software Component Instance.

Except for the lifecycle APIs any [RTE Implementation Plug-In Service](#) is defined according the following name scheme:

```
Rte_Rips_<PlugIn>_<useCase>_[<SwcBswI>] [Partition]  
[_<ExE>]_<elementInstance>
```

[SWS_Rte_70034] [[<PlugIn>](#) is the name of the related [RTE Implementation Plug-In](#) defined by the container [RteRipsPluginProps](#).] ([SRS_Rte_00306](#))

[SWS_Rte_70099] [[<useCase>](#) is the name part which denotes the purpose of the [RTE Implementation Plug-In Service](#) and is one of the following:

- IRead
- IWrite
- IRBufferRef
- IWBufferRef
- StartRead
- StopRead
- StartWrite
- StopWrite
- Read
- DRead
- Write
- Enter
- Exit
- EnterModeQueue
- ExitModeQueue
- Switch
- DequeueModeSwitch
- Trigger
- Invoke
- ReturnResult
- Prm

](SRS_Rte_00306)

Further details are described in section 7.2.4.

[SWS_Rte_70035] [`<SwcBswI>` `SWC-BSW-Instance name` is either the `shortName` of the `SwComponentPrototype` (in the `RootSwComposition` of the ECU Extract) or the BSW Module Instance Name according to [SWS_Rte_70036].](SRS_Rte_00306)

Note: in some RTE Implementation Plug-In Services the name part `<SwcBswI>` is mandatory, in others it is alternatively used with `<Partition>`

[SWS_Rte_70135]{DRAFT} [`<Partition>` is the `shortName` of the `EcucPartition` on which the `SwComponentPrototype` (in the `RootSwComposition` of the ECU Extract) of the accessing software component is mapped to or to which the using RTE code belongs.](SRS_Rte_00306)

[SWS_Rte_70036] [The BSW Module Instance Name `<bsnp>[_<vi>_<ai>]` is composed out of `<bsnp>` is the BSW Scheduler Name Prefix according [SWS_Rte_07593] and [SWS_Rte_07594], `<vi>` is the `vendorId` of the accessing BSW module, `<ai>` is the `vendorApiInfix` of the accessing BSW module.](SRS_Rte_00306)

[SWS_Rte_70037] [`<ExE>` is the `shortName` of the `ExecutableEntity` accessing an element instance. The name part `<ExE>` only exists in case the RTE offers the ability to distinguish the accesses of different `ExecutableEntities`.](SRS_Rte_00306)

[SWS_Rte_70038] [`<elementInstance>` identifies the element to which the access is provided. Since a specific use case is typically linked to a specific element, following specific element instance name parts will be used:

- `<CGI>` is the name of the `Communication Graph` Instance defined by the `shortName` of the `RIPS FlatInstanceDescriptor` referencing the `Communication Graph`.
- `<ExclusiveArea>` is the `shortName` of the `ExclusiveArea`.
- `<MMI>` is the `shortName` of the `RteModeMachineInstanceConfig` or `RteBswModeMachineInstanceConfig` container.
- `<DSMQ>` is the `shortName` of the `RteDistributedSharedModeQueue` or `RteBswModeMachineInstanceConfig` container.
- `<DE>` is the `shortName` of the `DataReceivedEvent`.

](SRS_Rte_00306)

7.2.2.2 Basic requirements on RTE Implementation Plug-In Service

The RTE Implementation Plug-In Services are intended to be used in the RTE's C-implementation. Hereby an important aspect is the fact that RTE APIs can

be implemented as C-functions and function like macros, see section 5.2.6.3. In case of function like macros the RTE implementation uses very likely comma expressions to return either the error code or a read return value. This requires that an [RTE Implementation Plug-In Service](#) can be used in such a comma expression.

[SWS_Rte_70030] [The [RTE Implementation Plug-In](#) shall implement every [RTE Implementation Plug-In Service](#) that it can be used in a comma expression.]([SRS_Rte_00306](#))

7.2.2.3 Basic requirements on RTE Implementation

7.2.2.3.1 Macro API implementations

API implementations as function like macros can have strange side effects. A special case is the nested call of APIs, e.g. an [Rte_DRead](#) as a parameter of an [Rte_Write](#). The user would naturally expect that the code of [Rte_DRead](#) is executed before entering into the [Rte_Write](#) API. But since macros are just text replacements, this is technically not the case. Instead, the [Rte_DRead](#) will be executed where the parameter is used inside the [Rte_Write](#). This can lead to various effects, such as undesired nesting of (RTE or [RTE Implementation Plug-Ins](#)) protection code or multiple executions of [Rte_DRead](#) with differing results. This has to be avoided.

[SWS_Rte_80025] [The RTE shall implement its code in a way to be robust against the undesired nesting of passed as macro parameter into the critical sections protected by the call of [RTE Implementation Plug-In Services](#), e.g. [Rte_Rips_StartRead](#), [Rte_Rips_StopRead](#), [Rte_Rips_StartWrite](#), and [Rte_Rips_StopWrite](#).]([SRS_Rte_00306](#), [SRS_Rte_00314](#))

Note: This can be achieved by either using real functions, inline functions, or by assigning the macro argument to an temporary variable outside the critical section.

7.2.3 API Data Types

[SWS_Rte_70087] [The [RTE Implementation Plug-In](#) shall determine the `<return>` type according to the [ImplementationDataType](#) applicable for the [global copy](#) or [parameter instance](#).]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00301](#))

Please note, that `<return>` is only applicable for primitive types, e.g. `uint8`, `float`.

[SWS_Rte_70088] [The [RTE Implementation Plug-In](#) shall determine the `<rips_return_ref>` type applicable for [global copy](#) according to [\[SWS_Rte_80041\]](#). Thereby the `<rips_return_ref>` type is a pointer to the *type of the global copy* using `P2VAR`.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00301](#))

In addition [RTE Implementation Plug-In Services](#) may use standard types or RTE specific types, e.g. `Std_TransformerError`. Those are not impacted by the usage of an [RTE Implementation Plug-In](#).

7.2.4 API Reference

7.2.4.1 Implicit buffer value access

7.2.4.1.1 Rte_Rips_IRead

[SWS_Rte_89000] [

Service Name	Rte_Rips_<PlugIn>_IRead_<SwcBswI>_<ExE>_<CGI>	
Syntax	<pre><return> Rte_Rips_<PlugIn>_IRead_<SwcBswI>_<ExE>_<CGI> (void)</pre>	
Service ID [hex]	0xE0	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	<return>	returns the value of the implicitly read primitive data.
Description	Rte_Rips_IRead returns the value of the implicitly read primitive data.	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

]()

Please note that the [Rte_Rips_IRead](#) Service is only applicable for [Local Software Cluster Communication Plug-Ins](#) since a [Cross Software Cluster Communication Plug-Ins](#) does not implement implicit communication buffering.

[SWS_Rte_70015] [The [associated Local Software Cluster Communication Plug-In](#) shall provide the [Rte_Rips_IRead](#) Service for each [VariableAccess](#) of a [RunnableEntity](#) in the role [dataReadAccess](#) and each [VariableAccess](#) in role [readLocalVariable](#) to an [implicitInterRunnableVariable](#) if

- for the related [Data Communication Graph](#) the [Local Software Cluster Communication Plug-In](#) support is enabled

AND

- where the data instance is typed by a primitive data type

AND

- the data instance is a [data element without status](#) according to [\[SWS_Rte_80041\]](#)

AND

- for the associated Local Software Cluster Communication Plug-In the `RtePluginSupportsIReadIWrite` is true.

]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_80010] [The RTE shall call `Rte_Rips_IRead` Service to implicitly read data if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- where the data instance is typed by a primitive data type

AND

- the data instance is a data element without status according to [\[SWS_Rte_80041\]](#)

AND

- for the associated Local Software Cluster Communication Plug-In the `RtePluginSupportsIReadIWrite` is true.

]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

7.2.4.1.2 Rte_Rips_IWrite

[SWS_Rte_89001] [

Service Name	Rte_Rips_<PlugIn>_IWrite_<SwcBswI>_<ExE>_<CGI>	
Syntax	<pre>void Rte_Rips_<PlugIn>_IWrite_<SwcBswI>_<ExE>_<CGI> (IN data)</pre>	
Service ID [hex]	0xE1	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	data	primitive data to write
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	Rte_Rips_IWrite writes the value of the implicitly written primitive data.	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

](

Please note that the `Rte_Rips_IWrite` Service is only applicable for Local Software Cluster Communication Plug-Ins since a Cross Software Cluster Communication Plug-Ins does not implement implicit communication buffering.

[SWS_Rte_70016] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_IWrite` Service for each `VariableAccess` of a `RunnableEntity` in the role `dataWriteAccess` and each `VariableAccess` in role `writtenLocalVariable` to an `implicitInterRunnableVariable` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- where the data instance is typed by a primitive data type

AND

- the data instance is a `data element without status` according to [\[SWS_Rte_80041\]](#)

AND

- for the associated RTE Implementation Plug-In the `RtePluginSupportsIReadIWrite` is true.

]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_80011] [The RTE shall call `Rte_Rips_IWrite` Service to implicitly write data if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- where the data instance is typed by a primitive data type

AND

- the data instance is a `data element without status` according to [\[SWS_Rte_80041\]](#)

AND

- for the associated Local Software Cluster Communication Plug-In the `RtePluginSupportsIReadIWrite` is true.

]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

7.2.4.2 Implicit buffer address access

7.2.4.2.1 Rte_Rips_IRBufferRef

[SWS_Rte_89002] [

Service Name	Rte_Rips_<PlugIn>_IRBufferRef_<SwcBswI>_<ExE>_<CGI>	
Syntax	<pre><rips_return_ref> Rte_Rips_<PlugIn>_IRBufferRef_<SwcBswI>_<ExE>_ <CGI> (void)</pre>	
Service ID [hex]	0xE2	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	<rips_return_ref>	Reference to the location in memory where the data values and optionally status can be read.
Description	Rte_Rips_IRBufferRef returns a pointer to the location in memory where the data value and status can be read. In case the SWC is provided as source code and not multiple instantiable, this macro is not guaranteed to resolve to a reference at compile time. It might also be resolved to a function or expression.	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

]()

Please note that the `Rte_Rips_IRBufferRef` Service is only applicable for Local Software Cluster Communication Plug-Ins since a Cross Software Cluster Communication Plug-Ins does not implement implicit communication buffering.

[SWS_Rte_70017] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_IRBufferRef` Service for each `VariableAccess` of a `RunnableEntity` in the role `dataReadAccess` and each `VariableAccess` in role `readLocalVariable` to an `implicitInterRunnableVariable` if for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled.]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_80012] [The RTE shall call `Rte_Rips_IRBufferRef` Service to get the address of the memory from which the value and/or status of an implicitly read data instance can be read. Thereby `Rte_Rips_IRBufferRef` shall only be applied if the usage of `Rte_Rips_IRead` is not applicable.(See [[SWS_Rte_80010](#)]).]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_80013] [The RTE shall initialize the related data handle for implicit read only access in the CDS with the `Rte_Rips_IRBufferRef` if the implicit data access needs to be implemented via a data handle in a `data handles section`

or an `inter runnable variable handles section`.] ([SRS_Rte_00306](#), [SRS_Rte_00301](#))

See also [[SWS_Rte_70108](#)].

Please note: A read only implicit access is required in case the `RunnableEntity` accesses an data element in an `RPortPrototype` or `PRPortPrototype` or the `RunnableEntity` has exclusive read access to an `implicitInterRunnableVariable`.

7.2.4.2.2 Rte_Rips_IWBufferRef

[[SWS_Rte_89003](#)] [

Service Name	Rte_Rips_<PlugIn>_IWBufferRef_<SwcBswI>_<ExE>_<CGI>	
Syntax	<pre><rips_return_ref> Rte_Rips_<PlugIn>_IWBufferRef_<SwcBswI>_<ExE>_ <CGI> (void)</pre>	
Service ID [hex]	0xE3	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	<rips_return_ref>	Reference to the location in memory where the data values and optionally status can be written.
Description	Rte_Rips_IWBufferRef returns a pointer to the implicitly written data element. In case the SWC is provided as source code and not multiple instantiable, this macro is not guaranteed to resolve to a reference at compile time. It might also be resolved to a function or expression.	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

]()

Please note that the `Rte_Rips_IWBufferRef` Service is only applicable for `Local Software Cluster Communication Plug-Ins` since a `Cross Software Cluster Communication Plug-Ins` does not implement implicit communication buffering.

[[SWS_Rte_70018](#)] [The `associated Local Software Cluster Communication Plug-In` shall provide the `Rte_Rips_IWBufferRef` Service for each `VariableAccess` of a `RunnableEntity` in the role `dataWriteAccess` and each `VariableAccess` in role `writtenLocalVariable` to an `implicitInterRunnableVariable` if for the related `Data Communication Graph` the `Local Software Cluster Communication Plug-In` support is enabled.] ([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[[SWS_Rte_80014](#)] [The RTE shall call `Rte_Rips_IWBufferRef` Service to get the address of the memory to which the value and/or status of an implicitly written data

instance can be written. Thereby `Rte_Rips_IWBufferRef` shall only be applied if the usage of `Rte_Rips_IWrite` is not applicable.(See [SWS_Rte_80011]).](SRS_Rte_00306, SRS_Rte_00301)

[SWS_Rte_80015] [The RTE shall initialize the related data handle for implicit write or implicit read-write access in the CDS with the `Rte_Rips_IWBufferRef` if the implicit data access needs to be implemented via a data handle in a `data handles section` or an `inter runnable variable handles section`.](SRS_Rte_00306, SRS_Rte_00301)

See also [SWS_Rte_70108].

Please note: A read-write implicit access is required in case the `RunnableEntity` accesses a data element in an `PRPortPrototype` or the `RunnableEntity` has read and write access to an `implicitInterRunnableVariable`. For read-write implicit access `Rte_Rips_IWBufferRef` Service applies as well.

7.2.4.3 Implicit communication buffer Fill Flush Routines

7.2.4.3.1 Rte_Rips_FillFlushRoutine

[SWS_Rte_89014] [

Service Name	<name of the Fill-Flush-Routine>
Syntax	<pre>void <name of the Fill-Flush-Routine> (void)</pre>
Service ID [hex]	0xEF
Sync/Async	Synchronous
Reentrancy	Conditional Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Performs buffer fill and flush operations for implicit communication
Available via	<code>Rte_Rips_<PlugIn>.h</code>

]()

Please note that the `Rte_Rips_FillFlushRoutine` Service is only applicable for `Local Software Cluster Communication Plug-Ins` since a `Cross Software Cluster Communication Plug-Ins` does not implement implicit communication buffering.

[SWS_Rte_70078] [The `associated Local Software Cluster Communication Plug-In` shall provide the `Rte_Rips_FillFlushRoutine` Service for each configured `RteRipsPluginFillFlushRoutineFnc`.](SRS_Rte_00306, SRS_Rte_00301)

Further details about the RTE usage of `Rte_Rips_FillFlushRoutine` are described in 7.3.4.7.1.

7.2.4.4 Explicit access protection

7.2.4.4.1 Rte_Rips_StartRead

[SWS_Rte_89004] [

Service Name	Rte_Rips_<PlugIn>_StartRead_<SwcBswI>[_<ExE>]_<CGI>
Syntax	<pre>void Rte_Rips_<PlugIn>_StartRead_<SwcBswI> [_<ExE>]_<CGI> (void)</pre>
Service ID [hex]	0xE4
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_StartRead starts the protection for explicit read access.
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h

]()

Please note that the `Rte_Rips_StartRead` Service is only applicable for Local Software Cluster Communication Plug-Ins since a Cross Software Cluster Communication Plug-Ins does not implement access protection for RTE code.

[SWS_Rte_70019] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_StartRead` Service for each `VariableDataPrototype` instance in an `AbstractRequiredPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role `dataReceivePointByArgument` or `dataReceivePointByValue` exists and

for each `VariableAccess` in role `readLocalVariable` to an `explicitInterRunnableVariable` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- for the associated Local Software Cluster Communication Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

] ([SRS_Rte_00306](#), [SRS_Rte_00300](#))

Please note: In case of protection of `explicitInterRunnableVariables` the name part `[_<ExE>]` exists.

[SWS_Rte_70020] [The `associated Local Software Cluster Communication Plug-In` shall provide the `Rte_Rips_StartRead` Service for each `BswVariableAccess` of a `BswModuleEntity` in the role `dataReceivePoint` if

- for the related `Data Communication Graph` the `Local Software Cluster Communication Plug-In` support is enabled

AND

- for the `associated Local Software Cluster Communication Plug-In` the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

] (`SRS_Rte_00306`, `SRS_Rte_00300`)

[SWS_Rte_80016] [The RTE shall call `Rte_Rips_StartRead` at the position and instead of the RTE's regular AUTOSAR get access protection action, e.g. `SuspendOsInterrupts()` or `GetResource()`, if for the related `Data Communication Graph` the `Local Software Cluster Communication Plug-In` support is enabled.] (`SRS_Rte_00306`, `SRS_Rte_00300`)

7.2.4.4.2 Rte_Rips_StopRead

[SWS_Rte_89005] [

Service Name	Rte_Rips_<PlugIn>_StopRead_<SwcBswI>[_<ExE>]_<CGI>
Syntax	<pre>void Rte_Rips_<PlugIn>_StopRead_<SwcBswI>[_<ExE>]_<CGI> (void)</pre>
Service ID [hex]	0xE5
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_StopRead stops the protection for explicit read access
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h

]()

Please note that the `Rte_Rips_StopRead` Service is only applicable for `Local Software Cluster Communication Plug-Ins` since a `Cross Software Cluster Communication Plug-Ins` does not implement access protection for RTE code.

[SWS_Rte_70021] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_StopRead` Service for each `VariableDataPrototype` instance in an `AbstractRequiredPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role `dataReceivePointByArgument` or `dataReceivePointByValue` exists and

for each `VariableAccess` in role `readLocalVariable` to an `explicitInterRunnableVariable` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- for the associated Local Software Cluster Communication Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

Please note: In case of protection of `explicitInterRunnableVariables` the name part [`_<ExE>`] exists.

[SWS_Rte_70022] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_StopRead` Service for each `BswVariableAccess` of a `BswModuleEntity` in the role `dataSendPoint` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- for the associated Local Software Cluster Communication Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

[SWS_Rte_80017] [The RTE shall call `Rte_Rips_StopRead` at the position and instead of the RTE's regular AUTOSAR release access protection action, e.g. `ResumeOsInterrupts()` or `ReleaseResource()`, if for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled.]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

7.2.4.4.3 Rte_Rips_StartWrite

[SWS_Rte_89006] [

Service Name	Rte_Rips_<PlugIn>_StartWrite_<SwcBswI>[_<ExE>]_<CGI>
Syntax	<pre> void Rte_Rips_<PlugIn>_StartWrite_<SwcBswI>[_<ExE>]_<CGI> (void) </pre>
Service ID [hex]	0xE6
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_StartWrite starts the protection for explicit write access.
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h

](()

Please note that the `Rte_Rips_StartWrite` Service is only applicable for Local Software Cluster Communication Plug-Ins since a Cross Software Cluster Communication Plug-Ins does not implement access protection for RTE code.

[SWS_Rte_70023] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_StartWrite` Service for each `VariableDataPrototype` instance in an `AbstractProvidedPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role `dataSendPoint` exists

and for each `VariableAccess` in role `writtenLocalVariable` to an `explicitInterRunnableVariable` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- for the associated Local Software Cluster Communication Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

Please note: In case of protection of `explicitInterRunnableVariables` the name part `[_<ExE>]` exists.

[SWS_Rte_70024] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_StartWrite` Service for each `BswVariableAccess` of a `BswModuleEntity` in the role `dataSendPoint` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- for the associated Local Software Cluster Communication Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

[SWS_Rte_80018] [The RTE shall call `Rte_Rips_StartWrite` at the position and instead of the RTE's regular AUTOSAR get access protection action, e.g. `SuspendOsInterrupts()` or `GetResource()`, if for the related [Data Communication Graph](#) the Local Software Cluster Communication Plug-In support is enabled.]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

7.2.4.4.4 Rte_Rips_StopWrite

[SWS_Rte_89007] [

Service Name	<code>Rte_Rips_<PlugIn>_StopWrite_<SwcBswI>[_<ExE>]_<CGI></code>
Syntax	<pre>void Rte_Rips_<PlugIn>_StopWrite_<SwcBswI>[_<ExE>]_<CGI> (void)</pre>
Service ID [hex]	0xE7
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	<code>Rte_Rips_StopWrite</code> stops the protection for explicit write access.
Available via	<code>Rte_Rips_<PlugIn>_<SwcBswI>.h</code>

](

Please note that the `Rte_Rips_StopWrite` Service is only applicable for Local Software Cluster Communication Plug-Ins since a Cross Software Cluster Communication Plug-Ins does not implement access protection for RTE code.

[SWS_Rte_70025] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_StopWrite` Service for each `VariableDataPrototype` instance in an `AbstractProvidedPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role `dataSendPoint` exists

and for each `VariableAccess` in role `writtenLocalVariable` to an `explicit-InterRunnableVariable` if

- for the related [Data Communication Graph](#) the [Local Software Cluster Communication Plug-In](#) support is enabled

AND

- for the associated [Local Software Cluster Communication Plug-In](#) the [RteRipsGlobalCopyInstantiationPolicy](#) is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

Please note: In case of protection of [explicitInterRunnableVariables](#) the name part [`__<ExE>`] exists.

[SWS_Rte_70026] [The [associated Local Software Cluster Communication Plug-In](#) shall provide the [Rte_Rips_StopWrite](#) Service for each [BswVariableAccess](#) of a [BswModuleEntity](#) in the role [dataSendPoint](#) if

- for the related [Data Communication Graph](#) the [Local Software Cluster Communication Plug-In](#) support is enabled

AND

- for the associated [Local Software Cluster Communication Plug-In](#) the [RteRipsGlobalCopyInstantiationPolicy](#) is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

[SWS_Rte_80019] [The RTE shall call [Rte_Rips_StopWrite](#) at the position and instead of the RTE's regular AUTOSAR release access protection action, e.g. `ResumeOsInterrupts()` or `ReleaseResource()`, if for the related [Data Communication Graph](#) the [associated Local Software Cluster Communication Plug-In](#) support is enabled.]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

7.2.4.5 Explicit data access services

7.2.4.5.1 Rte_Rips_Read

[SWS_Rte_89010]{OBSOLETE} [

Service Name	Rte_Rips_<PlugIn>_Read_<SwcBswI>[_<ExE>]_<CGI> (obsolete)
Syntax	<pre>Std_ReturnType Rte_Rips_<PlugIn>_Read_<SwcBswI>[_<ExE>]_<CGI> (OUT <data>, [Std_TransformerError transformerError])</pre>
Service ID [hex]	0xEA





Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	<data>	The OUT parameter <data> pass back the received data.
	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	Std_ReturnType	The return value is used to indicate communication errors.
Description	Rte_Rips_Read Performs an "explicit" read on a sender-receiver communication data element. Tags: atp.Status=obsolete	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

|()

Please note that [SWS_Rte_89010] is set to obsolete and will be replaced by [SWS_Rte_89020] to support Cross Software Cluster Communication Plug-Ins.

[SWS_Rte_89020]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_Read_[<SwcBswI>][Partition][_<ExE>]_<CGI>(draft)	
Syntax	<pre>Std_ReturnType Rte_Rips_<PlugIn>_Read_[<SwcBswI>][Partition][_<ExE>]_<CGI> (OUT <data>, [Std_TransformerError transformerError])</pre>	
Service ID [hex]	0xEA	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	<data>	The OUT parameter <data> pass back the received data.
	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	Std_ReturnType	The return value is used to indicate communication errors.
Description	Rte_Rips_Read Performs an "explicit" read on a sender-receiver communication data element.	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

|([SRS_Rte_00300](#), [SRS_Rte_00301](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

Please note that the Rte_Rips_Read Service is applicable for Local Software Cluster Communication Plug-Ins and Cross Software Cluster Communication Plug-Ins.

[SWS_Rte_70050] [The associated Local Software Cluster Communication Plug-In shall provide the Rte_Rips_Read Service for each Variable-DataPrototype instance in an AbstractRequiredPortPrototype for which an

`VariableAccess` of a `RunnableEntity` in the role `dataReceivePointByArgument` or `dataReceivePointByValue` exists and for each `VariableAccess` in role `readLocalVariable` to an `explicitInterRunnableVariable` if

- for the related `Data Communication Graph` the `Local Software Cluster Communication Plug-In` support is enabled

AND

- for the associated `Local Software Cluster Communication Plug-In` the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`

OR

- a data transformation is configured according [SWS_Rte_08794] or [SWS_Rte_08105].

](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00303)

Please note: In case the related `VariableDataPrototype` resolves to a `Primitive Implementation Data Type`, service `Rte_Rips_DRead` is available as an alternative. In case of protection of `explicitInterRunnableVariables` the name part [`<ExE>`] exists.

[SWS_Rte_70051] [The associated `Local Software Cluster Communication Plug-In` shall provide the `Rte_Rips_Read` Service for each `BswVariableAccess` of a `BswModuleEntity` in the role `dataReceivePoint` if

- for the related `Data Communication Graph` the `Local Software Cluster Communication Plug-In` support is enabled

AND

- for the associated `Local Software Cluster Communication Plug-In` the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`.

](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00303)

[SWS_Rte_70127]{DRAFT} [The associated `Cross Software Cluster Communication Plug-In` shall provide the `Rte_Rips_Read` Service for each `VariableDataPrototype` instance in an `AbstractRequiredPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role `dataReceivePointByArgument` exists if

- for the related `Data Communication Graph` the `Cross Software Cluster Communication Plug-In` support is enabled

AND

- for the `dataElement` “event” semantics (`swImplPolicy` = `queued`) applies.

]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_70128]{DRAFT} [In case of the existence condition described in [\[SWS_Rte_70050\]](#), [\[SWS_Rte_70050\]](#), [\[SWS_Rte_70127\]](#) the optional name part [`<SwcBswI>`] exists for the related `Rte_Rips_Read` Services.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_70129]{DRAFT} [The associated Cross Software Cluster Communication Plug-In shall provide the `Rte_Rips_Read` Service once for each partition which has a software component mapped to it where the software component has a `VariableDataPrototype` instance in an `AbstractRequiredPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role

- `dataReceivePointByArgument`
- or
- `dataReceivePointByValue`
- or
- `dataReadAccess`

exists.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_70130]{DRAFT} [In case of the existence condition described in [\[SWS_Rte_70129\]](#) the optional name part [`Partition`] exists for the related `Rte_Rips_Read` Services.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_70052] [The optional OUT parameter `transformerError` of the `Rte_Rips_Read` service shall be generated according [\[SWS_Rte_08563\]](#).]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

The return value is used to indicate errors detected by the `RTE Implementation Plug-In` during execution of the `Rte_Rips_Read` service call or errors detected by the communication system.

- **[SWS_Rte_70053]** [`RTE_E_OK` – data read successfully.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#))
- **[SWS_Rte_70054]** [`RTE_E_HARD_TRANSFORMER_ERROR` – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70055]** [`RTE_E_SOFT_TRANSFORMER_ERROR` – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70100]** [`RTE_E_NO_DATA` – (explicit non-blocking read) no events were received and no other error occurred when the read was attempted.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#))

- **[SWS_Rte_70101]** [RTE_E_LOST_DATA – Indicates that some incoming data has been lost due to an overflow of the receive queue or due to an error of the underlying communication layers. This is not an error of the data returned in the parameters. This [Overlayed Error](#) can be combined with any other error.] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00107](#), [SRS_Rte_00110](#), [SRS_Rte_00094](#))
- **[SWS_Rte_70125]{DRAFT}** [RTE_E_UNCONNECTED – Indicates that the receiver port is not connected] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00200](#), [SRS_Rte_00094](#))

[SWS_Rte_70126]{DRAFT} [In case of multiple faults during a call of [RteRips_Read](#) the resulting return value shall be derived according to the following priority rules (highest priority first):

1. RTE_E_UNCONNECTED
2. RTE_E_HARD_TRANSFORMER_ERROR
3. RTE_E_SOFT_TRANSFORMER_ERROR
4. RTE_E_NO_DATA

] ([SRS_Rte_00028](#), [SRS_Rte_00306](#), [SRS_Rte_00300](#))

[SWS_Rte_80065] [The RTE shall call [RteRips_Read](#) or [RteRips_DRead](#) at the position and instead of the RTE's regular read access to the data, if

- for the related [Data Communication Graph](#) the [Local Software Cluster Communication Plug-In](#) support is enabled

AND

- for the associated [Local Software Cluster Communication Plug-In](#) the [RteRipsGlobalCopyInstantiationPolicy](#) is set to RTE_RIPS_INSTANTIATION_BY_PLUGIN.

] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_80100] [The RTE shall call [RteRips_Read](#) or [RteRips_DRead](#) at the position and instead of the RTE's regular access to the transformed data, if

- for the related [Data Communication Graph](#) the [Local Software Cluster Communication Plug-In](#) support is enabled

AND

- a data transformation is configured according [\[SWS_Rte_08794\]](#) or [\[SWS_Rte_08105\]](#).

] ([SRS_Rte_00306](#), [SRS_Rte_00300](#))

[SWS_Rte_80148]{DRAFT} [The RTE shall call `Rte_Rips_Read` at the position and instead of the RTE's regular read access to the data, if for the related `Data Communication Graph` the `Cross Software Cluster Communication Plug-In` support is enabled.

In case of explicit communication (queued or last is the best) the the usage is expected in the context of the `Rte_Receive` or `Rte_Read` API.

In case of implicit communication the the usage is expected in the context where the RTE would fill the buffers of the `preemption area` in the OS tasks where `RunnableEntitys` with implicit access to related `Data Communication Graph` are mapped to it .

In case of data element with status the return value of `Rte_Rips_Read` is used to determine the data elements status.

And yet the `Rte_Rips_Read` related to the partition where the OS tasks belongs shall be applied.]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

[SWS_Rte_80149]{DRAFT} [The RTE shall call the `Rte_Rips_Read` Services created according to [[SWS_Rte_70051](#)], [[SWS_Rte_70127](#)], and [[SWS_Rte_70129](#)] for the related `Data Communication Graph` on which `Local Software Cluster Communication Plug-In` and `Cross Software Cluster Communication Plug-In` has been enabled in the following order:

- first the `Rte_Rips_Read` Service created according the `Local Software Cluster Communication Plug-In` and then
- the `Rte_Rips_Read` Service created according the `Cross Software Cluster Communication Plug-In`

]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

7.2.4.5.2 Rte_Rips_Write

[SWS_Rte_89011]{OBSOLETE} [

Service Name	Rte_Rips_<PlugIn>_Write_<SwcBswI>[_<ExE>]_<CGI> (obsolete)	
Syntax	<pre>Std_ReturnType Rte_Rips_<PlugIn>_Write_<SwcBswI>[_<ExE>]_<CGI> (IN <data>, [Std_TransformerError transformerError])</pre>	
Service ID [hex]	0xEB	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	<data>	The IN parameter <data> pass the received data.





Parameters (inout)	None	
Parameters (out)	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	Std_ReturnType	The return value is used to indicate communication errors.
Description	Rte_Rips_Write Performs an "explicit" write on a sender-receiver communication data element. Tags: atp.Status=obsolete	
Available via	Rte_Rips_<PlugIn>_<SwcBswl>.h	

⌋()

Please note that [SWS_Rte_89011] is set to `obsolete` and will be replaced by [SWS_Rte_89021] to support Cross Software Cluster Communication Plug-Ins.

[SWS_Rte_89021]{DRAFT} ⌈

Service Name	Rte_Rips_<PlugIn>_Write_<SwcBswl>[Partition]<ExE>_<CGI>(draft)	
Syntax	<pre>Std_ReturnType Rte_Rips_<PlugIn>_Write_<SwcBswl> [Partition] [<ExE>]_<CGI> (IN <data>, [Std_TransformerError transformerError])</pre>	
Service ID [hex]	0xEB	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	<data>	The IN parameter <data> pass the received data.
Parameters (inout)	None	
Parameters (out)	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	Std_ReturnType	The return value is used to indicate communication errors.
Description	Rte_Rips_Write Performs an "explicit" write on a sender-receiver communication data element.	
Available via	Rte_Rips_<PlugIn>_<SwcBswl>.h	

⌋(SRS_Rte_00300, SRS_Rte_00301, SRS_Rte_00306, SRS_BSW_00310)

Please note that the `Rte_Rips_Write` Service is applicable for Local Software Cluster Communication Plug-Ins and Cross Software Cluster Communication Plug-Ins.

[SWS_Rte_70056] ⌈The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_Write` Service for each `VariableDataPrototype` instance in an `AbstractProvidedPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role `dataSendPoint` exists

and for each `VariableAccess` in role `writtenLocalVariable` to an `explicit-InterRunnableVariable` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- for the associated Local Software Cluster Communication Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`.

OR

- a data transformation is configured according [SWS_Rte_08794] or [SWS_Rte_08105].

](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00303)

Please note: In case of protection of `explicitInterRunnableVariables` the name part [`__<ExE>`] exists.

[SWS_Rte_70057] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_Write` Service for each `BswVariableAccess` of a `BswModuleEntity` in the role `dataSendPoint` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- for the associated Local Software Cluster Communication Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`.

](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00303)

[SWS_Rte_70131]{DRAFT} [The associated Cross Software Cluster Communication Plug-In shall provide the `Rte_Rips_Wrie` Service for each `VariableDataPrototype` instance in an `AbstractProvidedPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role `dataSendPoint` exists if

- for the related Data Communication Graph the Cross Software Cluster Communication Plug-In support is enabled

AND

- for the `dataElement` “event” semantics (`swImplPolicy` = `queued`) applies.

](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00303)

[SWS_Rte_70132]{DRAFT} [In case of the existence condition described in [SWS_Rte_70056], [SWS_Rte_70057], [SWS_Rte_70131] the optional name part [`<SwcBswI>`] exists for the related `Rte_Rips_Write` Services.](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00303)

[SWS_Rte_70133]{DRAFT} [The associated Cross Software Cluster Communication Plug-In shall provide the `Rte_Rips_Write` Service once for each partition which has a software component mapped to it where the software

component has a `VariableDataPrototype` instance in an `AbstractProvidedPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role

- `dataSendPoint`
- or
- `dataWriteAccess`

exists.] (*SRS_Rte_00306*, *SRS_Rte_00300*, *SRS_Rte_00303*)

[SWS_Rte_70134]{DRAFT} [In case of the existence condition described in *[SWS_Rte_70133]* the optional name part `[Partition]` exists for the related `Rte_Rips_Write` Services.] (*SRS_Rte_00306*, *SRS_Rte_00300*, *SRS_Rte_00303*)

[SWS_Rte_70058] [The optional OUT parameter `transformerError` of the `Rte_Rips_Write` service shall be generated according to *[SWS_Rte_08574]*.] (*SRS_Rte_00306*, *SRS_Rte_00300*)

The return value is used to indicate errors detected by the `RTE Implementation Plug-In` during execution of the `Rte_Rips_Write` service call or errors detected by the communication system.

- **[SWS_Rte_70059]** [`RTE_E_OK` – data written successfully.] (*SRS_Rte_00306*, *SRS_Rte_00300*, *SRS_Rte_00094*)
- **[SWS_Rte_70060]** [`RTE_E_HARD_TRANSFORMER_ERROR` – The return value of one transformer in the transformer chain represented a hard transformer error.] (*SRS_Rte_00306*, *SRS_Rte_00300*, *SRS_Rte_00094*, *SRS_Rte_00091*)
- **[SWS_Rte_70061]** [`RTE_E_SOFT_TRANSFORMER_ERROR` – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.] (*SRS_Rte_00306*, *SRS_Rte_00300*, *SRS_Rte_00094*, *SRS_Rte_00091*)
- **[SWS_Rte_70102]** [`RTE_E_LIMIT` – an ‘event’ has been discarded due to a full queue by one of the ECU local receivers (intra ECU communication only).] (*SRS_Rte_00306*, *SRS_Rte_00300*, *SRS_Rte_00143*)

[SWS_Rte_70138]{DRAFT} [In case of multiple faults during a call of `Rte_Rips_Write` the resulting return value shall be derived according to the following priority rules (highest priority first):

1. `RTE_E_LIMIT`
2. `RTE_E_HARD_TRANSFORMER_ERROR`
3. `RTE_E_SOFT_TRANSFORMER_ERROR`

] (*SRS_Rte_00028*, *SRS_Rte_00306*, *SRS_Rte_00300*)

[SWS_Rte_80066] [The RTE shall call `Rte_Rips_Write` at the position and instead of the RTE’s regular write access to the data, if

- for the related [Data Communication Graph](#) the [Local Software Cluster Communication Plug-In](#) support is enabled

AND

- for the associated [Local Software Cluster Communication Plug-In](#) the [RteRipsGlobalCopyInstantiationPolicy](#) is set to [RTE_RIPS_INSTANTIATION_BY_PLUGIN](#).

]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_80101] [The RTE shall call [Rte_Rips_Write](#) at the position and instead of the RTE's regular access to the data transformer, if

- for the related [Data Communication Graph](#) the [Local Software Cluster Communication Plug-In](#) support is enabled

AND

- a data transformation is configured according to [\[SWS_Rte_08794\]](#) or [\[SWS_Rte_08105\]](#).

]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

[SWS_Rte_80150]{DRAFT} [The RTE shall call [Rte_Rips_Write](#) at the position and instead of the RTE's regular read access to the data, if for the related [Data Communication Graph](#) the [Cross Software Cluster Communication Plug-In](#) support is enabled.

In case of explicit communication (queued or last is the best) the the usage is expected in the context of the [Rte_Send](#) or [Rte_Write](#) API.

In case of implicit communication the the usage is expected in the context where the RTE would flush the buffers of the [preemption area](#) in the OS tasks where [RunnableEntity](#)s with implicit access to related [Data Communication Graph](#) are mapped to.

And yet the [Rte_Rips_Write](#) related to the partition where the OS tasks belongs shall be applied.]([SRS_Rte_00306](#), [SRS_Rte_00300](#))

[SWS_Rte_80151]{DRAFT} [The RTE shall call the [Rte_Rips_Write](#) Services created according to [\[SWS_Rte_70056\]](#), [\[SWS_Rte_70131\]](#), and [\[SWS_Rte_70133\]](#) for the related [Data Communication Graph](#) on which [Local Software Cluster Communication Plug-In](#) and [Cross Software Cluster Communication Plug-In](#) has been enabled in the following order:

- first the [Rte_Rips_Write](#) Service created according the [Local Software Cluster Communication Plug-In](#) and then
- the [Rte_Rips_Write](#) Service created according the [Cross Software Cluster Communication Plug-In](#)

]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

7.2.4.5.3 Rte_Rips_DRead

[SWS_Rte_91112] [

Service Name	Rte_Rips_<PlugIn>_DRead_<SwcBswI>[_<ExE>]_<CGI>	
Syntax	<pre><return> Rte_Rips_<PlugIn>_DRead_<SwcBswI> [_<ExE>]_<CGI> ([Std_TransformerError transformerError])</pre>	
Service ID [hex]	0xFF	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	<return>	Return value provides access to the data value of the Variable DataPrototype. For details of the <return> value definition see section 5.2.6.6.
Description	Rte_Rips_DRead Performs an "explicit" read on a sender-receiver communication data element typed by a primitive data type.	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

]()

Please note that [SWS_Rte_91112] will be replaced by [SWS_Rte_91122] to support Cross Software Cluster Communication Plug-Ins.

[SWS_Rte_91122]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_DRead_<SwcBswI>[Partition][_<ExE>]_<CGI>(draft)	
Syntax	<pre><return> Rte_Rips_<PlugIn>_DRead_<SwcBswI> [Partition] [_<ExE>]_< CGI> ([Std_TransformerError transformerError])</pre>	
Service ID [hex]	0xFF	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	<return>	Return value provides access to the data value of the Variable DataPrototype. For details of the <return> value definition see section 5.2.6.6.
Description	Rte_Rips_DRead Performs an "explicit" read on a sender-receiver communication data element typed by a primitive data type.	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

] (SRS_Rte_00300, SRS_Rte_00301, SRS_Rte_00306, SRS_BSW_00310, SRS_Rte_00183)

[SWS_Rte_08910] [The associated Local Software Cluster Communication Plug-In shall provide the `RteRips_DRead` Service for each `VariableDataPrototype` instance in an `AbstractRequiredPortPrototype` for which an `VariableAccess` of a `RunnableEntity` in the role `dataReceivePointByValue` exists and for each `VariableAccess` in role `readLocalVariable` to an `explicitInterRunnableVariable` if

- for the related Data Communication Graph the Local Software Cluster Communication Plug-In support is enabled

AND

- the related `VariableDataPrototype` resolves to `Primitive Implementation Data Type`

AND

- for the associated Local Software Cluster Communication Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`.

OR

- a data transformation is configured according **[SWS_Rte_08794]** or **[SWS_Rte_08105]**.

](*SRS_Rte_00306*, *SRS_Rte_00300*, *SRS_Rte_00303*)

Please note: The service is provided only if the related `VariableDataPrototype` resolves to `Primitive Implementation Data Type`. Otherwise, **[SWS_Rte_70050]** applies. In case of protection of `explicitInterRunnableVariables` the name part [`<ExE>`] exists.

[SWS_Rte_70139]{DRAFT} [The associated Cross Software Cluster Communication Plug-In shall provide the `RteRips_DRead` Service once for each partition which has a software component mapped to it with a `VariableDataPrototype` instance in an `AbstractRequiredPortPrototype` where

- a `VariableAccess` of a `RunnableEntity` in the role `dataReceivePointByValue` exists,

AND

- for the related Data Communication Graph the Cross Software Cluster Communication Plug-In support is enabled,

AND

- the related `VariableDataPrototype` resolves to a `Primitive Implementation Data Type`.

](*SRS_Rte_00306*, *SRS_Rte_00300*, *SRS_Rte_00303*)

[SWS_Rte_70140]{DRAFT} [In case of the existence condition described in [SWS_Rte_70139] the optional name part [Partition] exists for the related `Rte_Rips_DRead` Services.] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

7.2.4.6 ExclusiveArea protection

7.2.4.6.1 Rte_Rips_Enter

[SWS_Rte_89008] [

Service Name	<code>Rte_Rips_<PlugIn>_Enter_<SwcBswI>[_<Event>/_<ExE>]_<ExclusiveArea></code>
Syntax	<pre>void Rte_Rips_<PlugIn>_Enter_<SwcBswI>[_<Event>/_<ExE>]_<ExclusiveArea> (void)</pre>
Service ID [hex]	0xE8
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	<code>Rte_Rips_Enter</code> starts the protection of an <code>ExclusiveArea</code> .
Available via	<code>Rte_Rips_<PlugIn>_<SwcBswI>.h</code> or <code>Rte_Rips_<PlugIn>.h</code>

]()

Please note that the `Rte_Rips_Enter` Service is only applicable for a `Local Software Cluster Communication Plug-Ins`.

[SWS_Rte_70027] [The `associated Local Software Cluster Communication Plug-In` shall provide the `Rte_Rips_Enter` Service for all following cases:

- for each `RTEEvent` with a `startOnEvent` to `RunnableEntity` with a `runsInsideExclusiveArea` association with the name parts `<SwcBswI>`, `<Event>`, and `<ExclusiveArea>`
- for each `BswEvent` with a `startsOnEvent` to `BswModuleEntity` with a `runsInsideExclusiveArea` association with the name parts `<SwcBswI>`, `<Event>`, and `<ExclusiveArea>`
- for each `ExecutableEntity` with a `canEnterExclusiveArea` association if the `ExclusiveArea's SwcExclusiveAreaPolicy/ BswExclusiveAreaPolicy.apiPrinciple` is set to `perExecutable` with the name parts `<SwcBswI>`, `<ExE>`, and `<ExclusiveArea>`

- for each `ExclusiveArea` referenced by a `canEnterExclusiveArea` association if the `ExclusiveArea`'s `SwcExclusiveAreaPolicy/BswExclusiveAreaPolicy.apiPrinciple` is set to `common` with the name parts `<SwcBswI>` and `<ExclusiveArea>`

if the `Local Software Cluster Communication Plug-In` support is enabled for the related `ExclusiveArea`.] ([SRS_Rte_00302](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

[SWS_Rte_80020] [The RTE shall call `Rte_Rips_Enter` at the position and instead of the RTE's regular `ExclusiveArea` implementation mechanism, if the `Local Software Cluster Communication Plug-In` support is enabled for the related `ExclusiveArea`.] ([SRS_Rte_00302](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

For more details see section 7.3.5.

7.2.4.6.2 Rte_Rips_Exit

[SWS_Rte_89009] [

Service Name	Rte_Rips_<PlugIn>_Exit_<SwcBswI>[_<Event>/_<ExE>]_<ExclusiveArea>
Syntax	<pre>void Rte_Rips_<PlugIn>_Exit_<SwcBswI>[_<Event>/_<ExE>]_<ExclusiveArea> (void)</pre>
Service ID [hex]	0xE9
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_Exit stops the protection of an ExclusiveArea.
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h or Rte_Rips_<PlugIn>.h

]()

Please note that the `Rte_Rips_Exit` Service is only applicable for a `Local Software Cluster Communication Plug-Ins`.

[SWS_Rte_70028] [The associated `Local Software Cluster Communication Plug-In` shall provide the `Rte_Rips_Exit` Service for all following cases:

- for each `RTEEvent` with a `startOnEvent` to `RunnableEntity` with a `runsInsideExclusiveArea` association with the name parts `<SwcBswI>`, `<Event>`, and `<ExclusiveArea>`

- for each `BswEvent` with a `startsOnEvent` to `BswModuleEntity` with a `runsInsideExclusiveArea` association with the name parts `<SwcBswI>`, `<Event>`, and `<ExclusiveArea>`
- for each `ExecutableEntity` with a `canEnterExclusiveArea` association if the `ExclusiveArea`'s `SwcExclusiveAreaPolicy/BswExclusiveAreaPolicy.apiPrinciple` is set to `perExecutable` with the name parts `<SwcBswI>`, `<ExE>`, and `<ExclusiveArea>`
- for each `ExclusiveArea` referenced by a `canEnterExclusiveArea` association if the `ExclusiveArea`'s `SwcExclusiveAreaPolicy/BswExclusiveAreaPolicy.apiPrinciple` is set to `common` with the name parts `<SwcBswI>` and `<ExclusiveArea>`

]([SRS_Rte_00302](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

[SWS_Rte_80021] [The RTE shall call `Rte_Rips_Exit` at the position and instead of the RTE's regular `ExclusiveArea` implementation mechanism, if the `Local Software Cluster Communication Plug-In` support is enabled for the related `ExclusiveArea`.]([SRS_Rte_00302](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

For more details see section [7.3.5](#).

7.2.4.7 Mode queue protection functions

7.2.4.7.1 Rte_Rips_EnterModeQueue

[SWS_Rte_91100] [

Service Name	<code>Rte_Rips_<PlugIn>_EnterModeQueue_<MMI/DSMQ></code>
Syntax	<pre>void Rte_Rips_<PlugIn>_EnterModeQueue_<MMI/DSMQ> (void)</pre>
Service ID [hex]	0xF4
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	<code>Rte_Rips_EnterModeQueue</code> starts the protection for enqueue, dequeue, and read operations in a mode machine instance or distributed shared mode queue.
Available via	<code>Rte_Rips_<PlugIn>.h</code>

](

[SWS_Rte_70096] [The associated `Local Software Cluster Communication Plug-In` shall provide the `Rte_Rips_EnterModeQueue` Service if the `Local Software Cluster Communication Plug-In` support is enabled for the related

mode machine instance or distributed shared mode queue .](SRS_Rte_00315)

[SWS_Rte_80080] [The RTE shall call `Rte_Rips_EnterModeQueue` at the position and instead of the RTE's regular AUTOSAR get access protection action for the mode queue, e.g. `SuspendOsInterrupts()` or `GetResource()`, if for the related mode machine instance or distributed shared mode queue the Local Software Cluster Communication Plug-In support is enabled.](SRS_Rte_00315)

7.2.4.7.2 Rte_Rips_ExitModeQueue

[SWS_Rte_91101] [

Service Name	Rte_Rips_<PlugIn>_ExitModeQueue_<MMI/DSMQ>
Syntax	<pre>void Rte_Rips_<PlugIn>_ExitModeQueue_<MMI/DSMQ> (void)</pre>
Service ID [hex]	0xF5
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_ExitModeQueue stops the protection for enqueue, dequeue, and read operations in a mode machine instance or distributed shared mode queue.
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_70097] [The associated Local Software Cluster Communication Plug-In shall provide the `Rte_Rips_ExitModeQueue` Service if the Local Software Cluster Communication Plug-In support is enabled for the related mode machine instance or distributed shared mode queue .](SRS_Rte_00315)

[SWS_Rte_80081] [The RTE shall call `Rte_Rips_ExitModeQueue` at the position and instead of the RTE's regular AUTOSAR release access protection action, e.g. `ResumeOsInterrupts()` or `ReleaseResource()`, if for the related mode machine instance or distributed shared mode queue the Local Software Cluster Communication Plug-In support is enabled.](SRS_Rte_00315)

7.2.4.8 Cross cluster mode communication functions

[SWS_Rte_91113]{DRAFT} [

Name	Rte_Rips_SwitchNotificationStatusType (draft)		
Kind	Type		
Derived from	uint8		
Range	RTE_SWITCH_NOTIFICATION_SKIP	0x00	mode switch notification cannot be dequeued
	RTE_SWITCH_NOTIFICATION_ENQUEUED_FIRST	0x01	mode switch notification is enqueued into an empty mode queue
	RTE_SWITCH_NOTIFICATION_ENQUEUED_NOT_FIRST	0x02	mode switch notification is enqueued into a non empty mode queue
	RTE_SWITCH_NOTIFICATION_ENQUEUE_FAILED	0x03	enqueue operation into a non empty mode queue failed
	RTE_SWITCH_NOTIFICATION_DEQUEUED_LAST	0x04	last mode switch notification was enqueued from mode queue
	RTE_SWITCH_NOTIFICATION_DEQUEUED_NOT_LAST	0x05	mode switch notification was enqueued from mode queue, further mode switch notifications are in the queue
Description	Status of the en- and dequeue operation on a mode queue Tags: atp.Status=draft		
Available via	Rte_Type.h		

]([SRS_Rte_00321](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

7.2.4.8.1 Rte_Rips_Switch

[SWS_Rte_91114]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_Switch_<BswSwcI>_<MMI> (draft)	
Syntax	<pre>void Rte_Rips_<PlugIn>_Switch_<BswSwcI>_<MMI> (Rte_Rips_SwitchNotificationStatusType switchNotificationStatus , uint32 previousmode, uint32 nextmode)</pre>	
Service ID [hex]	0xB0	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	switchNotificationStatus	Status of the enqueue operation
	previousmode	The value of the ModeDeclaration of the mode being left
	nextmode	The value of the ModeDeclaration of the mode being entered
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	





Description	Rte_Rips_StartModeSwitch notifies the RTE Implementation Plug-In about an enqueue operation in a mode queue. Tags: atp.Status=draft
Available via	Rte_Rips_<PlugIn>.h

]([SRS_Rte_00321](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

[SWS_Rte_70122] [The [Cross Software Cluster Communication Plug-In](#) assigned to the [Mode Communication Graph](#) where the mode switch port is provided for other [Software Clusters](#) shall provide the [Rte_Rips_Switch](#) Service.] ([SRS_Rte_00321](#))

7.2.4.8.2 Rte_Rips_DequeueModeSwitch

[SWS_Rte_91115]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_DequeueModeSwitch_<MMI>_<OsTask> (draft)	
Syntax	<pre>Rte_Rips_SwitchNotificationStatusType Rte_Rips_<PlugIn> _DequeueModeSwitch_<MMI>_<OsTask> (void)</pre>	
Service ID [hex]	0xB1	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	Rte_Rips_SwitchNotificationStatusType	The return value is used indicate the status of the dequeue operation in a mode queue
Description	Rte_Rips_DequeueModeSwitch dequeues a mode switch notification from the mode queue when it is called after the last on-entry ExecutableEntity terminated. Tags: atp.Status=draft	
Available via	Rte_Buffers.h	

]([SRS_Rte_00321](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

[SWS_Rte_80141] [The RTE in an [Applicative Software Cluster](#) shall provide the [Rte_Rips_DequeueModeSwitch](#) function for each mode switch task if the [Cross Software Cluster Communication Plug-In](#) support for a [Mode Communication Graph](#) is enabled where the mode is provided to other [Software Clusters](#).] ([SRS_Rte_00321](#))

7.2.4.9 Distributed Shared Mode Queue schedule synchronization functions

[SWS_Rte_91102] [

Name	Rte_DsmqStatusType		
Kind	Type		
Derived from	uint8		
Range	RTE_DSMQ_ENQUEUED_FIRST	0x01	mode switch notification is enqueued into an empty distributed shared mode queue
	RTE_DSMQ_ENQUEUED_NOT_FIRST	0x02	mode switch notification is enqueued into a non empty distributed shared mode queue
	RTE_DSMQ_ENQUEUE_FAILED	0x03	enqueue operation into a non empty distributed shared mode queue failed
	RTE_DSMQ_DEQUEUED_LAST	0x04	last mode switch notification was enqueued from distributed shared mode queue
	RTE_DSMQ_DEQUEUED_NOT_LAST	0x05	mode switch notification was enqueued from distributed shared mode queue, further mode switch notifications are in the queue
Description	Status of the enqueue operation on a distributed shared mode queue		
Available via	Rte_Type.h		

]()

[SWS_Rte_80085] [The RTE shall define the [Rte_DsmqStatusType](#) and the belonging literals in the `Rte_Type.h` file.]([SRS_Rte_00315](#))

7.2.4.9.1 Rte_Rips_DsmqSwitch

[SWS_Rte_91103] [

Service Name	Rte_Rips_<PlugIn>_DsmqSwitch_<BswSwcI>_<MMI>	
Syntax	<pre>void Rte_Rips_<PlugIn>_DsmqSwitch_<BswSwcI>_<MMI> (Rte_DsmqStatusType dsmqstatus, uint32 previousmode, uint32 nextmode)</pre>	
Service ID [hex]	0xF6	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	dsmqstatus	Status of the enqueue operation
	previousmode	The value of the ModeDeclaration of the mode being left
	nextmode	The value of the ModeDeclaration of the mode being entered
Parameters (inout)	None	
Parameters (out)	None	





Return value	None
Description	Rte_Rips_DsmqSwitch notifies the RTE Implementation Plug-In about an enqueue operation in a distributed shared mode queue.
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_70103] [The Local Software Cluster Communication Plug-In assigned to the distributed shared mode queue shall provide the Rte_Rips_DsmqSwitch Service for each mode machine instance belonging to this distributed shared mode queue.](SRS_Rte_00315)

7.2.4.9.2 Rte_Rips_DsmqTransitionStart

[SWS_Rte_91104] [

Service Name	Rte_Rips_<PlugIn>_DsmqTransitionStart_<BswSwcI>_<MMI>	
Syntax	<pre>void Rte_Rips_<PlugIn>_DsmqTransitionStart_<BswSwcI>_<MMI> (uint32 previousmode, uint32 nextmode)</pre>	
Service ID [hex]	0xF7	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	previousmode	The value of the ModeDeclaration of the mode being left
	nextmode	The value of the ModeDeclaration of the mode being entered
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	Rte_Rips_DsmqTransitionStart notifies the RTE Implementation Plug-In about the start of a specific mode transition in a DSMQ transition OsTask	
Available via	Rte_Rips_<PlugIn>.h	

]()

[SWS_Rte_70104] [The Local Software Cluster Communication Plug-In assigned to the distributed shared mode queue shall provide the Rte_Rips_DsmqTransitionStart Service for each mode machine instance belonging to this distributed shared mode queue.](SRS_Rte_00315)

7.2.4.9.3 Rte_Rips_DsmqTransitionSync

[SWS_Rte_91105] [

Service Name	Rte_Rips_<PlugIn>_DsmqTransitionSync_<DsmqOsTask>	
Syntax	<pre>boolean Rte_Rips_<PlugIn>_DsmqTransitionSync_<DsmqOsTask> (void)</pre>	
Service ID [hex]	0xF8	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	boolean	The return value is used to release the dequeue operation on the distributed shared mode queue
Description	DsmqTransitionSync synchronizes (when necessary) the end of mode transition in the DSMQ transition OsTask and releases the dequeue operation on the distributed shared mode queue for the last DSMQ transition OsTask which quits this synchronization point.	
Available via	Rte_Rips_<PlugIn>.h	

]()

[SWS_Rte_70105] [The Local Software Cluster Communication Plug-In assigned to the distributed shared mode queue shall provide the Rte_Rips_<PlugIn>_DsmqTransitionSync Service for each DSMQ transition OsTask belonging to this distributed shared mode queue.] (SRS_Rte_00315)

7.2.4.9.4 Rte_Rips_DsmqTransitionEnd

[SWS_Rte_91106] [

Service Name	Rte_Rips_<PlugIn>_DsmqTransitionEnd_<BswSwcl>_<MMI>	
Syntax	<pre>void Rte_Rips_<PlugIn>_DsmqTransitionEnd_<BswSwcl>_<MMI> (Rte_DsmqStatusType dsmqstatus, uint32 previousmode, uint32 nextmode)</pre>	
Service ID [hex]	0xF9	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	dsmqstatus	Status of the enqueue operation
	previousmode	The value of the ModeDeclaration of the mode being left
	nextmode	The value of the ModeDeclaration of the mode being entered
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	Rte_Rips_DsmqTransitionEnd notifies the RTE Implementation Plug-In about the end of a specific mode transition in a DSMQ transition OsTask	





Available via	Rte_Rips_<PlugIn>.h
---------------	---------------------

]()

[SWS_Rte_70106] [The Local Software Cluster Communication Plug-In assigned to the distributed shared mode queue shall provide the Rte_Rips_DsmqTransitionEnd Service for each mode machine instance belonging to this distributed shared mode queue.] (SRS_Rte_00315)

7.2.4.10 Server Function Invocations

7.2.4.10.1 Rte_Rips_Invoke

[SWS_Rte_89012]{OBSOLETE} [

Service Name	Rte_Rips_<PlugIn>_Invoke_<SwcBswI>_<CGI> (obsolete)	
Syntax	<pre>Std_ReturnType Rte_Rips_<PlugIn>_Invoke_<SwcBswI>_<CGI> ([IN IN/OUT OUT] <data_1>, [IN IN/OUT OUT] ..., [IN IN/OUT OUT] <data_n>, [Std_TransformerError transformerError])</pre>	
Service ID [hex]	0xEC	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	<data_1>	The Rte_Rips_Invoke API includes zero or more IN, IN/OUT and OUT parameters according SWS_Rte_01102 and none in case of triggers
Parameters (inout)	...	The Rte_Rips_Invoke API includes zero or more IN, IN/OUT and OUT parameters according SWS_Rte_01102 and none in case of triggers
Parameters (out)	<data_n>	The Rte_Rips_Invoke API includes zero or more IN, IN/OUT and OUT parameters according SWS_Rte_01102 and none in case of triggers
	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	Std_ReturnType	The return value is used to indicate communication errors.
Description	Rte_Rips_Invoke Performs a transformer invocation for clients or trigger sources. Tags: atp.Status=obsolete	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

]()

Please note that [SWS_Rte_89012] is set to obsolete and will be replaced by [SWS_Rte_89022] to support Cross Software Cluster Communication Plug-Ins.

[SWS_Rte_89022]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_Invoke_<SwcBswI>_<CGI>(draft)	
Syntax	<pre> Std_ReturnType Rte_Rips_<PlugIn>_Invoke_<SwcBswI>_<CGI> ([IN IN/OUT OUT] <data_1>, [IN IN/OUT OUT] ..., [IN IN/OUT OUT] <data_n>, [Std_TransformerError transformerError]) </pre>	
Service ID [hex]	0xEC	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	<data_1>	The Rte_Rips_Invoke API includes zero or more IN, IN/OUT and OUT parameters according SWS_Rte_01102 and none in case of triggers
Parameters (inout)	...	The Rte_Rips_Invoke API includes zero or more IN, IN/OUT and OUT parameters according SWS_Rte_01102 and none in case of triggers
Parameters (out)	<data_n>	The Rte_Rips_Invoke API includes zero or more IN, IN/OUT and OUT parameters according SWS_Rte_01102 and none in case of triggers
	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	Std_ReturnType	The return value is used to indicate communication errors.
Description	Rte_Rips_Invoke performs a transformer or cross cluster invocation for clients or trigger sources.	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

]([SRS_Rte_00312](#), [SRS_Rte_00317](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

[SWS_Rte_70062] [The associated RTE Implementation Plug-In shall provide the [Rte_Rips_Invoke](#) Service for each [ClientServerOperation](#) instance in an [AbstractRequiredPortPrototype](#) of a [Atomic Software Component](#) if

- for the related [ClientServerOperation](#) a [ServerCallPoint](#) exists AND
- for the related [Client Server Communication Graph](#) the RTE Implementation Plug-In support is enabled

]([SRS_Rte_00306](#), [SRS_Rte_00304](#), [SRS_Rte_00312](#))

[SWS_Rte_70063] [The associated RTE Implementation Plug-In shall provide the [Rte_Rips_Invoke](#) Service for each [trigger](#) instance in an [Abstract-ProvidedPortPrototype](#) of a [Atomic Software Component](#) if

- for the related [Trigger Communication Graph](#) the [Software Cluster Local Communication](#) support is enabled

AND

- a transformation is configured according to [\[SWS_Rte_08794\]](#) or [\[SWS_Rte_08105\]](#).

]([SRS_Rte_00306](#), [SRS_Rte_00304](#), [SRS_Rte_00312](#))

[SWS_Rte_70064] [The optional OUT parameter `transformerError` of the `Rte_Rips_Invoke` service shall be generated according to [\[SWS_Rte_08566\]](#).] ([SRS_Rte_00306](#), [SRS_Rte_00312](#))

The return value is used to indicate errors detected by the `RTE Implementation Plug-In` during execution of the `Rte_Rips_Invoke` service call or errors detected by the communication system.

- **[SWS_Rte_70065]** [RTE_E_OK – The API call completed successfully and the invoked server did not return an error.] ([SRS_Rte_00094](#))
- **[SWS_Rte_70066]** [RTE_E_TRANSFORMER_LIMIT – The `RTE Implementation Plug-In` is not able to allocate the buffer needed to transform the data.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70067]** [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain represented a hard transformer error.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70068]** [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70069]** [RTE_E_COM_STOPPED – the `RTE Implementation Plug-In` could not perform the operation because the communication service is currently not available.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70118]** [RTE_E_COM_BUSY – the `RTE Implementation Plug-In` could not perform the operation because the transmission is rejected due to a currently ongoing transmission. The transmission is not executed.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_72004]**{DRAFT} [RTE_E_TIMEOUT – The server's result is not available within the specified timeout but no other error occurred within the API call. The buffers for the IN/OUT and OUT parameters shall not be modified.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_72005]**{DRAFT} [Application Errors – The error code of the server shall only be returned, if none of the above infrastructure errors or indications have occurred.] ([SRS_Rte_00094](#), [SRS_Rte_00091](#))

[SWS_Rte_80071] [The RTE shall call `Rte_Rips_Invoke` at the position and instead of the RTE's regular transformer invocation, if for the related `Client Server Communication Graph` or `Trigger Communication Graph` the `RTE Implementation Plug-In` support is enabled.] ([SRS_Rte_00306](#), [SRS_Rte_00304](#), [SRS_Rte_00312](#))

7.2.4.10.2 Rte_Rips_ReturnResult

[SWS_Rte_89013]{OBSOLETE} [

Service Name	Rte_Rips_<PlugIn>_ReturnResult_<SwcBswI>_<CGI> (obsolete)	
Syntax	<pre>Std_ReturnType Rte_Rips_<PlugIn>_ReturnResult_<SwcBswI>_<CGI> ([IN/OUT OUT] <param_1>, [IN/OUT OUT] <param_n>, [Std_TransformerError transformerError])</pre>	
Service ID [hex]	0xED	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	<param_1>	The Rte_Rips_ReturnResult API includes zero or more IN/OUT and OUT parameters according SWS_Rte_01111.
Parameters (out)	<param_n>	The Rte_Rips_ReturnResult API includes zero or more IN/OUT and OUT parameters according SWS_Rte_01111.
	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.
Return value	Std_ReturnType	The return value is used to indicate communication errors
Description	Rte_Rips_ReturnResult Performs a transformer invocation for clients to get the server results. Tags: atp.Status=obsolete	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

]()

Please note that [SWS_Rte_89013] is set to `obsolete` and will be replaced by [SWS_Rte_89023] to support `Cross Software Cluster Communication Plug-Ins`.

[SWS_Rte_89023]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_ReturnResult_<SwcBswI>_<CGI>(draft)	
Syntax	<pre>Std_ReturnType Rte_Rips_<PlugIn>_ReturnResult_<SwcBswI>_<CGI> ([IN/OUT OUT] <param_1>, [IN/OUT OUT] <param_n>, [Std_TransformerError transformerError])</pre>	
Service ID [hex]	0xED	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	<param_1>	The Rte_Rips_ReturnResult API includes zero or more IN/OUT and OUT parameters according SWS_Rte_01111.
Parameters (out)	<param_n>	The Rte_Rips_ReturnResult API includes zero or more IN/OUT and OUT parameters according SWS_Rte_01111.
	transformerError	The OUT parameter transformerError contains the transformer error which occurred during execution of the transformer chain.





Return value	Std_ReturnType	The return value is used to indicate communication errors
Description	Rte_Rips_ReturnResult get the server results of a performed a transformer or cross cluster invocation for clients.	
Available via	Rte_Rips_<PlugIn>_<SwcBswl>.h	

]([SRS_Rte_00312](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

[SWS_Rte_70070] [The associated RTE Implementation Plug-In shall provide the [Rte_Rips_ReturnResult](#) Service for each [ClientServerOperation](#) instance in an [AbstractRequiredPortPrototype](#) of a [Atomic Software Component](#) if

- for the related [ClientServerOperation](#) an [AsynchronousServerCallResultPoint](#) exists AND
- for the related [Client Server Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled

]([SRS_Rte_00306](#), [SRS_Rte_00304](#), [SRS_Rte_00312](#))

[SWS_Rte_70071] [The optional OUT parameter [transformerError](#) of the [Rte_Rips_ReturnResult](#) service shall be generated according to [\[SWS_Rte_08567\]](#).]
([SRS_Rte_00306](#), [SRS_Rte_00304](#), [SRS_Rte_00312](#))

The return value is used to indicate errors detected by the [RTE Implementation Plug-In](#) during execution of the [Rte_Rips_ReturnResult](#) service call or errors detected by the communication system:

- **[SWS_Rte_70072]** [[RTE_E_OK](#) – The API call completed successfully and the invoked server did not return an error.]([SRS_Rte_00094](#))
- **[SWS_Rte_70073]** [[RTE_E_TRANSFORMER_LIMIT](#) – The [RTE Implementation Plug-In](#) is not able to allocate the buffer needed to transform the data.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70074]** [[RTE_E_HARD_TRANSFORMER_ERROR](#) – The return value of one transformer in the transformer chain represented a hard transformer error.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70075]** [[RTE_E_SOFT_TRANSFORMER_ERROR](#) – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70076]** [[RTE_E_COM_STOPPED](#) – the [RTE Implementation Plug-In](#) could not perform the operation because the communication service is currently not available.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_70119]** [[RTE_E_COM_BUSY](#) – the [RTE Implementation Plug-In](#) could not perform the operation because the query for the result is rejected due to a currently ongoing reception. No result data can be provided.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

- **[SWS_Rte_72006]{DRAFT}** [RTE_E_NO_DATA – (non-blocking read) The server's result is not available but no other error occurred within the API call or the server was not called since [Rte_Start](#) or the restart of the Partition. The buffers for the IN/OUT and OUT parameters shall not be modified.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_72007]{DRAFT}** [RTE_E_TIMEOUT – The server's result is not available within the specified timeout but no other error occurred within the API call. The buffers for the IN/OUT and OUT parameters shall not be modified.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))
- **[SWS_Rte_72008]{DRAFT}** [Application Errors – The error code of the server shall only be returned, if none of the above infrastructure errors or indications have occurred.]([SRS_Rte_00094](#), [SRS_Rte_00091](#))

[SWS_Rte_80072] [The RTE shall call [Rte_Rips_ReturnResult](#) at the position and instead of the RTE's regular transformer invocation for transformation of the server results, if for the related [Client Server Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled.]([SRS_Rte_00306](#), [SRS_Rte_00304](#), [SRS_Rte_00312](#))

7.2.4.10.3 Rte_Rips_InvocationHandler

[SWS_Rte_89015] [

Service Name	<name of the Invocation Handler>
Syntax	<pre>void <name of the Invocation Handler> (void)</pre>
Service ID [hex]	0xEE
Sync/Async	Synchronous
Reentrancy	Conditional Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Performs invocation of server runnables, hard error runnables, ASCR runnables and triggered runnables via a transformer".
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_70077] [The associated RTE Implementation Plug-In shall provide the [Rte_Rips_InvocationHandler](#) Service for each configured [RteRipsInvocationHandlerFnc](#).]([SRS_Rte_00306](#), [SRS_Rte_00304](#), [SRS_Rte_00312](#))

Further details about the RTE usage of [Rte_Rips_InvocationHandler](#) are described in [7.3.11.2](#).

7.2.4.11 Signal notifications for transformer

7.2.4.11.1 Rte_Rips_NotifyRxAck

[SWS_Rte_91107] [

Service Name	Rte_Rips_<PlugIn>_NotifyRxAck_<CGI>
Syntax	<pre>void Rte_Rips_<PlugIn>_NotifyRxAck_<CGI> (void)</pre>
Service ID [hex]	0xFA
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_NotifyRxAck notifies the RTE Implementation Plug-In that the signal used for the Data Communication Graph requiring transformation is ready for reception
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_70110] [The associated RTE Implementation Plug-In shall provide the [Rte_Rips_NotifyRxAck](#) Service for each

- [dataElement](#) instance in an [AbstractRequiredPortPrototype](#) of an [Atomic Software Component](#)
- [operation](#) instance in a [PortPrototype](#) of an [Atomic Software Component](#)
- [trigger](#) instance in an [AbstractRequiredPortPrototype](#) of an [Atomic Software Component](#)

if

- for the related [Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled

AND

- a transformation is configured according [[SWS_Rte_08794](#)].

]([SRS_Rte_00300](#), [SRS_Rte_00312](#), [SRS_Rte_00317](#))

[SWS_Rte_80106] [The RTE Generator shall call all [Rte_Rips_NotifyRxAck](#) Services from the [Rte_COMCbK_<sn>](#) or [Rte_COMCbK_<sg>](#) callback respectively for [Communication Graphs](#) where

- Rx signals are configured

AND

- for the related [Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled

AND

- a transformation is configured according to [\[SWS_Rte_08794\]](#).

]([SRS_Rte_00312](#))

7.2.4.11.2 Rte_Rips_NotifyRxTOut

[\[SWS_Rte_91108\]](#) [

Service Name	Rte_Rips_<PlugIn>_NotifyRxTOut_<CGI>
Syntax	<pre>void Rte_Rips_<PlugIn>_NotifyRxTOut_<CGI> (void)</pre>
Service ID [hex]	0xFB
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_NotifyRxTOut notifies the RTE Implementation Plug-In that for the signal used for the Data Communication Graph requiring transformation the aliveTimeout has expired.
Available via	Rte_Rips_<PlugIn>.h

](

[\[SWS_Rte_70111\]](#) [The associated RTE Implementation Plug-In shall provide the [Rte_Rips_NotifyRxTOut](#) Service for each

- [dataElement](#) instance in an [AbstractRequiredPortPrototype](#) of an [Atomic Software Component](#)
- [operation](#) instance in a [PortPrototype](#) of an [Atomic Software Component](#)
- [trigger](#) instance in an [AbstractRequiredPortPrototype](#) of an [Atomic Software Component](#)

if

- for the related [Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled

AND

- a transformation is configured according to [\[SWS_Rte_08794\]](#).

]([SRS_Rte_00300](#), [SRS_Rte_00312](#), [SRS_Rte_00317](#))

[SWS_Rte_80107] [The RTE Generator shall call all [Rte_Rips_NotifyRxTOut](#) Services from the `Rte_COMCbRxTOut_<sn>` or `Rte_COMCbRxTOut_<sg>` callback respectively for [Communication Graphs](#) where

- Rx signals are configured
- AND
- for the related [Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled
- AND
- a transformation is configured according to [[SWS_Rte_08794](#)].

]([SRS_Rte_00312](#))

7.2.4.11.3 Rte_Rips_NotifyTxAck

[SWS_Rte_91109] [

Service Name	Rte_Rips_<PlugIn>_NotifyTxAck_<CGI>
Syntax	<pre>void Rte_Rips_<PlugIn>_NotifyTxAck_<CGI> (void)</pre>
Service ID [hex]	0xFC
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_NotifyTxAck notifies the RTE Implementation Plug-In that the signal used for the Data Communication Graph requiring transformation is already handed to the PDU router.
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_70112] [The associated RTE Implementation Plug-In shall provide the [Rte_Rips_NotifyTxAck](#) Service for each

- [dataElement](#) instance in an [AbstractProvidedPortPrototype](#) of an [Atomic Software Component](#)
- [operation](#) instance in a [PortPrototype](#) of an [Atomic Software Component](#)
- [trigger](#) instance in an [AbstractProvidedPortPrototype](#) of an [Atomic Software Component](#)

if

- for the related [Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled

AND

- a transformation is configured according to [\[SWS_Rte_08794\]](#).

]([SRS_Rte_00300](#), [SRS_Rte_00312](#), [SRS_Rte_00317](#))

[SWS_Rte_80108] [The RTE Generator shall call all [Rte_Rips_NotifyTxAck](#) Services from the `Rte_COMCbkTack_<sn>` or `Rte_COMCbkTack_<sg>` callback respectively for [Communication Graphs](#) where

- Tx signals are configured

AND

- for the related [Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled

AND

- a transformation is configured according to [\[SWS_Rte_08794\]](#).

]([SRS_Rte_00312](#))

7.2.4.11.4 Rte_Rips_NotifyTxErr

[SWS_Rte_91110] [

Service Name	Rte_Rips_<PlugIn>_NotifyTxErr_<CGI>
Syntax	<pre>void Rte_Rips_<PlugIn>_NotifyTxErr_<CGI> (void)</pre>
Service ID [hex]	0xFD
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_NotifyTxErr notifies the RTE Implementation Plug-In that for the signal used for the Data Communication Graph requiring transformation an error occurred when the signal was handed over to the PDU router.
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_70113] [The associated RTE Implementation Plug-In shall provide the [Rte_Rips_NotifyTxErr](#) Service for each

- `dataElement` instance in an `AbstractProvidedPortPrototype` of an Atomic Software Component
- `operation` instance in a `PortPrototype` of an Atomic Software Component
- `trigger` instance in an `AbstractProvidedPortPrototype` of an Atomic Software Component

if

- for the related `Communication Graph` the RTE Implementation Plug-In support is enabled

AND

- a transformation is configured according to [SWS_Rte_08794].

]([SRS_Rte_00300](#), [SRS_Rte_00312](#), [SRS_Rte_00317](#))

[SWS_Rte_80109] [The RTE Generator shall call all `Rte_Rips_NotifyTxErr` Services from the `Rte_COMCbkTErr_<sn>` or `Rte_COMCbkTErr_<sg>` callback respectively for `Communication Graphs` where

- Tx signals are configured

AND

- for the related `Communication Graph` the RTE Implementation Plug-In support is enabled

AND

- a transformation is configured according to [SWS_Rte_08794].

]([SRS_Rte_00312](#))

7.2.4.11.5 Rte_Rips_NotifyTxTOut

[SWS_Rte_91111] [

Service Name	<code>Rte_Rips_<PlugIn>_NotifyTxTOut_<CGI></code>
Syntax	<pre>void Rte_Rips_<PlugIn>_NotifyTxTOut_<CGI> (void)</pre>
Service ID [hex]	0xFE
Sync/Async	Synchronous
Reentrancy	Non Reentrant



△

Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_NotifyTxTOut notifies the RTE Implementation Plug-In that for signal used for the Data Communication Graph requiring transformation the timeout of Transmission AcknowledgementRequest for sending the signal has expired.
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_70114] [The associated RTE Implementation Plug-In shall provide the `Rte_Rips_NotifyTxTOut` Service for each

- `dataElement` instance in an `AbstractProvidedPortPrototype` of an Atomic Software Component
- `operation` instance in a `PortPrototype` of an Atomic Software Component
- `trigger` instance in an `AbstractProvidedPortPrototype` of an Atomic Software Component

if

- for the related `Communication Graph` the RTE Implementation Plug-In support is enabled

AND

- a transformation is configured according to [\[SWS_Rte_08794\]](#).

]([SRS_Rte_00300](#), [SRS_Rte_00312](#), [SRS_Rte_00317](#))

[SWS_Rte_80110] [The RTE Generator shall call all `Rte_Rips_NotifyTxTOut` Services from the `Rte_COMCbktOut_<sn>` or `Rte_COMCbktOut_<sg>` callback respectively for `Communication Graphs` where

- Tx signals are configured

AND

- for the related `Communication Graph` the RTE Implementation Plug-In support is enabled

AND

- a transformation is configured according to [\[SWS_Rte_08794\]](#).

]([SRS_Rte_00312](#))

7.2.4.12 Cross cluster trigger communication functions

7.2.4.12.1 Rte_Rips_Trigger

[SWS_Rte_91117]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_Trigger_<BswSwcI>_<MMI> (draft)
Syntax	<pre>void Rte_Rips_<PlugIn>_Trigger_<BswSwcI>_<MMI> (void)</pre>
Service ID [hex]	0xB2
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_Trigger notifies the RTE Implementation Plug-In about a raised trigger. Tags: atp.Status=draft
Available via	Rte_Rips_<PlugIn>.h

]([SRS_Rte_00317](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

[SWS_Rte_70124]{DRAFT} [The [Cross Software Cluster Communication Plug-In](#) assigned to the [Trigger Communication Graph](#) where the trigger port is provided for other Software Clusters shall provide the [Rte_Rips_Trigger](#) Service.]([SRS_Rte_00162](#), [SRS_00235](#))

7.2.4.13 Data and Event Notifications

7.2.4.13.1 Rte_Rips_Feedback

[SWS_Rte_91121]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_Feedback_<SwcBswI>[Partition]_<CGI> (draft)
Syntax	<pre>Std_ReturnType Rte_Rips_<PlugIn>_Feedback_<SwcBswI>[Partition]_<CGI> (void)</pre>
Service ID [hex]	0xB6
Sync/Async	Synchronous
Reentrancy	Reentrant
Parameters (in)	None





Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	The return value is used to pass error notifications.
Description	The Rte_Rips_Feedback API provides access to acknowledgment notifications for explicit and implicit sender-receiver communication and to pass error notification to senders in a Software Cluster Tags: atp.Status=draft	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

]([SRS_Rte_00319](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

[SWS_Rte_72009]{DRAFT} [The associated Cross Software Cluster Communication Plug-In shall provide the Rte_Rips_Feedback Service for each VariableDataPrototype instance in an AbstractProvidedPortPrototype for which a VariableAccess of a RunnableEntity in the role dataSendPoint exists, if

- for the related Data Communication Graph the Cross Software Cluster Communication Plug-In support is enabled

AND

- acknowledgement is enabled for a provided VariableDataPrototype by the existence of a TransmissionAcknowledgementRequest in the SenderComSpec

In this case the name part [`<SwcBswI>`] exists.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_72010]{DRAFT} [The associated Cross Software Cluster Communication Plug-In shall provide the Rte_Rips_Feedback Service once for each partition which has a software component map to it where the software component has VariableDataPrototype instance in an AbstractProvidedPortPrototype for which a VariableAccess of a RunnableEntity in the role dataWriteAccess exists, if

- for the related Data Communication Graph the Cross Software Cluster Communication Plug-In support is enabled

AND

- acknowledgement is enabled for a provided VariableDataPrototype by the existence of a TransmissionAcknowledgementRequest in the SenderComSpec

In this case the name part [`Partition`] exists.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_82013]{DRAFT} [The RTE shall call Rte_Rips_Feedback at the position and instead of the RTE's regular acknowledgement notification API for explicit

sender receiver communication, if for the related [Data Communication Graph](#) the [Cross Software Cluster Communication Plug-In](#) support is enabled] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

[SWS_Rte_82014]{DRAFT} [The RTE shall call [Rte_Rips_Feedback](#) to determine the acknowledgement notification status for implicit sender receiver communication at the position where the according data is written o global copy, if for the related [Data Communication Graph](#) the [Cross Software Cluster Communication Plug-In](#) support is enabled.] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#))

The return value is used to indicate errors detected by the [RTE Implementation Plug-In](#) during execution of the [Rte_Rips_Feedback](#) service call or errors detected by the communication system.

- **[SWS_Rte_72011]** [RTE_E_NO_DATA – No acknowledgments or error notifications were received from COM when the [Rte_Rips_Feedback](#) servive was called (non-blocking call).

This error code is only applicable in case of transformer handling by the [Local Software Cluster Communication Plug-In](#).] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00122](#))

- RTE_E_COM_STOPPED – returned in one of these cases:
 - **[SWS_Rte_72012]** [RTE_E_COM_STOPPED is returned in case the last transmission was rejected (when the [Rte_Rips_Write](#) service was called).

This error code is only applicable in case of transformer handling by the [Local Software Cluster Communication Plug-In](#).] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00122](#))

- **[SWS_Rte_72013]** [RTE_E_COM_STOPPED is returned in case an error notification from COM was received before any timeout notification.

This error code is only applicable in case of transformer handling by the [Local Software Cluster Communication Plug-In](#).] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00122](#))

- **[SWS_Rte_72014]** [RTE_E_TIMEOUT – A timeout notification was received from COM, IOC or [Cross Software Cluster Communication Plug-In](#) before any error notification.] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00122](#))
- **[SWS_Rte_72015]** [RTE_E_TRANSMIT_ACK – In case of inter ECU communication via transformer, a transmission acknowledgment was received from COM; or in case of [Cross Cluster Communication](#), even if a queue overflow occurred.] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00122](#))
- **[SWS_Rte_72016]** [RTE_E_UNCONNECTED is returned in case that the sender port is not connected to another [Software Cluster](#).

This error code is only applicable in case of Cross Cluster Communication.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00139](#))

- **[SWS_Rte_72017]** [RTE_E_HARD_TRANSFORMER_ERROR – The return value of one transformer in the transformer chain represented a hard transformer error.

This error code is only applicable in case of transformer handling by the Local Software Cluster Communication Plug-In.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00091](#))

- **[SWS_Rte_72018]** [RTE_E_SOFT_TRANSFORMER_ERROR – The return value of at least one transformer in the transformer chain was a soft error and no hard error occurred in the transformer chain.

This error code is only applicable in case of transformer handling by the Local Software Cluster Communication Plug-In.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00091](#))

The RTE_E_NO_DATA, RTE_E_TRANSMIT_ACK and RTE_E_UNCONNECTED return values are not considered to be an error but rather indicates correct operation of the API call.

[SWS_Rte_72019] [The initial return value of the [Rte_Rips_Feedback](#) service, before any attempt to write some data shall be RTE_E_TRANSMIT_ACK.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00122](#), [SRS_Rte_00128](#), [SRS_Rte_00185](#))

[SWS_Rte_72020] [In case of multiple faults during a call of [Rte_Rips_Feedback](#) the resulting return value shall be derived according to the following priority rules (highest priority first):

- (1) RTE_E_UNCONNECTED,
- (2) RTE_E_TIMEOUT,
- (3) RTE_E_HARD_TRANSFORMER_ERROR,
- (4) RTE_E_COM_STOPPED,
- (5) RTE_E_NO_DATA,
- (6) RTE_E_SOFT_TRANSFORMER_ERROR,
- (7) RTE_E_TRANSMIT_ACK.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00122](#))

7.2.4.13.2 Rte_Rips_DatalsUpdated

[SWS_Rte_91119]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_DataIsUpdated_<SwcBswI>_<CGI> (draft)	
Syntax	<pre> boolean Rte_Rips_<PlugIn>_DataIsUpdated_<SwcBswI>_<CGI> (void) </pre>	
Service ID [hex]	0xB4	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	boolean	The return value is used to indicate if the data has been updated or not.
Description	The Rte_Rips_DataIsUpdated API provides access to the update flag for an explicit receiver Tags: atp.Status=draft	
Available via	Rte_Rips_<PlugIn>_<SwcBswI>.h	

](SRS_Rte_00300, SRS_Rte_00301, SRS_Rte_00306, SRS_BSW_00310)

[SWS_Rte_72021]{DRAFT} [The associated Cross Software Cluster Communication Plug-In shall provide the Rte_Rips_DataIsUpdated Service for each VariableDataPrototype in an AbstractRequiredPortPrototype for which a VariableAccess of a RunnableEntity in the role dataReceivePoint-ByValue or dataReceivePointByValue exists, if

- for the related Data Communication Graph the Cross Software Cluster Communication Plug-In support is enabled

AND

- the enableUpdate attribute is enabled in the NonqueuedReceiverComSpec of the VariableDataPrototype.

](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00303, SRS_Rte_00179)

[SWS_Rte_82015]{DRAFT} [The RTE shall call Rte_Rips_DataIsUpdated at the position and instead of the RTE's regular API to access the update flag for an explicit receiver, if for the related Data Communication Graph the Cross Software Cluster Communication Plug-In support is enabled.](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00303)

The return value of the Rte_Rips_DataIsUpdated is used to indicate status of data detected by the RTE Implementation Plug-In during by the communication system.

- **[SWS_Rte_72002]{DRAFT}** [TRUE – Data element updated since last call of corresponding Rte_Rips_Read or Rte_Rips_DRead.](SRS_Rte_00306, SRS_Rte_00300, SRS_Rte_00094, SRS_Rte_00179)

- **[SWS_Rte_72003]{DRAFT}** [FALSE – Data element not updated since last call of corresponding `Rte_Rips_Read` or `Rte_Rips_DRead`.] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00179](#))

7.2.4.13.3 Rte_Rips_DatalsUpdated_EventActivation

[SWS_Rte_91000]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_DatalsUpdatedEventActivation_<SwcBswI>_<DR>_<CGI> (draft)	
Syntax	<pre>boolean Rte_Rips_<PlugIn>_DataIsUpdatedEventActivation_<SwcBswI>_<DR>_<CGI> (void)</pre>	
Service ID [hex]	0xB5	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	boolean	The return value is used to indicate if the Runnable shall be activated or not.
Description	<p>The <code>Rte_Rips_DatalsUpdated_EventActivation</code> API indicates the RTE to activate the Runnable Entity triggered by <code>DataReceivedEvent</code> when the related <code>VariableDataPrototype</code> has been updated</p> <p>Tags:atp.Status=draft</p>	
Available via	Rte_Rips_<PlugIn>.h	

] ([SRS_Rte_00300](#), [SRS_Rte_00301](#), [SRS_Rte_00306](#), [SRS_BSW_00310](#))

[SWS_Rte_72022]{DRAFT} [The associated Cross Software Cluster Communication Plug-In to a Data Communication Graph shall provide the `Rte_Rips_DataIsUpdated_EventActivation` Service for each `RunnableEntity` accessing a `VariableDataPrototype` in the role `dataReadAccess`, or `dataReceivePointByValue`, or `dataReceivePointByArgument`, if

- for the related Data Communication Graph the Cross Software Cluster Communication Plug-In support is enabled

AND

- the `RunnableEntity` accessing a `VariableDataPrototype` is triggered by a `DataReceivedEvent`.

] ([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00303](#), [SRS_Rte_00179](#))

[SWS_Rte_82016]{DRAFT} [The RTE Generator shall invoke `Rte_Rips_DataIsUpdated_EventActivation` Service and evaluate its return value (See [\[SWS_Rte_72000\]](#), [\[SWS_Rte_72001\]](#)) to determine whether or not it shall fire the related `DataReceivedEvent` if for the related Data Communication Graph

the [Cross Software Cluster Communication Plug-In](#) support is enabled.]([SRS_Rte_00246](#))

Please note as well the specific mapping of [DataReceivedEvents](#) in [[SWS_Rte_82001](#)]

The return value of the `Rte_Rips_DataIsUpdated_EventActivation` is used to indicate status of data detected by the [RTE Implementation Plug-In](#) during by the communication system.

- **[SWS_Rte_72000]{DRAFT}** [TRUE – Data element updated since last call of corresponding `Rte_Rips_DataIsUpdated_EventActivation`.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00179](#))
- **[SWS_Rte_72001]{DRAFT}** [FALSE – Data element not updated since last call of corresponding `Rte_Rips_DataIsUpdated_EventActivation`.]([SRS_Rte_00306](#), [SRS_Rte_00300](#), [SRS_Rte_00094](#), [SRS_Rte_00179](#))

7.2.4.14 External Parameter Access

7.2.4.14.1 Rte_Rips_Prm

[[SWS_Rte_91116](#)]{DRAFT} [

Service Name	Rte_Rips_<PlugIn>_Prm_<CGI> (draft)	
Syntax	<pre><return> Rte_Rips_<PlugIn>_Prm_<CGI> (void)</pre>	
Service ID [hex]	0x100	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	<return>	For primitive data types, the <code>Rte_Rips_Prm</code> API returns the parameter value. For composite data types, the <code>Rte_Rips_Prm</code> API returns a reference (in C, a pointer) to the constant parameter.
Description	The <code>Rte_Rips_Prm</code> API provides access to a parameter provided by another Software Cluster Tags: atp.Status=draft	
Available via	Rte_Rips_<PlugIn>_<SwcBswl>.h	

]()

[SWS_Rte_70141]{DRAFT} [The [associated Cross Software Cluster Communication Plug-In](#) shall provide the `Rte_Rips_Prm` Service for each [parameter](#) instance in an [RPortPrototype](#) at the [at the CompositionSwComponentType](#) of the [rootSoftwareComposition](#) of the [Ecu Extract](#) if for the

related [Parameter Communication Graph](#) the [Cross Software Cluster Communication Plug-In](#) support is enabled.

]([SRS_Rte_00300](#), [SRS_Rte_00319](#))

[SWS_Rte_80126]{DRAFT} [The RTE Generator shall call all [Rte_Rips_Prm](#) Services at the position and instead of the RTE's regular access to the parameter for the related [Parameter Communication Graph](#) if the [Cross Software Cluster Communication Plug-In](#) support is enabled.]([SRS_Rte_00312](#))

7.2.4.15 RTE Implementation Plug-In Lifecycle API

[RTE Implementation Plug-Ins](#) might need initialization in the same way the RTE might need it. Consequently, there will be init/deinit and start/stop APIs, which the RTE has to call. As the RTE's lifecycle APIs will be called on every core, also the [RTE Implementation Plug-In](#)'s lifecycle APIs will do so.

[SWS_Rte_70047] [The [RTE Implementation Plug-In](#) shall always provide the Lifecycle APIs [Rte_Rips_SchM_Init](#), [Rte_Rips_Rte_Start](#), [Rte_Rips_Rte_Stop](#), and [Rte_Rips_SchM_Deinit](#).]([SRS_BSW_00101](#), [SRS_BSW_00336](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

[SWS_Rte_80055] [The RTE shall call the Lifecycle APIs of all participating [RTE Implementation Plug-Ins](#) in the order given by index of the [RteRipsPluginConfigurationRefs](#).]([SRS_BSW_00101](#), [SRS_BSW_00336](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

7.2.4.15.1 Rte_Rips_SchM_Init

[SWS_Rte_89016] [

Service Name	Rte_Rips_<PlugIn>_SchM_Init
Syntax	<pre>void Rte_Rips_<PlugIn>_SchM_Init (void)</pre>
Service ID [hex]	0xF0
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_SchM_Init initializes those RTE Implementation Plug-In parts which are relevant for the SchM related operations.





Available via	Rte_Rips_<PlugIn>.h
----------------------	---------------------

]()

[SWS_Rte_80051] [The RTE shall call the init functions [Rte_Rips_SchM_Init](#) of all participating [RTE Implementation Plug-Ins](#) in [SchM_Init](#).] ([SRS_BSW_00101](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

7.2.4.15.2 Rte_Rips_Rte_Start

[SWS_Rte_89017] [

Service Name	Rte_Rips_<PlugIn>_Rte_Start
Syntax	<pre>void Rte_Rips_<PlugIn>_Rte_Start (void)</pre>
Service ID [hex]	0xF1
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_Rte_Start initializes those RTE Implementation Plug-In parts which are relevant for the RTE related operation.
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_80052] [The RTE shall call the init functions [Rte_Rips_Rte_Start](#) of all participating [RTE Implementation Plug-Ins](#) in [Rte_Start](#), after the variable initializations have been performed, but before the execution of any [RunnableEntity](#) (e.g. [on-entry ExecutableEntitys](#)).] ([SRS_BSW_00101](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

7.2.4.15.3 Rte_Rips_Rte_Stop

[SWS_Rte_89018] [

Service Name	Rte_Rips_<PlugIn>_Rte_Stop
Syntax	<pre>void Rte_Rips_<PlugIn>_Rte_Stop (void)</pre>
Service ID [hex]	0xF2
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_Rte_Stop deinitializes those RTE Implementation Plug-In parts which are relevant for the RTE related operation.
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_80053] [The RTE shall call the stop functions [Rte_Rips_Rte_Stop](#) of all participating [RTE Implementation Plug-Ins](#) in [Rte_Stop](#).] ([SRS_BSW_00336](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

7.2.4.15.4 Rte_Rips_SchM_Deinit

[SWS_Rte_89019] [

Service Name	Rte_Rips_SchM_Deinit
Syntax	<pre>void Rte_Rips_SchM_Deinit (void)</pre>
Service ID [hex]	0xF3
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in)	None
Parameters (inout)	None
Parameters (out)	None
Return value	None
Description	Rte_Rips_SchM_Deinit deinitializes those RTE Implementation Plug-In parts which are relevant for the SchM related operations.
Available via	Rte_Rips_<PlugIn>.h

]()

[SWS_Rte_80054] [The RTE shall call the deinit functions [Rte_Rips_SchM_Deinit](#) of all participating [RTE Implementation Plug-Ins](#) in [SchM_Deinit](#).] ([SRS_BSW_00336](#), [SRS_Rte_00306](#), [SRS_Rte_00304](#))

7.3 RTE Implementation Plug-Ins Functional Specification

7.3.1 Specializations of AtomicSwComponentTypes

The AUTOSAR Metamodel defines several specializations of AtomicSwComponentTypes in order to indicate the architectural meaning of such a software component in the AUTOSAR Layered Software Architecture, e.g. an ApplicationSwComponentType or an EcuAbstractionSwComponentType. In the context of RTE Implementation Plug-Ins all specializations of AtomicSwComponentTypes except for the NvBlockSwComponentType require identical support with respect to protection of port based communication and are just called in the following chapter Atomic Software Component.

7.3.2 Interaction with VFB Tracing

RTE Implementation Plug-In Service opening and closing some protection mechanisms is required to always be called as close as possible to the protected code in order to keep the lock-times low. This especially means that VFB Tracing hooks shall enclose the related RIPS hooks and not vice versa.

[SWS_Rte_80078] [The RTE shall call RTE Implementation Plug-In protection macros closer to the "to be protected" code than the related VFB Tracing hooks.] (*SRS_Rte_00306*)

Please note that [SWS_Rte_80078] applies in particular for Rte_Rips_StartRead, Rte_Rips_StopRead, Rte_Rips_StartWrite, and Rte_Rips_StopWrite services.

Example 7.3

```
1  uint64 Rte_DRead_myComponent_myRPort1_myExplicitLargePrimitiveData(void)
2  {
3      uint64 rtn;
4      Rte_DReadHook_myComponent_myRPort1_myExplicitLargePrimitiveData_Start
        ();
5      Rte_Rips_myPlugin_StartRead_myComponent_myLargePrimitiveData1();
6      rtn = Rte_Rips_GlobalCopy_myLargePrimitiveData1.value;
7      Rte_Rips_myPlugin_StopRead_myComponent_myLargePrimitiveData1();
8      Rte_DReadHook_myComponent_myRPort1_myExplicitLargePrimitiveData_Return
        ();
9      return rtn;
10 }
```


7.3.3 Validation Strategy for RTE Implementation Plug-Ins

7.3.3.1 Graduated Validation Strategy

7.3.3.2 Validation Implication w.r.t. Exclusive Areas

Implementing [ExclusiveAreas](#) with the means of [RTE Implementation Plug-Ins](#) can optimize the ECU software when very selective measures are taken to protect a particular [ExclusiveArea](#). In addition it is easier to ensure the consistency of the [ExclusiveArea](#) implementations with the protections applied in RTE APIs using [RTE Implementation Plug-Ins](#).

Nevertheless this kind of optimization cannot overcome the general limitations stated in [A.15](#). Especially since the current capability of [RTE Implementation Plug-Ins](#) does not include blocking APIs. Further on the consistent handling of [ExclusiveAreas](#) APIs by the software component or Basic Software Module's implementation is still required. The following requirements and constraints are still applicable:

- [\[SWS_Rte_07524\]](#)
- [\[SWS_Rte_07005\]](#)
- [\[SWS_Rte_02741\]](#)
- [\[SWS_Rte_02740\]](#)
- [\[SWS_Rte_02744\]](#)
- [\[SWS_Rte_CONSTR_09028\]](#)
- [\[SWS_Rte_CONSTR_09029\]](#)
- [\[SWS_Rte_CONSTR_09046\]](#)
- [\[SWS_Rte_CONSTR_09047\]](#)

7.3.3.3 Validation Implication w.r.t. Event To Task Mapping

In general, which kind of direct or trusted function calls an RTE Generator supports is a property of the RTE Generator. But an important use case of the utilization of [RTE Implementation Plug-Ins](#) is the resource optimized scheduling and implementation of data consistency mechanisms in complex scenarios. Therefore it is beneficial if an RTE Generator supports additionally the [ExecutableEntity](#) activation via direct or trusted function calls in additional scenarios as the already standardized ones, see [\[SWS_Rte_06798\]](#), [\[SWS_Rte_07409\]](#), [\[SWS_Rte_07173\]](#), [\[SWS_Rte_07214\]](#), [\[SWS_Rte_07224\]](#), and [\[SWS_Rte_07554\]](#).

[SWS_Rte_80029] [The RTE and Basic Software Scheduler should support the activation of [ExecutableEntity](#) via direct and trusted function call for

- `DataReceivedEvents`
- `DataReceiveErrorEvents`,
- `DataWriteCompletedEvents`,
- `DataSendCompletedEvents`
- `OperationInvokedEvents` where the client uses `SynchronousServerCallPoints` as well as `AsynchronousServerCallPoints`
- `AsynchronousServerCallReturnsEvents` where the server's `OperationInvokedEvent` is not mapped to a `OsTask`.

when the support for `RTE Implementation Plug-Ins` is globally enabled (`RteRipsSupport = true`)]([SRS_Rte_00305](#))

[SWS_Rte_CONSTR_80013] [Restrictions on direct and trusted function call configurations in the scope of `RTE Implementation Plug-Ins` If an RTE Generator supports an activation of `ExecutableEntity`s via direct or trusted function call listed in [\[SWS_Rte_80029\]](#) only when the support for `RTE Implementation Plug-Ins` is enabled the input configuration needs to fulfill following condition:

- all `Communication Graphs`, `ExclusiveAreas` and `mode machine instances` accessed by the to-be-activated `ExecutableEntity` are assigned to `RTE Implementation Plug-Ins`

AND

- the to-be-activated `ExecutableEntity` do not in turn activate `RTEEvents` or `BswEvents` which are mapped to `OsTasks`.

]([SRS_Rte_00305](#))

Please note: The activation of `OsTasks` is still a duty of the RTE. [\[SWS_Rte_CONSTR_80011\]](#) shall ensure, that the RTE Generator is not forced to implement OS interacting code in a context which can only occur in an `RTE Implementation Plug-Ins` specific configuration.

When utilizing `RTE Implementation Plug-Ins` the RTE Generator is no longer able to validate the overall scenario. This means the RTE Generator can only validate, if the activation of an `ExecutableEntity` at the configured position in the `OsTask` or via direct or trusted function call can be supported by the RTE Generator. But it can not finally judge whether the utilized `RTE Implementation Plug-Ins` can support the requested functionality (e.g. an implicit communication) in the resulting call context(s).

But the specific validation whether the implementation of the data consistency mechanism or `ExclusiveAreas` implementations is possible is the task of the utilized `RTE Implementation Plug-Ins`.

[SWS_Rte_70040] [The `RTE Implementation Plug-Ins` tool shall validate whether the requested functionality can be implemented with the given Event To Task Mapping.]([SRS_Rte_00305](#))

[SWS_Rte_80030] [The RTE Generator shall restrict its applied validation on the input configuration w.r.t. Event To Task Mapping and the resulting call tree to the aspects concerning the RTE code generation, when the support for RTE Implementation Plug-Ins is globally enabled (`RteRipsSupport`) and all Communication Graphs, ExclusiveAreas, and mode machine instances accessed by the to-be-activated ExecutableEntity are assigned to RTE Implementation Plug-Ins.](*SRS_Rte_00305*)

For instance:

According [\[SWS_Rte_07007\]](#) the RTE generator would reject configurations where a `RunnableEntity` with implicit access gets potentially concurrently invoked. When configuring such a component the RTE Generator would be required to create an implicit buffering which depends on the current invocation context of the `RunnableEntity` and this is not foreseen in chapter [4.3.1.5.1](#).

Now when applying RTE Implementation Plug-Ins according [\[SWS_Rte_80030\]](#) the validation scope of the RTE Generator is reduced to the scope of the RTE, which just ensures, that the triggering of the `RunnableEntity` can be implemented by the RTE Generator. If the implicit buffering strategy can deal with the dynamic side conditions - like a potential concurrent invocation - shall be checked by the RTE Implementation Plug-Ins handling a specific Data Communication Graph accessed by this `RunnableEntity` with implicit access.

7.3.3.4 Validation Implication w.r.t. communication multiplicity

In case a Cross Software Cluster Communication Plug-In and a Local Software Cluster Communication Plug-In is assigned to a Data Communication Graph the Local Software Cluster Communication Plug-In may utilize a Complex Driver to access the Cross Software Cluster Communication Plug-In. See section [7.3.4.7](#).

[SWS_Rte_80152]{DRAFT} [The RTE Generator shall restrict its applied validation on the input configuration w.r.t. communication multiplicity to the aspects concerning the RTE code generation, when the support for RTE Implementation Plug-Ins is globally enabled (`RteRipsSupport`) and a Communication Graphs is assigned to an RTE Implementation Plug-In.](*SRS_Rte_00305*)

7.3.4 Data Communication

7.3.4.1 Enable RTE Implementation Plug-In support for communication graphs

According Document [\[8\]](#) a Data Communication Graph gets assigned to an RTE Implementation Plug-In with a `FlatInstanceDescriptor` that points on one hand to the instance of a `VariableDataPrototype` and on the

other hand points via `FlatInstanceDescriptor.rtePluginProps.associate-dRtePlugin` or via `FlatInstanceDescriptor.rtePluginProps.associated-CrossSwClusterComRtePlugin` to the container `RteRipsPluginProps`.

[SWS_Rte_80031] [The RTE Generator shall enable the RTE Implementation Plug-In support for a Data Communication Graph, if a `FlatInstanceDescriptor` with `rtePluginProps` references the Data Communication Graph.](*SRS_Rte_00300*, *SRS_Rte_00301*)

[SWS_Rte_80128]{DRAFT} [The RTE Generator shall enable the Local Software Cluster Communication Plug-In support for a Data Communication Graph, if a `FlatInstanceDescriptor` with `rtePluginProps.associate-dRtePlugin` references the Data Communication Graph.](*SRS_Rte_00300*, *SRS_Rte_00301*)

[SWS_Rte_80129]{DRAFT} [The RTE Generator shall enable the Cross Software Cluster Communication Plug-In support for a Data Communication Graph, if a `FlatInstanceDescriptor` with `rtePluginProps.associated-CrossSwClusterComRtePlugin` references the Data Communication Graph.](*SRS_Rte_00300*, *SRS_Rte_00301*)

In the later document those specific `FlatInstanceDescriptors` are called `RIPS FlatInstanceDescriptor`.

[SWS_Rte_CONSTR_80203]{DRAFT} **Data Communication Graph is handled by at most one Local Software Cluster Communication Plug-In and one Cross Software Cluster Communication Plug-In.** [A Data Communication Graph is handled by at most one Local Software Cluster Communication Plug-In and at most one Cross Software Cluster Communication Plug-In. But it's possible, that both RTE Implementation Plug-Ins are enabled together.](*SRS_Rte_00304*, *SRS_Rte_00318*)

Rationale: Incase of an arbitrary number of RTE Implementation Plug-Ins the interaction between RTE and the RTE Implementation Plug-Ins is unspecified.

[SWS_Rte_70042] [The associated RTE Implementation Plug-In shall implement the required implicit communication buffering and data protection for the related Data Communication Graphs.](*SRS_Rte_00300*, *SRS_Rte_00301*)

[SWS_Rte_80032] [The RTE Generator shall treat `RIPS FlatInstanceDescriptors` as regular AUTOSAR `FlatInstanceDescriptors`, independent of their special meaning for RTE Implementation Plug-In support.](*SRS_Rte_00300*, *SRS_Rte_00301*)

Besides the RTE Implementation Plug-In related special meaning, the `RIPS FlatInstanceDescriptors` keep their AUTOSAR meaning. This especially means that also `RIPS FlatInstanceDescriptors` can lead to entries in the `McSupport-Data` as described in section 4.2.9.4. This has the intended side effect that the globally unique names used for RTE Implementation Plug-In can be kept identical to the names visible in a MCD tool.

Examples of [Data Communication Graphs](#) are given in figures [7.3](#) and [7.4](#).

7.3.4.2 Details on [RIPS FlatInstanceDescriptors](#) for [Data Communication Graphs](#)

Since a [Data Communication Graph](#) - in case of port based communication - is typically composed out of various [PortPrototypes](#), [DataPrototypes](#) in [PortInterfaces](#), and [AssemblySwConnectors](#) in theory such a [RIPS FlatInstanceDescriptor](#) could point to different locations in the [Data Communication Graph](#). To harmonize the interface between the RTE Generator and the RTE Implementation Plug-In tools [[SWS_Rte_CONSTR_80002](#)] regulates the creation of [RIPS FlatInstanceDescriptors](#) for Rte Implementation Plug-Ins.

[SWS_Rte_CONSTR_80002] [Valid instance reference targets of Rte Implementation Plug-Ins The [RIPS FlatInstanceDescriptors](#) for a [Data Communication Graph](#) shall reference the data instances according table [7.1](#)] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

Data Communication Graph involves Cross SW Cluster Com	Data Communication Graph involves NvBlock-SwComponent	Conversion	Communication multiplicity	RIPS FlatInstanceDescriptors
No	No	No	1:n	VariableDataPrototype instance in the AbstractProvidedPortPrototype
Yes	No	No	1:n	VariableDataPrototype instance in the RPortPrototype at the CompositionSwComponentType of the rootSoftwareComposition of the Ecu Extract.
Yes/No	No	No	n:1	VariableDataPrototype instance in the RPortPrototype OR VariableDataPrototype instance in the PPortPrototype at the CompositionSwComponentType of the rootSoftwareComposition of the Ecu Extract.
No/Yes	No	No	n:m where n > 1 and m > 1	VariableDataPrototype instance in any of the PRPortPrototypes





No/Yes	Yes	No	n:m where n ≥ 1 and m ≥ 1	VariableDataPrototype instance in the AbstractProvidedPortPrototype at the NvBlockSwComponent
No	No	Yes	1:n	VariableDataPrototype instance in the AbstractProvidedPortPrototype AND one per different representation of VariableDataPrototype instance in the RPortPrototype
Yes	No	Yes	1:n	VariableDataPrototype instance in the AbstractProvidedPortPrototype AND one per different representation of VariableDataPrototype instance in the RPortPrototype AND one per different representation of VariableDataPrototype instance in the PPortPrototype at the CompositionSwComponentType of the root-SoftwareComposition of the Ecu Extract .
No	No	Yes	n:1	VariableDataPrototype instance in the AbstractRequiredPortPrototype AND one per different representation of VariableDataPrototype instance in the PPortPrototype
Yes	No	Yes	n:1	VariableDataPrototype instance in the AbstractRequiredPortPrototype AND one per different representation of VariableDataPrototype instance in the PPortPrototype AND one per different representation of VariableDataPrototype instance in the PPortPrototype at the CompositionSwComponentType of the root-SoftwareComposition of the Ecu Extract .
No	Yes	Yes	where n ≥ 1 and m ≥ 1	VariableDataPrototype instance in the AbstractProvidedPortPrototype at the NvBlockSwComponent AND one per different representation of VariableDataPrototype instance in the PortPrototype



△

Yes	Yes	Yes	where $n \geq 1$ and $m \geq 1$	<p>VariableDataPrototype instance in the AbstractProvidedPortPrototype at the NvBlockSwComponent</p> <p>AND one per different representation of VariableDataPrototype instance in the PortPrototype</p> <p>AND one per different representation of VariableDataPrototype instance in the PPortPrototype at the CompositionSwComponentType of the rootSoftwareComposition of the Ecu Extract.</p>
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Table 7.1: Reference targets of RIPS FlatInstanceDescriptors

In case of conversion several [RIPS FlatInstanceDescriptors](#) are required to define the interface name spaces for the individual different representations of data and/or data status. Nevertheless it is not possible that the different representations get handled by different [RTE Implementation Plug-Ins](#).

[SWS_Rte_CONSTR_80003] [A [Data Communication Graph](#) is handled by at most one [Local Software Cluster Communication Plug-In](#) In the case that a [Data Communication Graph](#) is referenced by several [RIPS FlatInstanceDescriptors](#) all those [RIPS FlatInstanceDescriptors](#) shall reference via [FlatInstanceDescriptor.rtePluginProps.associatedRtePlugin](#) the identical [RteRipsPluginProps](#) container.] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

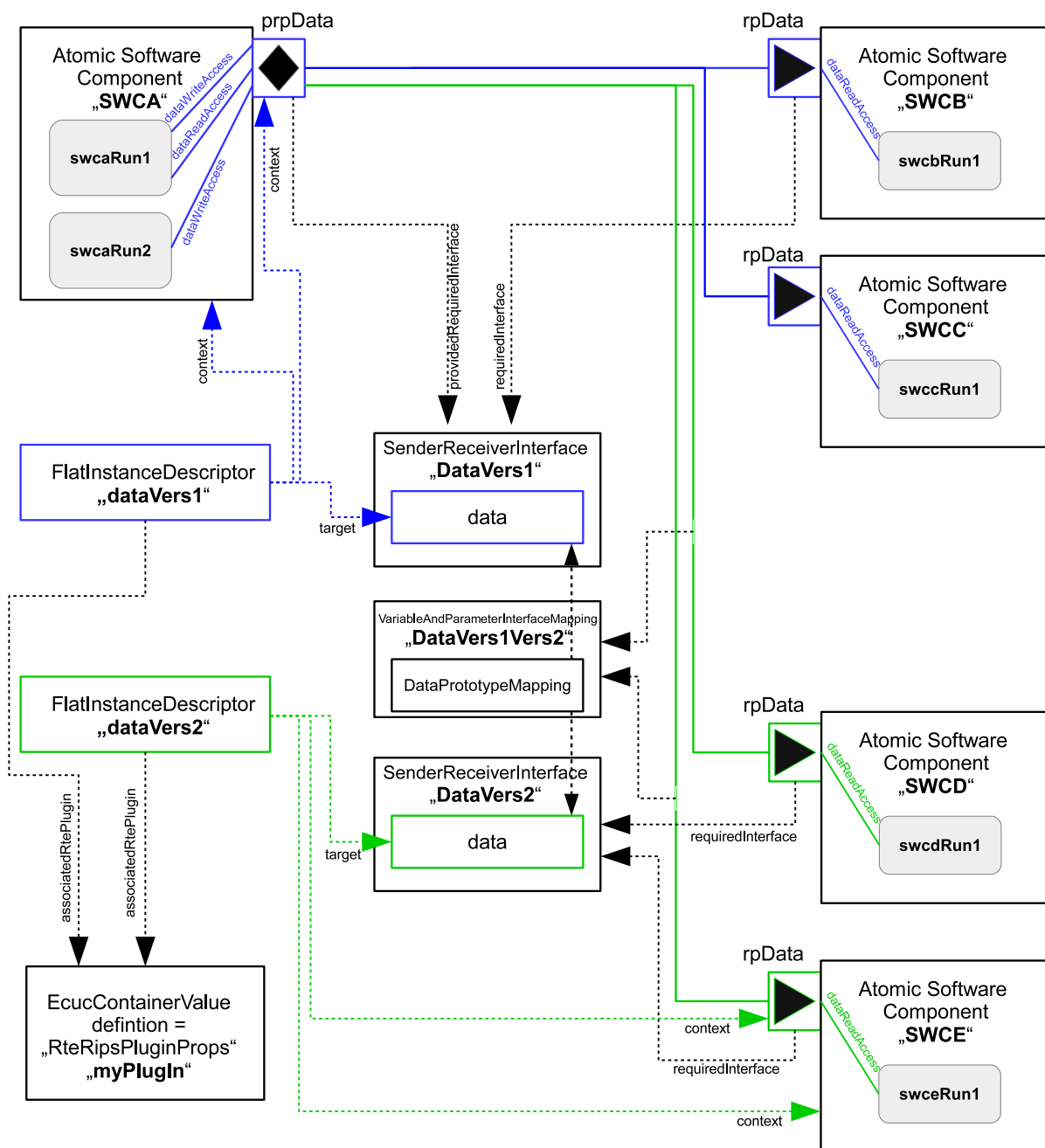


Figure 7.3: Data Communication Graph with conversion

The figure 7.3 illustrates an example for a **Data Communication Graph** with data conversion. Thereby it shall be assumed, that the **dataElements** data given in two different **SenderReceiverInterfaces** are typed by **ApplicationDataTypes** describing a different resolution (not shown in the figure).

The **RIPS FlatInstanceDescriptor** **dataVers1** assigns the blue part of the **Data Communication Graph** for the ports of the **Atomic Software Components** SWCA, SWCB, and SWCC to the **RTE Implementation Plug-In**. The **RIPS**

`FlatInstanceDescriptor` `dataVers2` assigns the green part of the `Data Communication Graph` - with the converted representation of data - for the `Atomic Software Components` `SWCD` and `SWCE` to the `RTE Implementation Plug-In`.

As demanded by [SWS_Rte_CONSTR_80003] both parts of the `Data Communication Graph` are assigned to the same `RTE Implementation Plug-In` `myPlugIn`.

The `RIPS FlatInstanceDescriptor` is referencing the targets as demanded by [SWS_Rte_CONSTR_80002].

Please note that the `RIPS FlatInstanceDescriptor` `dataVers2` is applicable for all ports of the `Atomic Software Components` accessing the `Data Communication Graph` on the basis of the `dataElement` data in `SenderReceiverInterface` `DataVers2`.

Further details about conversion are described in section 7.3.4.4

7.3.4.3 Data Communication Graphs involving `NvBlockSwComponents`

In the special case of non volatile data the `RIPS FlatInstanceDescriptor` will reference the `AbstractProvidedPortPrototype` of the `NvBlockSwComponent`. As the protection and buffering always has to consider the complete `Data Communication Graph` and this `Data Communication Graph` in this case not only includes the direction from the data element of the `ramBlock` to the consuming software component, but also from the producing software component to the data element in the `ramBlock`, this single `RIPS FlatInstanceDescriptor` also affects the latter connection.

[SWS_Rte_80033] [The RTE Generator and the `RTE Implementation Plug-In` shall consider all `VariableDataPrototype` instances in `PortPrototypes` of `Atomic Software Components` which are connected to `VariableDataPrototype` instances in `PortPrototypes` of the `NvBlockSwComponent` which in turn are mapped together with the same `NvBlockDataMapping` to an element of the `ramBlock` as belonging to the same `Data Communication Graph`. Additionally the mapped element of the `ramBlock` belongs to this `Data Communication Graph`.] (*SRS_Rte_00300, SRS_Rte_00301*)

The RTE Generator can use the fact of [SWS_NvM_00347] that all `ramBlock` accesses within a `NvBlockSwComponent` are done in the call context of the `ExecutableEntity` `NvM_MainFunction`.

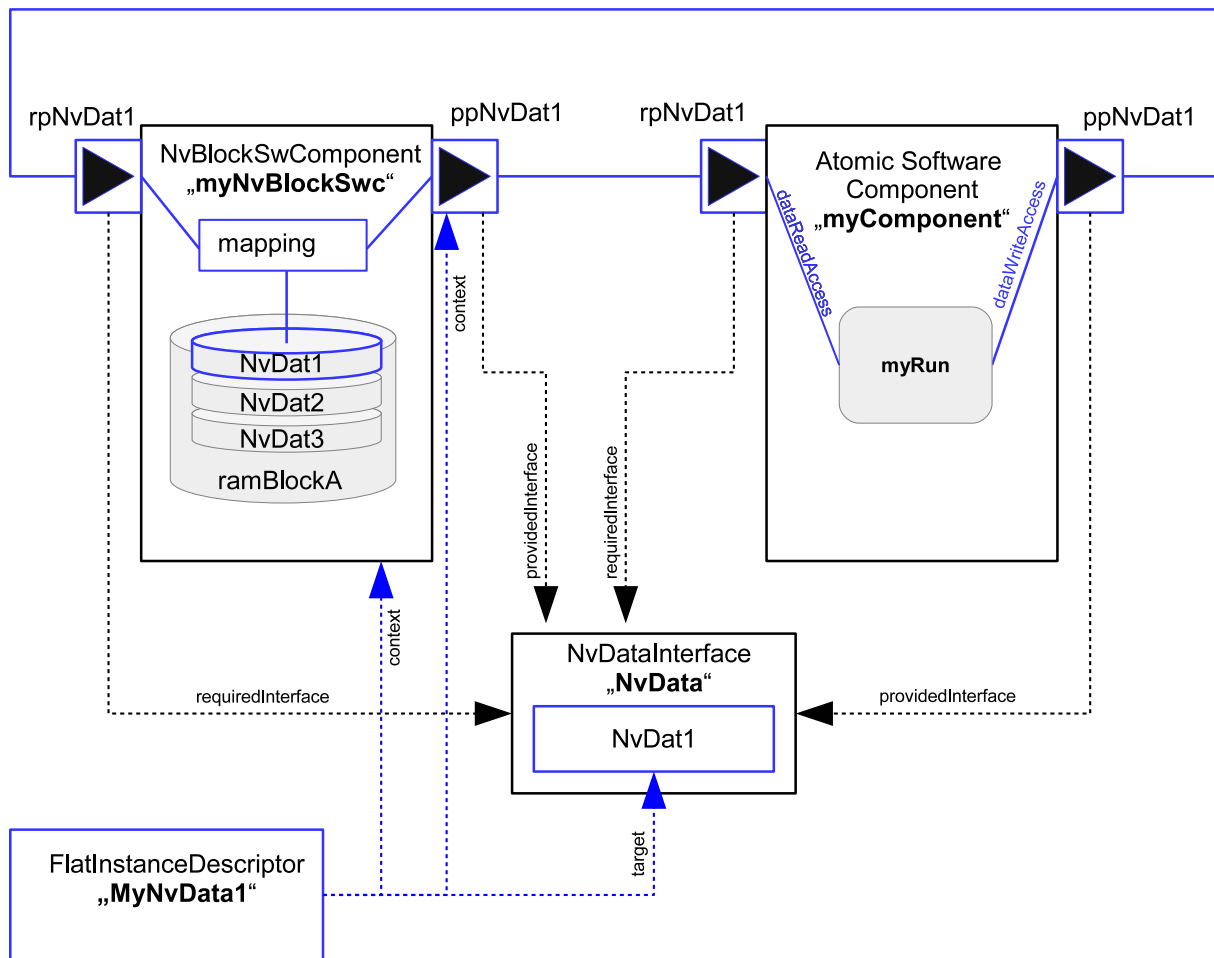


Figure 7.4: Data Communication Graph involving a NvBlockSwComponent

The figure 7.4 illustrates an example for a Data Communication Graph involving a NvBlockSwComponent. Thereby the RIPS FlatInstanceDescriptor MyNvData1 is referencing the p-port ppNvDat1 of the NvBlockSwComponent myNvBlockSwc. This enables the RTE Implementation Plug-In also for the partial Data Communication Graph from the p-port ppNvDat1 of the Atomic Software Component myComponent to the r-port rpNvDat1 of the NvBlockSwComponent. The shortName of this FlatInstanceDescriptor defines the name of the RTE Implementation Plug-In Services for this, not explicitly marked Data Communication Graph.

Due to the structure nature of the ramBlock it is possible, that different Data Communication Graphs overlay within the same ramBlock. There exist valid use cases for such configurations, since it can be required to write (and optionally also read) the whole ramBlock or a larger sub-structure of it via one port whereas the single data elements are provided in distinct p-ports.

[SWS_Rte_80103] [The RTE Generator shall support the overlay of Data Communication Graphs in ramBlocks.] (SRS_Rte_00300, SRS_Rte_00301)

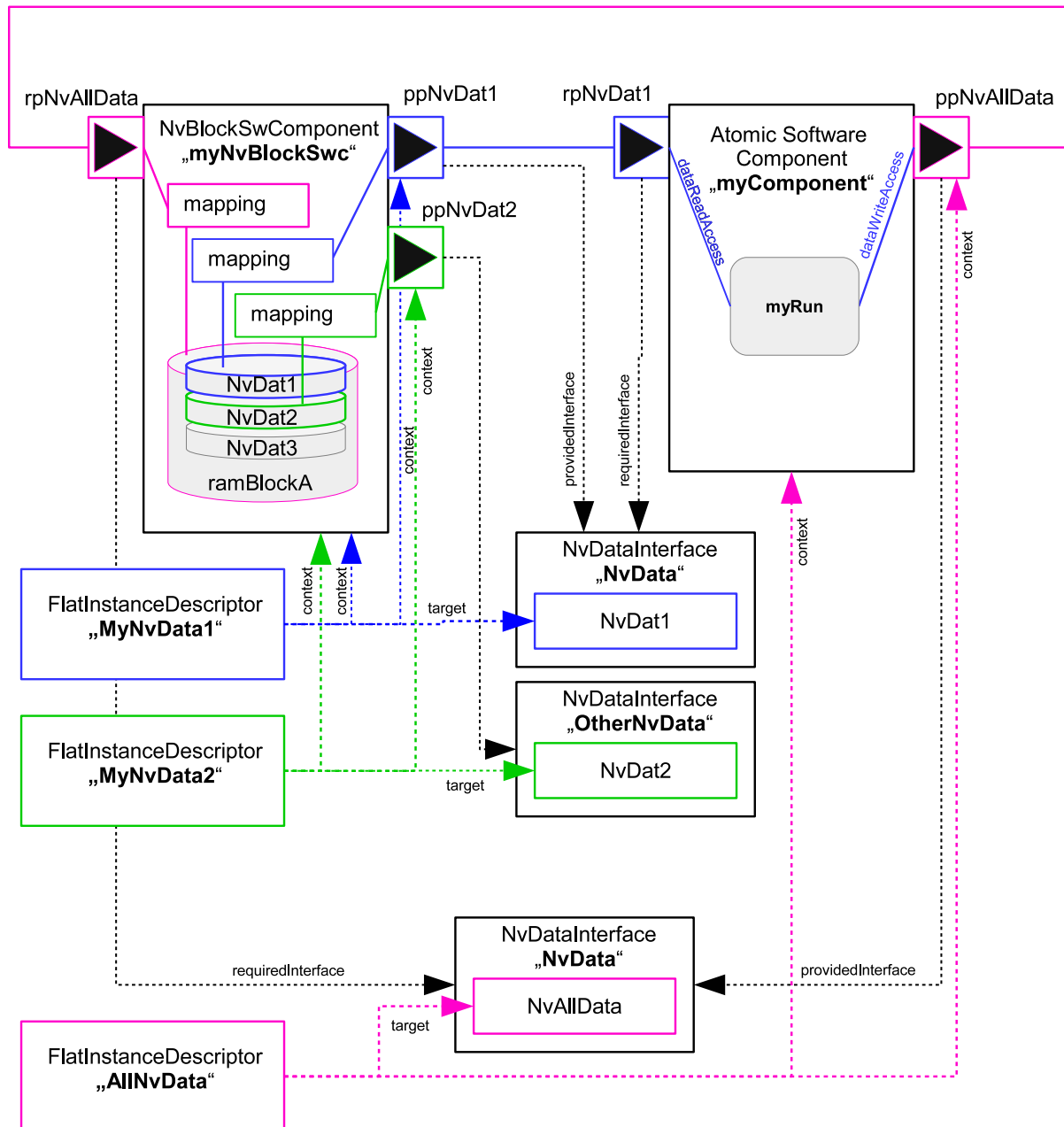


Figure 7.5: Overlay of Data Communication Graphs in a ramBlock

The figure 7.5 illustrates an example for the overlay of Data Communication Graphs in a `ramBlock`. In this example the Data Communication Graph `AllNvData` gets written by the Atomic Software Component `myComponent` via the p-port `ppNvAllData`. Further on Data Communication Graph `AllNvData` overlays the Data Communication Graphs `MyNvData1` and `MyNvData2` which are sub-elements of the `ramBlock`.

7.3.4.4 Handling of Communication Status and Conversion with RTE Implementation Plug-Ins

In general compatibility of `PortInterfaces` and `PortInterface` mapping rules are not affected by the usage of `RTE Implementation Plug-In`. But as a consequence, besides the buffering or access protection there are some operations the RTE has to perform on the data. These are the online conversion of data, range checks, and status calculations and updates.

Although these are basically RTE internal operations not having any relation to `RTE Implementation Plug-Ins`, the RTE still needs to know when and where (in terms of memory address) it can perform these operations. Remember that the RTE will not know the buffering decision for the individual data and therefore e.g. also does not know whether to operate on the global or local copy of this data. So there is a need for an agreement between RTE and `RTE Implementation Plug-In` on this. The first important point to note is that in this sense status calculations of data are treated just as online conversions, although they do not affect the value of the data itself.

For instance such a status conversion occurs when in a `Data Communication Graph` software components request different settings in `ReceiverComSpec` attributes, which would lead to a different status value for the individual software components.

[SWS_Rte_80034] [The RTE Generator shall handle a conversion between different `VariableDataPrototype` instances in `PortPrototypes` inside a `Data Communication Graph` if either the data values can differ for the individual `Atomic Software Components` or if the status belonging to the data can differ for the individual `Atomic Software Components` as defined in table 7.2.](*SRS_Rte_00300*, *SRS_Rte_00301*)

<i>PPortPrototype</i> (1)	<i>PPortPrototype</i> (2)	<i>RPortPrototype</i> (3)	<i>Status Conversion</i>
None	None	None	no
None	None	Receiver Status	no
None	Sender Status	None	no
None	Sender Status	Receiver Status	Yes (1,2 -> 3)
Sender Status	None	None	no
Sender Status	None	Receiver Status	Yes (1,2 -> 3)
Sender Status	Sender Status	None	no
Sender Status	Sender Status	Receiver Status	Yes (1,2 -> 3)
Receiver Status	None	None	no
Receiver Status	None	Receiver Status	No
Receiver Status	Sender Status	None	Yes (2 -> 1,3)
Receiver Status	Sender Status	Receiver Status	Yes (2 -> 1,3)
Sender Status Receiver Status	None	None	no
Sender Status Receiver Status	None	Receiver Status	No
Sender Status Receiver Status	Sender Status	None	Yes (2 -> 1,3)
Sender Status Receiver Status	Sender Status	Receiver Status	Yes (2 -> 1,3)

Table 7.2: Status Conversion between the provide and the require ports

The existence of the Sender Status and Receiver Status depends on the configuration of the communication features in a [Data Communication Graph](#). The enabling of communication features is controlled by the [SenderComSpec](#), [ReceiverComSpec](#), and the [InvalidationPolicy](#).

[SWS_Rte_80035] [The RTE Generator and the [RTE Implementation Plug-In](#) consider the Sender Status as required, if

- [InvalidationPolicy.handleInvalid](#) is not set to [dontInvalidate](#)
- AND/OR
- [SenderComSpec.handleOutOfRange](#) is not set to [none](#)
- AND/OR
- [SenderComSpec.transmissionAcknowledge](#) is defined

] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

[SWS_Rte_80036] [The RTE Generator and the [RTE Implementation Plug-In](#) consider the Receiver Status as required, if

- [InvalidationPolicy.handleInvalid](#) is not set to [dontInvalidate](#)
- AND/OR

- `ReceiverComSpec.handleOutOfRange` is not set to `none`
AND/OR
- `NonqueuedReceiverComSpec.aliveTimeout` is set to a value greater than zero
AND/OR
- `NonqueuedReceiverComSpec.handleNeverReceived` is set to `TRUE`
AND/OR
- `NonqueuedReceiverComSpec.enableUpdate` is set to `TRUE`
AND/OR
- `NonqueuedReceiverComSpec.handleDataStatus` is set to `TRUE`.

]([SRS_Rte_00300](#), [SRS_Rte_00301](#))

Additionally the enabling of communication features can impact the data value which is accessible by the reading software component. Since this value can differ from the written value the setup of following communication attributes requires a conversion between the sender and the receiver in any case.

[SWS_Rte_80037] [The RTE Generator and the [RTE Implementation Plug-In](#) consider a conversion between Sender and Receiver, if

- `NonqueuedReceiverComSpec.handleTimeoutType` is not set to `none`
AND/OR
- `InvalidationPolicy.handleInvalid` is not set to `dontInvalidate` nor `keep`.

]([SRS_Rte_00300](#), [SRS_Rte_00301](#))

When several `AbstractProvidedPortPrototypes` are connected in one `Data Communication Graph` it is possible that the Sender Statuses differ due to different communication attributes.

[SWS_Rte_80038] [The RTE Generator and the [RTE Implementation Plug-In](#) consider different Senders Statuses, if the values of `SenderComSpec.transmissionAcknowledge.timeout` are not set identically.]([SRS_Rte_00300](#), [SRS_Rte_00301](#))

Last but not least when several `AbstractRequiredPortPrototypes` are connected in one `Data Communication Graph` it is possible that the Receiver Statuses or the received values differ due to different communication attributes.

[SWS_Rte_80039] [The RTE Generator and the [RTE Implementation Plug-In](#) shall consider different Receiver Statuses or received data values, if

- `NonqueuedReceiverComSpec.handleTimeoutType` is not equal for all `AbstractRequiredPortPrototypes`

AND/OR

- `NonqueuedReceiverComSpec.handleTimeoutType` is set to `replaceByTimeoutSubstitutionValue` AND `timeoutSubstitutionValue` is not equal for all `AbstractRequiredPortPrototypes`

AND/OR

- `InvalidationPolicy.handleInvalid` is not equal for all `AbstractRequiredPortPrototypes`

AND/OR

- `InvalidationPolicy.handleInvalid` is set to `replace` AND `initValue` is not equal for all `AbstractRequiredPortPrototypes`

AND/OR

- `InvalidationPolicy.handleInvalid` is set to `externalReplacement` AND `replaceWith` results in a different data instance providing the replacement value

AND/OR

- `ReceiverComSpec.handleOutOfRange` is not equal for all `AbstractRequiredPortPrototypes`

AND/OR

- `ReceiverComSpec.handleOutOfRange` is set to `default` AND `initValue` is not equal for all `AbstractRequiredPortPrototypes`

AND/OR

- `ReceiverComSpec.handleOutOfRange` is set to `invalid` AND `invalidValue` is not equal for all `AbstractRequiredPortPrototypes`

AND/OR

- `ReceiverComSpec.handleOutOfRange` is set to `externalReplacement` AND `replaceWith` results in a different data instance providing the replacement value.

](*SRS_Rte_00300*, *SRS_Rte_00301*)

If a `Data Communication Graph` is handled by an `RTE Implementation Plug-In`, the online data conversion will always be done during the production of the data rather than the consumption. This implies that there will be a separate local or `global copy` of the data for each of its representations (see also [*SWS_Rte_80034*]). This might take some optimization potential, but as usually each of the representations will be measurable anyway, the risk is very limited.

Typical examples of different representations are different resolutions or different sets of status bits. On the other hand a pure name mapping of `TEXTTABLES` does not represent a different representation. Please note however that this does not mean that the only reason for a `RIPS FlatInstanceDescriptors` on an `RPortPrototype` is having a different representation. It could as well happen that the "conversion" between producer and consumer of data in an `Data Communication Graph` is just a copy.

This means, either the RTE provides an individual data instance per representation (see [SWS_Rte_80040]), or, in case `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`, it is a duty of the `RTE Implementation Plug-Ins` to do so.

[SWS_Rte_80057] [The RTE shall reject configurations where not for each required representation according [SWS_Rte_80040] a `RIPS FlatInstanceDescriptor` is provided.](*SRS_Rte_00300, SRS_Rte_00301*)

Please note: On the opposite side a configuration may contain `RIPS FlatInstanceDescriptors` which are not needed by the RTE but have to be accepted by the RTE.

As the online conversion shall be done on producer side, it is obvious that for explicit producers this means inside the explicit write API. For implicit producers this is not so obvious. Such a conversion could be done during the whole life cycle of the local copy, including the flush operation. However, as the RTE does not know the buffering decision, it is not clear, whether for certain data there will even be a dedicated flush operation. So the conversion has to be done directly after termination of the producer `RunnableEntity`.

For explicit communication this means:

[SWS_Rte_80058] [For explicit producers, the RTE generator shall place the conversion or status update code necessary for a `Data Communication Graph` handled by `RTE Implementation Plug-Ins` into the explicit write API. The conversion code shall manipulate the global copies of all representations of the written data.](*SRS_Rte_00300, SRS_Rte_00301*)

Manipulating the other global copies as well will also mean to either protect their write accesses via the `Rte_Rips_StartWrite` / `Rte_Rips_StopWrite` or to use the write API `Rte_Rips_Write` of the `RTE Implementation Plug-Ins` for all representations of the data.

[SWS_Rte_80059] [In case of explicit write access to a `Data Communication Graph` handled by `RTE Implementation Plug-Ins` with `RTE_RIPS_INSTANTIATION_BY_RTE` where the `Data Communication Graph` requires status or data conversion, the RTE shall use the explicit access protection macros of all representations to protect the write action of their calculated values or status, just as if the producer `ExecutableEntity` would have explicit write accesses to all representations.](*SRS_Rte_00300, SRS_Rte_00301*)

[SWS_Rte_80060] [In case of explicit write access to a [Data Communication Graph](#) handled by [RTE Implementation Plug-Ins](#) with `RTE_RIPS_INSTANTIATION_BY_PLUGIN` where the [Data Communication Graph](#) requires status or data conversion, the RTE shall use the explicit write service of all representations to implement the write action of their calculated values or status, just as if the producer [ExecutableEntity](#) would have explicit write accesses to all representations.] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

[SWS_Rte_70048] [The [RTE Implementation Plug-Ins](#) shall provide the set of explicit access protection services or explicit write services for each representation in a [Data Communication Graph](#), even though the producing Runnable only models a single access point.] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

For implicit communication this means:

[SWS_Rte_80061] [For implicit producers, the RTE generator shall place the conversion or status update code necessary for a certain [Data Communication Graph](#) handled by [RTE Implementation Plug-Ins](#) directly after the call of the implicit producer [RunnableEntity](#). Thereby executing the VFB tracing hook for this [RunnableEntity](#) still before the conversion or the status update code is acceptable.] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

As in the implicit case, the RTE Generator still does not know whether the other representations are buffered or not. It needs a clear interface to get access to the locations where the original producer has written the data to and where the consumers will read the converted data from. Note that the unconverted data will be written by the [Rte_Rips_IWrite](#)/[Rte_Rips_IWBufferRef](#) API or the Flush-Routine, depending on the buffering strategy. A separate name space will be used for the [Rte_Rips_IWBufferRef](#) and [Rte_Rips_IRBufferRef](#) services used by the RTE conversion and status calculation code. This avoids name clashes as well as it supports source code implementations of the [Rte_Rips_IWBufferRef](#) and [Rte_Rips_IRBufferRef](#) services used by the RTE, even if the software component is delivered as object code.

[SWS_Rte_80063] [The name space of [Rte_Rips_IWBufferRef](#) and [Rte_Rips_IRBufferRef](#) services used by the RTE conversion and status calculation code is created by prefixing the `<SwcBswI>` and `<ExE>` name part with `RteCnv`.] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

[SWS_Rte_80064] [In case of implicit write access to a [Data Communication Graph](#) handled by [RTE Implementation Plug-Ins](#) with data or status conversion, the RTE shall use [Rte_Rips_IWrite](#) without `RteCnv` prefix and [Rte_Rips_IWBufferRef](#) without `RteCnv` prefix to implement the `dataWriteAccess` of the [RunnableEntity](#), and the implicit [Rte_Rips_IWBufferRef](#) service with `RteCnv` prefix of all representations different to the producer's one to write their calculated values or status. If needed, the unconverted value written by the producer shall be retrieved via the [Rte_Rips_IRBufferRef](#) with `RteCnv` prefix only.] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

[SWS_Rte_70049] [The RTE Implementation Plug-Ins shall provide for the RunnableEntity with the dataWriteAccess for each representation in a Data Communication Graph the set of implicit access services Rte_Rips_IWrite / Rte_Rips_IWBufferRef, Rte_Rips_IRBufferRef, even though the producing Runnable only models a single access point. Thereby following set of RTE Implementation Plug-In Services shall be provided:

- For the data representation in the accessed PPortPrototype:
 - Rte_Rips_IWrite without RteCnv prefix, if applicable due to data type
 - Rte_Rips_IWBufferRef without RteCnv prefix
 - Rte_Rips_IRBufferRef with RteCnv prefix.
- For each to be converted data representation connected to the accessed PPort-Prototype: One Rte_Rips_IWBufferRef with RteCnv prefix.

](SRS_Rte_00300, SRS_Rte_00301)

For illustration please note example 7.11.

7.3.4.5 Instantiation of global copy

The RTE Implementation Plug-In interface assumes that the RTE implements a variable that holds the actual value of communication data and where readers and writers can set or get the data value. This variable is called *global copy* in the RTE Implementation Plug-In relevant sections. In addition the concept of implicit communication requires further buffers to ensure the stability of data for specific accessing RunnableEntities. Those are called *implicit communication buffers*.

As described in section 7.3.4.2 one or multiple RIPS FlatInstanceDescriptors can point to a Data Communication Graph to enable the RTE Implementation Plug-In support. Thereby the number of RIPS FlatInstanceDescriptors determines the number of possible different representations of the data. Furthermore the shortName of the RIPS FlatInstanceDescriptor defines the name space of such a *global copy* and the belonging RTE Implementation Plug-In Services.

[SWS_Rte_80040] [The RTE shall provide an individual *global copy* for each RIPS FlatInstanceDescriptor referencing the Data Communication Graph, if the associated Local Software Cluster Communication Plug-In has set the RteRipsGlobalCopyInstantiationPolicy to RTE_RIPS_INSTANTIATION_BY_RTE.](SRS_Rte_00300, SRS_Rte_00301)

Please note that the RTE Generator still has the freedom to decide about the naming of the *global copy* as well as to group several global copies in RTE specific structures.

In this case the requirement [SWS_Rte_80006] ensures the accessibility by a defined name.

The typing of the global copies reuses the already existing concept of data handles (see [data handles section](#)). This eases encapsulation of the implicit buffering into a RTE Implementation Plug-In, since the types of the handles already fit to the [global copy](#). This supports an easy fill and flush of the data with the belonging status values. Further on it avoids additional RTE Implementation Plug-In Services to access the status of data.

[SWS_Rte_80041] [When the RTE provides an individual [global copy](#) for a [Data Communication Graph](#) with any implicit access, it shall use the data type according table 7.3.](SRS_Rte_00300, SRS_Rte_00301)

Sender Status	Receiver Status	Type of global copy
No	No	data element without status
Yes	No	data element with status
No	Yes	data element with status
Yes	Yes	data element with extended status

Table 7.3: Data type of global copy

Please note: [SWS_Rte_80041] ensures a well defined data type for [Data Communication Graphs](#) with implicit accesses, but it leaves the data type open for [Data Communication Graphs](#) with solely explicit accesses.

To support the coexistence of multiple optimization domains in a single ECU, certain [Data Communication Graphs](#) can be assigned to distinct, specialized [Local Software Cluster Communication Plug-In](#). Those RTE Implementation Plug-Ins could then even take over the responsibility to instantiate the global copies of the related [Data Communication Graph](#).

[SWS_Rte_70043] [The [associated Local Software Cluster Communication Plug-In](#) shall instantiate the required global copies for a [Data Communication Graphs](#), if the associated RTE Implementation Plug-In has set the [RteRipsGlobalCopyInstantiationPolicy](#) to [RTE_RIPS_INSTANTIATION_BY_PLUGIN](#).](SRS_Rte_00300, SRS_Rte_00301, SRS_Rte_00303)

Please note, that in case of [SWS_Rte_70043] the [associated Local Software Cluster Communication Plug-In](#) has now freedom to name and group the [global copy](#). It could even implement strategies working with multiple global copies for the same [Data Communication Graph](#).

In contrast to [Local Software Cluster Communication Plug-Ins](#), [Cross Software Cluster Communication Plug-Ins](#) will create a communication buffer which is accessible to / from other [Software Clusters](#). In case only a [Cross Software Cluster Communication Plug-In](#) is associated to a [Data Communication Graph](#) the RTE could omit its [global copy](#), except it is still required for measurement purpose or other RTE requirements leading to those [global copy](#).

[SWS_Rte_70116] [The [associated Local Software Cluster Communication Plug-In](#) shall initialize the global copies for [Data Communication Graphs](#) if

- an `initValue` is defined
- AND
- either
 - no `SwAddrMethod` is defined for the `VariableDataPrototype`.
 - or
 - a `SwAddrMethod` is defined for the `VariableDataPrototype`.
- AND
- the `sectionInitializationPolicy` of the related `SwAddrMethod` is NOT set to `NO-INIT`.

] ([SRS_Rte_00052](#), [SRS_Rte_00068](#), [SRS_Rte_00116](#))

Note: Concerning the calculation of the init values the [RTE Implementation Plug-In](#) has to support the different possibilities of init value expression offered by the meta model, in particular:

- [NumericalValueSpecification](#)
- [ApplicationValueSpecification](#)
- [NumericalRuleBasedValueSpecification](#)
- [ApplicationRuleBasedValueSpecification](#)
- [CompositeValueSpecification](#)
- [ConstantReference](#)
- [TextValueSpecification](#)

[SWS_Rte_70117] [The [RTE Implementation Plug-In](#) shall support the different kind of [ValueSpecifications](#) applicable for software components.] ([SRS_Rte_00052](#), [SRS_Rte_00068](#), [SRS_Rte_00116](#))

[ValueSpecifications](#) are defined in document [\[2\]](#).

7.3.4.6 Explicit Communication and RTE Implementation Plug-Ins

The support for handling explicit communication via [RTE Implementation Plug-In](#) basically differs whether the [RTE Implementation Plug-In](#) provides the global copy or whether the RTE provides the global copy. In the first case the RTE

just forwards the explicit accesses via the [RTE Implementation Plug-In Services](#) whereas in the second case the RTE has to use the [RTE Implementation Plug-In Services](#) to protect potentially non atomic accesses.

7.3.4.6.1 Global copy provided by RTE

In the case the global copy is provided by the RTE the only point of interest for the [RTE Implementation Plug-In](#) is the kind of protection. For that purpose for read and write accesses pairs of [RTE Implementation Plug-In Services](#) are provided for opening the protection block and another one for closing it. The rest remains like in an RTE code not using an [RTE Implementation Plug-In](#). The [RTE Implementation Plug-In](#) only needs to know whether there is an according interruption scenario and whether the data type is atomic in the given platform or not. Special care has to be taken for the data status handling, as this might also lead to a protection need, even though the pure data would be atomic otherwise. So the [RTE Implementation Plug-In](#) has to check whether a Sender Status or Receiver Status exists. An RTE in turn has to make sure that the complete buffer manipulation happens under a single protection block.

[SWS_Rte_80043] [The RTE shall use the protecting [RTE Implementation Plug-In Services](#) [Rte_Rips_StartRead](#), [Rte_Rips_StopRead](#), [Rte_Rips_StartWrite](#), and [Rte_Rips_StopWrite](#) for any access to the [Data Communication Graph](#) where the implemented algorithm would suffer from a pre-emption or concurrent execution. The usage shall be independent of the actual pre-emption scenario found in the configuration.] ([SRS_Rte_00300](#))

Please note: [\[SWS_Rte_80043\]](#) applies for unqueued and queued communication.

The [RTE Implementation Plug-Ins](#) will know the possible pre-emptions and provides an appropriate protection macro implementation.

[SWS_Rte_70044] [The associated RTE Implementation Plug-In shall provide the protecting [RTE Implementation Plug-In Services](#) [Rte_Rips_StartRead](#), [Rte_Rips_StopRead](#), [Rte_Rips_StartWrite](#), and [Rte_Rips_StopWrite](#) with an appropriate protection functionality for any explicit access to the [Data Communication Graph](#). Thereby the [RTE Implementation Plug-Ins](#) shall consider whether the access is non-atomic due to the following side conditions

- the size of the data
- the existence of Sender Status or Receiver Status
- potential pre-emptions caused due to configured scheduling during the accesses to the [Data Communication Graphs](#)
- usage of queued communication.

] ([SRS_Rte_00300](#))

Please note, that the associated RTE Implementation Plug-In has to provide the protecting RTE Implementation Plug-In Services regardless whether any protection is needed. In case that no protection is needed the RTE Implementation Plug-In Services can be empty. See also the according existence conditions [SWS_Rte_70019], [SWS_Rte_70020], [SWS_Rte_70021], [SWS_Rte_70022], [SWS_Rte_70023], [SWS_Rte_70024], [SWS_Rte_70025], [SWS_Rte_70026].

The protection blocks can be nested, e.g. when a Runnable uses explicit communication while being executed in an ExclusiveArea. It is therefore recommended to generally use protection block implementations which support nesting. As a minimum, such implementations have to be used where nesting can occur, which would have to be analyzed beforehand. On one hand those ExclusiveAreas are relevant which are directly used by the ExecutableEntity (1) accessing the Data Communication Graphs. Additionally those ExclusiveAreas are relevant which are used by all ExecutableEntities invoking the ExecutableEntity (1) by a direct or trusted function call with the Data Communication Graphs access.

[SWS_Rte_70045] [RTE Implementation Plug-In shall implement the protecting RTE Implementation Plug-In Services Rte_Rips_StartRead, Rte_Rips_StopRead, Rte_Rips_StartWrite, and Rte_Rips_StopWrite in a way, that those support a potential nesting with ExclusiveAreas when it can occur in the call graph.] (SRS_Rte_00300)

7.3.4.6.1.1 Simple example about non-queued read and write

The example code below shows the basic implementation in case the data does not have any assigned status and the software component does not support multiple instantiation and is provided as source code. Additionally, 64bit accesses are not atomic on the underlying platform to demonstrate a protection scenario. In contrast to the others, Rte_DRead is not implemented as a macro in order to show a different implementation flavour.

Example 7.4

Code example for Rte_myComponent.h in case the RTE Generator implements the explicit APIs:

```

1  extern uint64 Rte_myExplicitSimpleData;
2
3  #define Rte_Write_myPPort1_myExplicitSimpleData(data) ( \
4      Rte_WriteHook_myComponent_myPPort1_myExplicitSimpleData_Start(data), \
5      SuspendOSInterrupts(), \
6      (Rte_myExplicitSimpleData = data), \
7      ResumeOSInterrupts(), \
8      Rte_WriteHook_myComponent_myPPort1_myExplicitSimpleData_Return(data), \
9      RTE_E_OK)
10

```

```

11 #define Rte_Read_myRPort1_myExplicitSimpleData(data) ( \
12   Rte_ReadHook_myComponent_myRPort1_myExplicitSimpleData_Start(data), \
13   SuspendOSInterrupts(), \
14   ((*data) = Rte_myExplicitSimpleData), \
15   ResumeOSInterrupts(), \
16   Rte_ReadHook_myComponent_myRPort1_myExplicitSimpleData_Return(data), \
17   RTE_E_OK)
18
19 extern uint64 Rte_DRead_myComponent_myRPort1_myExplicitSimpleData(void)
20   ;
21 #define Rte_DRead_myRPort1_myExplicitSimpleData() (
22   Rte_DRead_myComponent_myRPort1_myExplicitSimpleData())

```

Code example for `Rte.c` in case the RTE Generator implements the explicit APIs:

```

1 #include "Rte_myComponent.h"
2
3 uint64 Rte_myExplicitSimpleData;
4 uint64 Rte_DRead_myComponent_myRPort1_myExplicitSimpleData(void)
5 {
6     uint64 rtn;
7
8     Rte_DReadHook_myComponent_myRPort1_myExplicitSimpleData_Start();
9     SuspendOSInterrupts();
10    rtn = Rte_myExplicitSimpleData;
11    ResumeOSInterrupts();
12    Rte_DReadHook_myComponent_myRPort1_myExplicitSimpleData_Return();
13    return rtn;
14 }

```

The following example 7.5 shows an equivalent implementation of the explicit APIs via an [RTE Implementation Plug-In](#).

Example 7.5

Code example for `Rte_DataHandleType.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```

1 /* Since the Communication Graph has only explicit accesses
   SWS_Rte_80041 is not applicable */

```

Code example for `Rte_myComponent.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the explicit APIs:

```

1 #include "Rte_Rips_myPlugin_myComponent.h"
2
3 extern uint64 Rte_myExplicitSimpleData;
4
5 #define Rte_Write_myPPort1_myExplicitSimpleData(data) ( \
6   Rte_WriteHook_myComponent_myPPort1_myExplicitSimpleData_Start(data), \
7   Rte_Rips_myPlugin_StartWrite_myComponent_myGlobalData1(), \
8   (Rte_myExplicitSimpleData = data), \
9   Rte_Rips_myPlugin_StopWrite_myComponent_myGlobalData1(), \
10  Rte_WriteHook_myComponent_myPPort1_myExplicitSimpleData_Return(data),
11  \

```

```

11 RTE_E_OK)
12
13 #define Rte_Read_myRPort1_myExplicitSimpleData(data) ( \
14 Rte_ReadHook_myComponent_myRPort1_myExplicitSimpleData_Start(data), \
15 Rte_Rips_myPlugin_StartRead_myComponent_myGlobalData1(), \
16 ((*data) = Rte_myExplicitSimpleData), \
17 Rte_Rips_myPlugin_StopRead_myComponent_myGlobalData1(), \
18 Rte_ReadHook_myComponent_myRPort1_myExplicitSimpleData_Return(data), \
19 RTE_E_OK)
20
21 extern uint64 Rte_DRead_myComponent_myRPort1_myExplicitSimpleData(void)
22 ;
23 #define Rte_DRead_myRPort1_myExplicitSimpleData() (
    Rte_DRead_myComponent_myRPort1_myExplicitSimpleData())

```

Code example for `Rte.c` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the explicit APIs:

```

1 #include "Rte_myComponent.h"
2
3 uint64 Rte_myExplicitSimpleData;
4 uint64 Rte_DRead_myComponent_myRPort1_myExplicitSimpleData(void)
5 {
6     uint64 rtn;
7
8     Rte_DReadHook_myComponent_myRPort1_myExplicitSimpleData_Start();
9     Rte_Rips_myPlugin_StartRead_myComponent_myGlobalData1();
10    rtn = Rte_myExplicitSimpleData;
11    Rte_Rips_myPlugin_StopRead_myComponent_myGlobalData1();
12    Rte_DReadHook_myComponent_myRPort1_myExplicitSimpleData_Return();
13    return rtn;
14 }

```

Code example for `Rte_Buffers.h` when an [RTE Implementation Plug-In](#) is associated to the [Data Communication Graph](#):

```

1 /* Since the Communication Graph has only explicit accesses
   SWS_Rte_80041 and SWS_Rte_80005 is not applicable */

```

Code example for `Rte_Rips_myPlugin_myComponent.h` when an [RTE Implementation Plug-In](#) is associated to the [Data Communication Graph](#):

```

1 #include "Rte_Buffers.h"
2
3 #define Rte_Rips_myPlugin_StartWrite_myComponent_myGlobalData1() \
4 SuspendOSInterrupts()
5
6 #define Rte_Rips_myPlugin_StopWrite_myComponent_myGlobalData1() \
7 ResumeOSInterrupts()
8
9 #define Rte_Rips_myPlugin_StartRead_myComponent_myGlobalData1() \
10 SuspendOSInterrupts()
11
12 #define Rte_Rips_myPlugin_StopRead_myComponent_myGlobalData1() \
13 ResumeOSInterrupts()

```

7.3.4.6.1.2 Simple example about queued read and write

The example 7.6 shows the basic implementation in case the data does not have any assigned status and the software component does not support multiple instantiation. The RTE uses own standard queue implementations, but those are not protected.

Example 7.6

Code example for `Rte_myComponent.h` in case the RTE Generator implements the explicit APIs:

```

1  extern Std_ReturnType
    Rte_Write_myComponent_myPPort1_myExplicitSimpleData(uint32 data);
2
3  #define Rte_Write_myPPort1_myExplicitSimpleData(data) (
    Rte_Write_myComponent_myPPort1_myExplicitSimpleData(data))
4
5  extern Std_ReturnType
    Rte_Read_myComponent_myRPort1_myExplicitSimpleData(uint32 * data);
6
7  #define Rte_Read_myRPort1_myExplicitSimpleData(data) (
    Rte_Read_myComponent_myRPort1_myExplicitSimpleData(data))

```

Code example for `Rte.c` in case the RTE Generator implements the explicit APIs:

```

1  #include "Rte_myComponent.h"
2
3  Rte_QueueType_uint32 Rte_Queue_myExplicitSimpleData;
4
5  Std_ReturnType Rte_Write_myComponent_myPPort1_myExplicitSimpleData(
    uint32 data)
6  {
7      Std_ReturnType rtn;
8
9      Rte_WriteHook_myComponent_myPPort1_myExplicitSimpleData_Start(data)
10     ;
11     SuspendOSInterrupts();
12     rtn = Rte_EnqueueUInt32(&Rte_Queue_myExplicitSimpleData, data);
13     ResumeOSInterrupts();
14     Rte_WriteHook_myComponent_myPPort1_myExplicitSimpleData_Return(data)
15     ;
16     return rtn;
17 }
18
19 Std_ReturnType Rte_Read_myComponent_myRPort1_myExplicitSimpleData(
    uint32 * data)
20 {
21     Std_ReturnType rtn;
22
23     Rte_ReadHook_myComponent_myRPort1_myExplicitSimpleData_Start(data);
24     SuspendOSInterrupts();
25     rtn = Rte_DequeueUInt32(&Rte_Queue_myExplicitSimpleData, data);
26     ResumeOSInterrupts();
27     Rte_ReadHook_myComponent_myRPort1_myExplicitSimpleData_Return(data)
28     ;
29     return rtn;

```

```
27 }
```

The following example 7.7 shows an equivalent implementation of the explicit APIs via an RTE Implementation Plug-In.

Example 7.7

Code example for `Rte_myComponent.h` in case the RTE Generator redirects towards an RTE Implementation Plug-In to implement the explicit APIs:

```
1 extern Std_ReturnType
   Rte_Write_myComponent_myPPort1_myExplicitSimpleData(uint32 data);
2
3 #define Rte_Write_myPPort1_myExplicitSimpleData(data) (
   Rte_Write_myComponent_myPPort1_myExplicitSimpleData(data))
4
5 extern Std_ReturnType
   Rte_Read_myComponent_myRPort1_myExplicitSimpleData(uint32 * data);
6
7 #define Rte_Read_myRPort1_myExplicitSimpleData(data) (
   Rte_Read_myComponent_myRPort1_myExplicitSimpleData(data))
```

Code example for `Rte.c` in case the RTE Generator redirects towards an RTE Implementation Plug-In to implement the explicit APIs:

```
1 #include "Rte_myComponent.h"
2
3 Rte_QueueType_uint32 Rte_Queue_myExplicitSimpleData;
4
5 Std_ReturnType Rte_Write_myComponent_myPPort1_myExplicitSimpleData(
   uint32 data)
6 {
7     Std_ReturnType rtn;
8
9     Rte_WriteHook_myComponent_myPPort1_myExplicitSimpleData_Start(data)
10    ;
11    Rte_Rips_myPlugin_StartWrite_myComponent_myGlobalData1();
12    rtn = Rte_EnqueueUInt32(&Rte_Queue_myExplicitSimpleData, data);
13    Rte_Rips_myPlugin_StopWrite_myComponent_myGlobalData1();
14    Rte_WriteHook_myComponent_myPPort1_myExplicitSimpleData_Return(data)
15    ;
16    return rtn;
17 }
18
19 Std_ReturnType Rte_Read_myComponent_myRPort1_myExplicitSimpleData(
   uint32 * data)
20 {
21     Std_ReturnType rtn;
22
23     Rte_ReadHook_myComponent_myRPort1_myExplicitSimpleData_Start(data);
24     Rte_Rips_myPlugin_StartRead_myComponent_myGlobalData1();
25     rtn = Rte_DequeueUInt32(&Rte_Queue_myExplicitSimpleData, data);
26     Rte_Rips_myPlugin_StopRead_myComponent_myGlobalData1();
27     Rte_ReadHook_myComponent_myRPort1_myExplicitSimpleData_Return(data)
28     ;
```

```

26     return rtn;
27 }

```

Code example for `Rte_Buffers.h` when an RTE Implementation Plug-In is associated to the Data Communication Graph:

```

1 // empty, as the communication is queued

```

Code example for `Rte_Rips_myPlugin_myComponent.h` when an RTE Implementation Plug-In is associated to the Data Communication Graph:

```

1 #include "Rte_Buffers.h"
2
3 #define Rte_Rips_myPlugin_StartWrite_myComponent_myGlobalData1()
   SuspendOSInterrupts()
4
5 #define Rte_Rips_myPlugin_StopWrite_myComponent_myGlobalData1()
   ResumeOSInterrupts()
6
7 #define Rte_Rips_myPlugin_StartRead_myComponent_myGlobalData1()
   SuspendOSInterrupts()
8
9 #define Rte_Rips_myPlugin_StopRead_myComponent_myGlobalData1()
   ResumeOSInterrupts()

```

7.3.4.6.2 Global copy provided by RTE Implementation Plug-In

In the case the global copy is provided by the RTE Implementation Plug-In the RTE Implementation Plug-In has to provide the read and write RTE Implementation Plug-In Services `Rte_Rips_Read`, `Rte_Rips_DRead` and `Rte_Rips_Write`. Those access services implement the pure data access in a protected manner to the global copy(s) provided by the RTE Implementation Plug-In. Thereby it is assumed, that a data access in an intra ECU communication scenario is always successful. In case the `Rte_Rips_Read`, `Rte_Rips_DRead` and `Rte_Rips_Write` services are used for transformer access the according error codes can occur. (see section 7.3.11.1).

Further on requirements about existence and usage are already stated in section 7.2.4.5.

The creation of the global copy is described in section 7.3.4.5.

[SWS_Rte_80075] [The RTE shall use the data access RTE Implementation Plug-In Services `Rte_Rips_Read`, `Rte_Rips_DRead` and `Rte_Rips_Write` for any explicit access to the Data Communication Graph.](*SRS_Rte_00300*, *SRS_Rte_00306*)

The RTE Implementation Plug-Ins will know the possible pre-emptions and provide an appropriate protection implementation.

[SWS_Rte_70090] [The associated Implementation Plug-In shall provide the data access RTE Implementation Plug-In Services `Rte_Rips_Read` and `Rte_Rips_Write` with an appropriate protection functionality for any access to the Data Communication Graph. Thereby the RTE Implementation Plug-In shall consider whether the access is non-atomic due to the size of the data and due to the existence of Sender Status or Receiver Status and whether the configured scheduling causes potential pre-emptions during the accesses to the Data Communication Graph.]([SRS_Rte_00300](#), [SRS_Rte_00306](#))

In case of queued communication the RTE Implementation Plug-Ins is additionally obliged to implement the queue.

[SWS_Rte_70107] [In case the `swImplPolicy` is set to `queued` in the Data Communication Graph the associated Implementation Plug-In shall implement the queuing.]([SRS_Rte_00300](#), [SRS_Rte_00306](#)) The queuing behavior is described in section 4.3.1.10.2.

The figure 7.6 illustrates how the RTE provides access with the `Rte_Rips_Read` and `Rte_Rips_Write` services to the queue implemented by the Cross Software Cluster Communication Plug-In. In addition, the Cross Software Cluster Communication Plug-In manages the access from other Software Clusters without RTE.

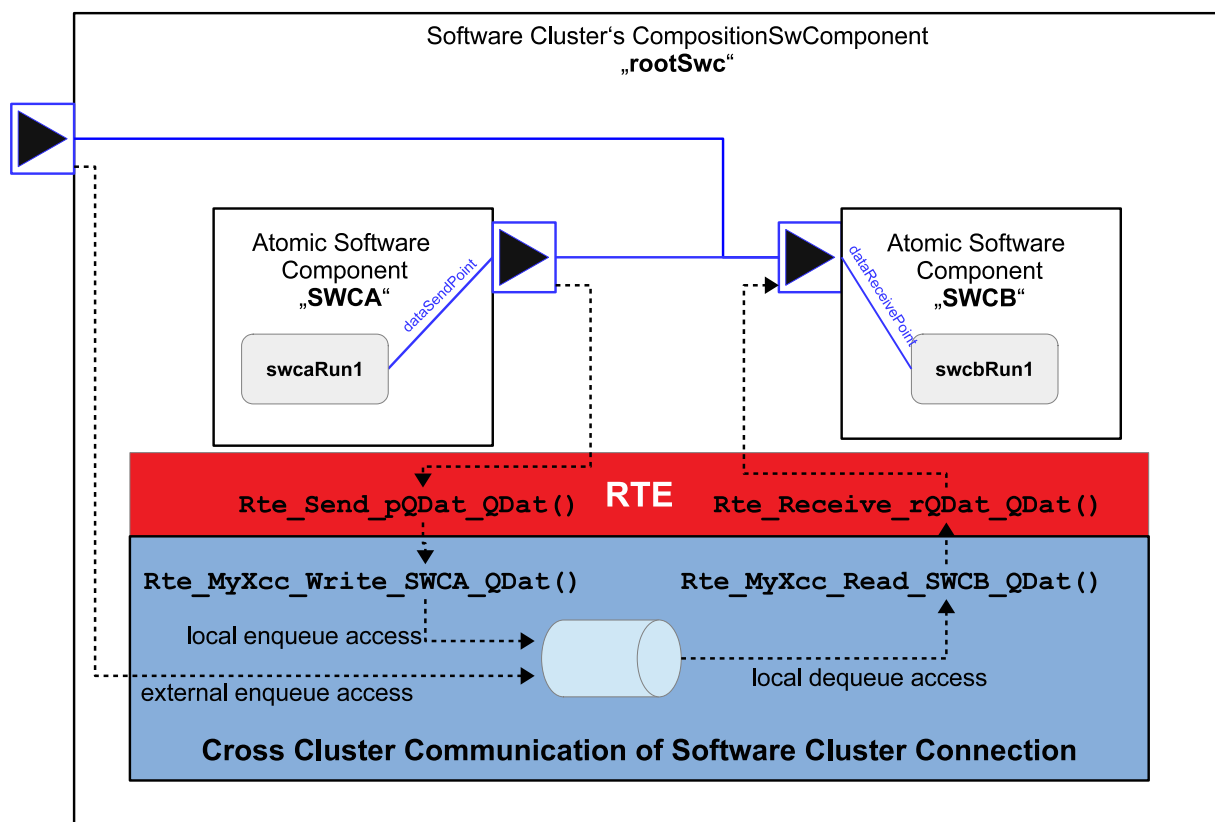


Figure 7.6: Example of queued communication with Cross Software Cluster Communication Plug-In

The protection blocks can be nested, e.g. when a Runnable uses explicit communication while being executed in an [ExclusiveArea](#). It is therefore recommended, to generally use protection block implementations which support nesting. As a minimum, such implementations have to be used where nesting can occur, which would have to be analysed beforehand. On one hand those [ExclusiveAreas](#) are relevant which are directly used by the [ExecutableEntity](#) (1) accessing the [Data Communication Graphs](#). Additionally those [ExclusiveAreas](#) are relevant which are used by all [ExecutableEntity](#)s invoking the [ExecutableEntity](#) (1) by direct or trusted function call with the [Data Communication Graph](#) access.

[SWS_Rte_70091] [RTE Implementation Plug-In shall implement the protecting RTE Implementation Plug-In Services [Rte_Rips_Read](#) and [Rte_Rips_Write](#) in a way, that those support a potential nesting with [ExclusiveAreas](#) when it can occur in the call graph.]([SRS_Rte_00300](#), [SRS_Rte_00306](#))

7.3.4.7 Implicit Communication and RTE Implementation Plug-Ins

Generally, implicit access APIs point directly to or work directly on a memory address (the task buffer or the global copy). The goal is therefore to offer a possibility that the [Local Software Cluster Communication Plug-In](#) defines this memory address. This implies that also the buffer synchronization (i.e. fill and flush) has to be done by the [Local Software Cluster Communication Plug-In](#). To do so, it needs a possibility to insert the respective code at the desired positions in the runnable call context (which might be a task body but also a caller's [Rte_Call](#), [Rte_Trigger](#) or [Rte_Switch](#) API). The RTE in turn has to disable its respective model checks (e.g. if implicit communication is allowed in a certain interruption scenario) and buffer creation for the [Data Communication Graphs](#) handled by an associated [Local Software Cluster Communication Plug-In](#).

In case of source code delivered software components, not for all implicit access macros it is strictly necessary that the implicit access macros work on a memory address, but in case of [Rte_IWrite](#) or [Rte_IRead](#) there could be some more optimized implementations. To make such implementations possible, the RTE should not provide component data structures in case of software components not requiring the compatibility mode due to source code delivery which it should anyway not do in this case to reduce ROM consumption.

The usage of the according [RTE Implementation Plug-In Services](#) is described in section [7.2.4.2](#) and [7.2.4.1](#).

[SWS_Rte_80044] [The RTE shall use the Data Handles Section and Inter Runnable Variable Handles Section for implicit communication only if the specific software component requires compatibility mode due to delivery as object code or if the specific software component supports multiple instantiations.]([SRS_Rte_00301](#), [SRS_Rte_00316](#))

[SWS_Rte_80046] [The RTE Generator shall inhibit the creation of implicit buffers and according fill and flush routines for a [Data Communication Graph](#) if it is assigned to an [Local Software Cluster Communication Plug-In](#).] ([SRS_Rte_00301](#))

[SWS_Rte_80056] [The RTE shall reject the configuration if any [RteImplicitCommunication](#) buffering related needs ([RteCoherentAccess](#) or [RteImmediateBufferUpdate](#)) affect a [Data Communication Graph](#) which is associated to an [Local Software Cluster Communication Plug-In](#).] ([SRS_Rte_00301](#))

This refers to the section [4.3.1.5](#).

In case a [Cross Software Cluster Communication Plug-In](#) is assigned to a [Data Communication Graph](#) using implicit accesses, RTE utilizes the [Rte_Rips_Read](#) and [Rte_Rips_Write](#) services to get the data from a other [Software Cluster](#) or to communicate data towards other [Software Clusters](#). Please note [\[SWS_Rte_80148\]](#) and [\[SWS_Rte_80150\]](#).

In case a [Cross Software Cluster Communication Plug-In](#) and a [Local Software Cluster Communication Plug-In](#) is assigned to a [Data Communication Graph](#) using implicit accesses, RTE can not handle read and writes from the [Cross Software Cluster Communication Plug-In](#) since it neither knows the real point in time when the [Local Software Cluster Communication Plug-In](#) fill or flush the data nor can the RTE impact the implementation of those fill and flush routines.

[SWS_Rte_70136]{DRAFT} [If the data is required from another [Software Cluster](#) the [Local Software Cluster Communication Plug-In](#) shall call the [Rte_Rips_Read](#) Services of the [Cross Software Cluster Communication Plug-In](#) when it would read from the global copy.] ([SRS_Rte_00300](#), [SRS_Rte_00306](#), [SRS_Rte_00320](#))

[SWS_Rte_70137]{DRAFT} [If the data is provided to another [Software Cluster](#) the [Local Software Cluster Communication Plug-In](#) shall call the [Rte_Rips_Write](#) Services of the [Cross Software Cluster Communication Plug-In](#) when it writes to the global copy.] ([SRS_Rte_00300](#), [SRS_Rte_00306](#), [SRS_Rte_00320](#))

Please note: Due to [\[SWS_Rte_70136\]](#) and [\[SWS_Rte_70137\]](#) the [Local Software Cluster Communication Plug-In](#) is free in the point in time when [Rte_Rips_Read](#) and [Rte_Rips_Write](#) are called. This point in time depends on the to be implemented buffering strategy. For example, this can be compliant to the classical implicit communication behavior or be compliant to Logical Execution Time (LET).

The [Local Software Cluster Communication Plug-In](#) is free to implement [\[SWS_Rte_70136\]](#) and [\[SWS_Rte_70136\]](#) with the means of a Complex Driver. This is illustrated in figure [7.7](#).

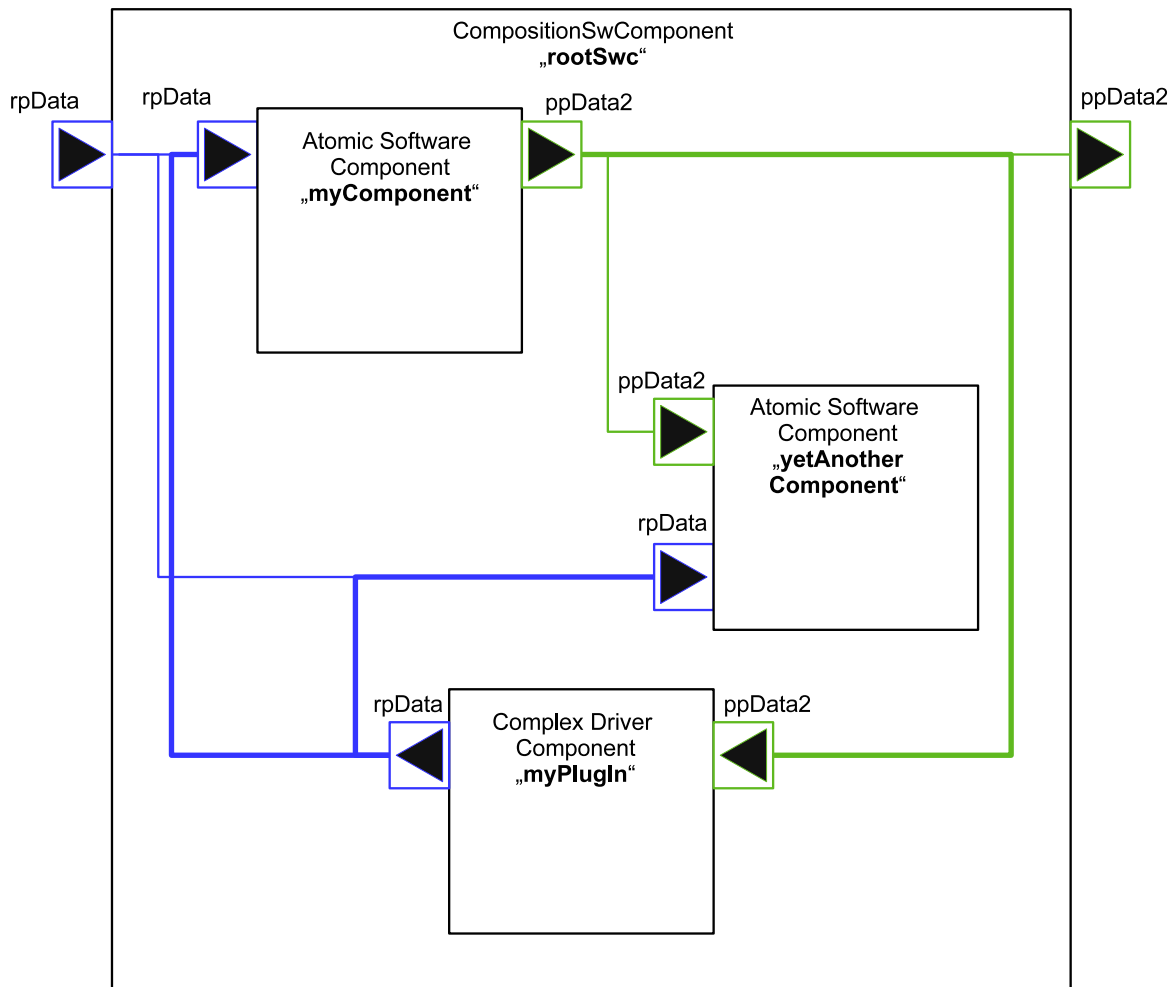


Figure 7.7: Example of implicit communication via RTE Implementation Plug-In

For sure an approach may change the communication multiplicity seen by the RTE. Please note section 7.3.3.4.

7.3.4.7.1 Fill Flush Routines

Nevertheless the RTE needs to invoke the Buffer Fill Routines and Buffer Flush Routines at the right place in the call sequence of `ExecutableEntities`. In general an associated Local Software Cluster Communication Plug-In is free to implement both functionalities in one common function. Therefore those functions are called `RteRips_FillFlushRoutine`. The information whether an `RteRips_FillFlushRoutine` shall be invoked before or after an `ExecutableEntity` is given by configuration via `RteRipsFillRoutineRef` and `RteRipsFlushRoutineRef` at the related `RteEventToTaskMapping` / `RteBswEventToTaskMapping`.

[SWS_Rte_80047] [The RTE shall invoke `RteRips_FillFlushRoutines` configured via `RteRipsFillRoutineRef` with the identical activation conditions as the

`RTEEvent` / `BswEvent` mapped by the owing `RteEventToTaskMapping` / `RteBswEventToTaskMapping` before the to-be-activated `ExecutableEntity` gets invoked and after configured `RteSyncPoint` given via `RteEventPredecessorSyncPointRef` / `RteBswEventPredecessorSyncPointRef` is passed.]([SRS_Rte_00301](#))

[SWS_Rte_80048] [The RTE shall invoke `Rte_Rips_FillFlushRoutines` configured via `RteRipsFlushRoutineRef` with the identical activation conditions as the `RTEEvent` / `BswEvent` mapped by the owing `RteEventToTaskMapping` / `RteBswEventToTaskMapping` after the to-be-activated `ExecutableEntity` gets invoked. Thereby the `Rte_Rips_FillFlushRoutine` runs after a configured `RteOsSchedulePoint`, but before a configured `RteSyncPoint` given via `RteEventSuccessorSyncPointRef` / `RteBswEventSuccessorSyncPointRef` is entered.]([SRS_Rte_00301](#))

[SWS_Rte_80049] [When the `RteRipsModeDisablingHandling` is set to `RTE_RIPS_IGNORE_MODE_DISABLING`, the RTE shall invoke the configured `Rte_Rips_FillFlushRoutines` regardless of currently active mode disabling dependencies.]([SRS_Rte_00301](#))

[SWS_Rte_80050] [When the `RteRipsModeDisablingHandling` is set to `RTE_RIPS_CONSIDER_MODE_DISABLING`, the RTE shall invoke the configured `Rte_Rips_FillFlushRoutines`, only if the `RTEEvent` / `BswEvent` mapped by the owing `RteEventToTaskMapping` / `RteBswEventToTaskMapping` is currently not disabled by a mode disabling dependencies.]([SRS_Rte_00301](#))

Please note: The configuration of `Rte_Rips_FillFlushRoutines` is applicable for any kind of `RTEEvent` or `BswEvent`, regardless whether the activated `ExecutableEntity` has any access to a `Data Communication Graph` handled by any `RTE Implementation Plug-In`, and regardless whether the `RteEventToTaskMapping` or `RteBswEventToTaskMapping` is mapped to an `OsTask`, to a `RteInitializationRunnableBatch`, or no `OsTask` at all. This enables the `Local Software Cluster Communication Plug-In` to apply its `Rte_Rips_FillFlushRoutines` at any level in the call graph in any circumstance of activation.

[SWS_Rte_80084] [The RTE Generator shall create an unconditional call to the `Os API Schedule` after the execution of the `Rte_Rips_FillFlushRoutine`, if the `RteRipsOsSchedulePoint` configuration parameter is set to `UNCONDITIONAL`. In the generated code the call to the `Os API Schedule` shall only be performed when the `Rte_Rips_FillFlushRoutine` itself has been executed (called).]([SRS_Rte_00301](#))

Please note: A schedule point according [\[SWS_Rte_80084\]](#) is useful to trigger the scheduler of the OS in a pre-emptive task after the `implicit communication buffers` are written back to the `global copy`. Therefore `RunnableEntities` executed in tasks which get in running state after such schedule point may already see the latest written value. But this depends on the placement of their fill routines.

In opposite, a schedule point placed at the `RteEventToTaskMapping` via `RteOsSchedulePoint` is always executed before the execution of the `RteRipsOsSchedulePoint` and therefore before the `implicit communication buffers` are written back to the `global copy`!

7.3.4.7.2 Simple example about implicit w/o component data structure

The example 7.8 shows the basic implementation in case the data is primitive, the `Data Communication Graph` does not require Sender Status nor Receiver Status, and the software component does not support multiple instantiation and is provided as source code.

Example 7.8

Code example for `Rte_DataHandleType.h` in case the RTE Generator implements the implicit communication:

```

1  typedef struct
2  {
3      uint32 value;
4  } Rte_DE_uint32;
5
6  typedef struct
7  {
8      Rte_DE_uint32 myImplicitSimpleData;
9  } Rte_PerTaskBuffers_TASK_COOP_10MS_Type;
10
11 typedef struct
12 {
13     Rte_DE_uint32 myImplicitSimpleData;
14 } Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type;
```

Code example for `Rte_myComponent.h` in case the RTE Generator implements the implicit communication:

```

1  #include "Rte_DataHandleType.h"
2
3  /* task buffer for TASK_COOP_10MS */
4  extern Rte_PerTaskBuffers_TASK_COOP_10MS_Type
5      Rte_PerTaskBuffers_TASK_COOP_10MS;
6
7  /* task buffer for TASK_PREEMPT_1MS */
8  extern Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type
9      Rte_PerTaskBuffers_TASK_PREEMPT_1MS;
10
11 #define Rte_IWrite_myProducerRunnable1_myPPort1_myImplicitSimpleData(
12     data) ( \
13     Rte_PerTaskBuffers_TASK_COOP_10MS.myImplicitSimpleData.value = (data)
14     )
15
16 #define Rte_IWriteRef_myProducerRunnable1_myPPort1_myImplicitSimpleData
17     () ( \
18     &Rte_PerTaskBuffers_TASK_COOP_10MS.myImplicitSimpleData.value )
```

```

13 #define Rte_IRead_myConsumerRunnable_myRPort1_myImplicitSimpleData() (
    \
14 Rte_PerTaskBuffers_TASK_PREEMPT_1MS.myImplicitSimpleData.value )

```

Code example for `Rte.c` in case the RTE Generator implements the implicit communication:

```

1  #include "Rte_myComponent.h"
2
3  Rte_DE_uint32 Rte_myImplicitSimpleData;
4
5  /* task buffer for TASK_COOP_10MS */
6  Rte_PerTaskBuffers_TASK_COOP_10MS_Type
    Rte_PerTaskBuffers_TASK_COOP_10MS;
7
8  /* task buffer for TASK_PREEMPT_1MS */
9  Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type
    Rte_PerTaskBuffers_TASK_PREEMPT_1MS;
10
11 TASK(TASK_COOP_10MS)
12 {
13     Rte_Runnable_myComponent_myProducerRunnable1_Start();
14     myProducerRunnable1();
15     Rte_Runnable_myComponent_myProducerRunnable1_Return();
16     Rte_myImplicitSimpleData = Rte_PerTaskBuffers_TASK_COOP_10MS.
        myImplicitSimpleData;
17 }
18
19 TASK(TASK_PREEMPT_1MS)
20 {
21     Rte_PerTaskBuffers_TASK_PREEMPT_1MS.myImplicitSimpleData =
        Rte_myImplicitSimpleData;
22     Rte_Runnable_myComponent_myConsumerRunnable_Start();
23     myConsumerRunnable();
24     Rte_Runnable_myComponent_myConsumerRunnable_Return();
25 }

```

In the following example the [Data Communication Graph](#) is handled by an [RTE Implementation Plug-In](#) named `myPlugin` having `RtePluginSupport-sIReadIWrite` set to `true`, a flush-routine with `RteRipsPluginFillFlushRoutineFncSymbol` set to `Rips_Flush_Runnable1`, and a fill-routine with `RteRipsPluginFillFlushRoutineFncSymbol` set to `Rips_Fill_Runnable1`.

Example 7.9

Code example for `Rte_DataHandleType.h` in case the [RTE Implementation Plug-In](#) implements the implicit communication:

```

1  typedef struct
2  {
3      uint32 value;
4  } Rte_DE_uint32;
5
6  /* wrapper type according SWS_Rte_80079 */

```

```
7 typedef Rte_DE_uint32 Rte_Rips_GlobalCopy_myGlobalData2_Type;
```

Code example for `Rte_myComponent.h` in case the [RTE Implementation Plug-In](#) implements the implicit communication:

```
1 #include "Rte_DataHandleType.h"
2 #include "Rte_Rips_myPlugin_myComponent.h"
3
4 #define Rte_IWrite_myProducerRunnable1_
   myPPort1_myImplicitSimpleData(data) ( \
5   Rte_Rips_myPlugin_IWrite_myComponent_
   myProducerRunnable1_myGlobalData2(data) )
6
7 #define Rte_IWriteRef_myProducerRunnable1_
   myPPort1_myImplicitSimpleData() ( \
8   &Rte_Rips_myPlugin_IWBufferRef_myComponent_
   myProducerRunnable1_myGlobalData2()->value)
9
10 #define Rte_IRead_myConsumerRunnable_
   myRPort1_myImplicitSimpleData() ( \
11   Rte_Rips_myPlugin_IRead_myComponent_
   myConsumerRunnable_myGlobalData2() )
```

Code example for `Rte.c` in case the [RTE Implementation Plug-In](#) implements the implicit communication:

```
1 #include "Rte_myComponent.h"
2 #include "Rte.h" /* which will include Rte_Rips_myPlugin.h */
3
4 Rte_DE_uint32 Rte_myGlobalData2;
5
6 TASK(TASK_COOP_10MS)
7 {
8     Rte_Runnable_myComponent_myProducerRunnable1_Start();
9     myProducerRunnable1();
10    Rte_Runnable_myComponent_myProducerRunnable1_Return();
11    Rips_Flush_Runnable1();
12 }
13
14 TASK(TASK_PREEMPT_1MS)
15 {
16     Rips_Fill_Runnable1();
17     Rte_Runnable_myComponent_myConsumerRunnable_Start();
18     myConsumerRunnable();
19     Rte_Runnable_myComponent_myConsumerRunnable_Return();
20 }
```

Code example for `Rte_Buffers.h` in case the [RTE Implementation Plug-In](#) implements the implicit communication:

```
1 #include "Rte_DataHandleType.h"
2 #include "Rte_Rips_myPlugin_Buffers.h"
3
4 #extern Rte_DE_uint32 Rte_myGlobalData2;
5
```



```

6  /* the mapping according SWS_Rte_80006 below can be omitted, if the RTE
   Generator names the variable Rte_Rips_GlobalCopy_myGlobalData2 */
7  #define Rte_Rips_GlobalCopy_myGlobalData2 Rte_myGlobalData2

```

Code example for `Rte_Rips_myPlugin_myComponent.h` in case the RTE Implementation Plug-In implements the implicit communication:

```

1  #include "Rte_Buffers.h"
2
3  #define Rte_Rips_myPlugin_IWrite_myComponent_
   myProducerRunnable1_myGlobalData2(data) \
4  (Rte_PerTaskBuffers_TASK_COOP_10MS.myGlobalData2.value = data)
5
6  #define Rte_Rips_myPlugin_IWBufferRef_myComponent_
   myProducerRunnable1_myGlobalData2() \
7  (&Rte_PerTaskBuffers_TASK_COOP_10MS.myGlobalData2)
8
9  #define Rte_Rips_myPlugin_IRead_myComponent_
   myConsumerRunnable_myGlobalData2() \
10 (Rte_PerTaskBuffers_TASK_PREEMPT_1MS.myGlobalData2.value)

```

Code example for `Rte_Rips_myPlugin_Buffers.h` in case the RTE Implementation Plug-In implements the implicit communication:

```

1  #include "Rte_DataHandleType.h"
2
3  /* task buffer type for TASK_COOP_10MS */
4  typedef struct
5  {
6      Rte_DE_uint32 myGlobalData2;
7  } Rte_PerTaskBuffers_TASK_COOP_10MS_Type;
8
9  /* task buffer type for server runnable */
10 typedef struct
11 {
12     Rte_DE_uint32 myGlobalData2;
13 } Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type;
14
15 /* task buffer for TASK_COOP_10MS */
16 extern Rte_PerTaskBuffers_TASK_COOP_10MS_Type
   Rte_PerTaskBuffers_TASK_COOP_10MS;
17
18 /* task buffer for TASK_PREEMPT_1MS */
19 extern Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type
   Rte_PerTaskBuffers_TASK_PREEMPT_1MS;

```

Code example for `Rte_Rips_myPlugin.c` in case the RTE Implementation Plug-In implements the implicit communication:

```

1  #include "Rte_Buffers.h"
2
3  /* task buffer for TASK_COOP_10MS */
4  Rte_PerTaskBuffers_TASK_COOP_10MS_Type
   Rte_PerTaskBuffers_TASK_COOP_10MS;
5
6  /* task buffer for TASK_PREEMPT_1MS */

```

```

7
8 Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type
   Rte_PerTaskBuffers_TASK_PREEMPT_1MS;
9 void Rips_Flush_Runnable1(void)
10 {
11     Rte_Rips_GlobalCopy_myGlobalData2 =
        Rte_PerTaskBuffers_TASK_COOP_10MS.myGlobalData2;
12 }
13
14 void Rips_Fill_Runnable1(void)
15 {
16     Rte_PerTaskBuffers_TASK_PREEMPT_1MS.myGlobalData2 =
        Rte_Rips_GlobalCopy_myGlobalData2;
17 }

```

7.3.4.7.3 Example of object code software component with conversion

The example 7.10 shows the basic implementation in case the data is primitive, the [Communication Graph](#) does not require Sender Status nor Receiver Status, but has a different resolution on sender and receiver side, the software component does not support multiple instantiation, but is provided as object code. Besides being an object code delivered software component and showing conversion, the example is identical to example 7.8.

Example 7.10

Code example for `Rte_DataHandleType.h` in case the RTE Generator implements the implicit communication:

```

1 typedef struct
2 {
3     uint16 value;
4 } Rte_DE_uint16;
5
6 typedef struct
7 {
8     uint32 value;
9 } Rte_DE_uint32;
10
11 typedef struct
12 {
13     Rte_DE_uint32 myImplicitSimpleData;
14 } Rte_PerTaskBuffers_TASK_COOP_10MS_Type;
15
16 typedef struct
17 {
18     Rte_DE_uint16 myImplicitSimpleData2;
19 } Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type;

```

Code example for `Rte_myComponent.h` (already compiled into the software component) in case the RTE Generator implements the implicit communication:

```

1  #include "Rte_DataHandleType.h"
2
3  typedef struct
4  {
5      Rte_DE_uint16 * myConsumerRunnable_myRPort1_myImplicitSimpleData2;
6      Rte_DE_uint32 * myProducerRunnable1_myPPort1_myImplicitSimpleData;
7  } Rte_CDS_myComponent;
8
9  extern CONSTP2CONST(Rte_CDS_myComponent, RTE_CONST, RTE_CONST)
    Rte_Inst_myComponent;
10
11 #define Rte_IWrite_myProducerRunnable1_myPPort1_myImplicitSimpleData(
    data) ( \
12     Rte_Inst_myComponent->
        myProducerRunnable1_myPPort1_myImplicitSimpleData->value = (data)
    )
13
14 #define Rte_IWriteRef_myProducerRunnable1_myPPort1_myImplicitSimpleData
    () ( \
15     &Rte_Inst_myComponent->
        myProducerRunnable1_myPPort1_myImplicitSimpleData->value )
16
17 #define Rte_IRead_myConsumerRunnable_myRPort1_myImplicitSimpleData2() (
    \
18     Rte_Inst_myComponent->
        myConsumerRunnable_myRPort1_myImplicitSimpleData2->value )

```

Code example for `Rte.c` in case the RTE Generator implements the implicit communication:

```

1  #include "Rte_myComponent.h"
2
3  Rte_DE_uint32 Rte_myImplicitSimpleData;
4
5  /* task buffer for TASK_COOP_10MS */
6  Rte_PerTaskBuffers_TASK_COOP_10MS_Type
    Rte_PerTaskBuffers_TASK_COOP_10MS;
7
8  /* task buffer for TASK_PREEMPT_1MS */
9  Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type
    Rte_PerTaskBuffers_TASK_PREEMPT_1MS;
10
11 const Rte_CDS_myComponent Rte_Inst_myComponent = {
12     &Rte_PerTaskBuffers_TASK_PREEMPT_1MS.myImplicitSimpleData2,
13     &Rte_PerTaskBuffers_TASK_COOP_10MS.myImplicitSimpleData };
14
15 TASK(TASK_COOP_10MS)
16 {
17     Rte_Runnable_myComponent_myProducerRunnable1_Start();
18     myProducerRunnable1();
19     Rte_Runnable_myComponent_myProducerRunnable1_Return();
20     Rte_myImplicitSimpleData = Rte_PerTaskBuffers_TASK_COOP_10MS.
        myImplicitSimpleData;
21 }
22
23 TASK(TASK_PREEMPT_1MS)

```

```

24 {
25     Rte_PerTaskBuffers_TASK_PREEMPT_1MS.myImplicitSimpleData2 =
        Rte_myImplicitSimpleData/2;
26     Rte_Runnable_myComponent_myConsumerRunnable_Start();
27     myConsumerRunnable();
28     Rte_Runnable_myComponent_myConsumerRunnable_Return();
29 }

```

In the following example the [Data Communication Graph](#) is handled by an [RTE Implementation Plug-In](#). Due to data conversion two [RIPS FlatInstanceDescriptors](#) need to be configured. The first [RIPS FlatInstanceDescriptor](#) named `myGlobalData2` points to `myImplicitSimpleData` of `myPPort1`. The second [RIPS FlatInstanceDescriptor](#) named `myGlobalData1` points to data element `myImplicitSimpleData2` of [RPortPrototype](#) `myRPort1` of the software component `myComponent`.

There is also an additional flush-routine with [RteRipsPluginFillFlushRoutineFncSymbol](#) = `Rips_Flush_Runnable1` and configured at the [RteEventToTaskMapping](#) of the [RunnableEntity](#) `myProducerRunnable1`.

Furthermore there is a fill-routine with [RteRipsPluginFillFlushRoutineFncSymbol](#) = `Rips_Fill_Runnable1` and configured at the [RteEventToTaskMapping](#) of the [RunnableEntity](#) `myConsumerRunnable`.

Example 7.11

Code example for `Rte_DataHandleType.h` in case the [RTE Implementation Plug-In](#) implements the implicit communication:

```

1  typedef struct
2  {
3      uint16 value;
4  } Rte_DE_uint16;
5
6  typedef struct
7  {
8      uint32 value;
9  } Rte_DE_uint32;
10
11 /* wrapper type according SWS_Rte_80079 */
12 typedef Rte_DE_uint16 Rte_Rips_GlobalCopy_myGlobalData1_Type;
13 typedef Rte_DE_uint32 Rte_Rips_GlobalCopy_myGlobalData2_Type;
14
15 /* definition of RTE Task buffers are not necessary any longer */

```

Code example for `Rte_myComponent.h` from contract phase (already compiled into the software component) in case the [RTE Implementation Plug-In](#) implements the implicit communication. Please note, that the contract phase is not impacted by the application of [RTE Implementation Plug-Ins](#).

```

1  #include "Rte_DataHandleType.h"
2
3  typedef struct
4  {
5      Rte_DE_uint16 * myConsumerRunnable_myRPort1_myImplicitSimpleData2;
6      Rte_DE_uint32 * myProducerRunnable1_myPPort1_myImplicitSimpleData;
7  } Rte_CDS_myComponent;
8
9  extern CONSTP2CONST(Rte_CDS_myComponent, RTE_CONST, RTE_CONST)
      Rte_Inst_myComponent;
10
11 #define Rte_IWrite_myProducerRunnable1_myPPort1_myImplicitSimpleData(
      data) ( \
12     Rte_Inst_myComponent->
        myProducerRunnable1_myPPort1_myImplicitSimpleData->value = (data)
13     )
14 #define Rte_IWriteRef_myProducerRunnable1_myPPort1_myImplicitSimpleData
      () ( \
15     &Rte_Inst_myComponent->
        myProducerRunnable1_myPPort1_myImplicitSimpleData->value )
16
17 #define Rte_IRead_myConsumerRunnable_myRPort1_myImplicitSimpleData2() (
      \
18     Rte_Inst_myComponent->
        myConsumerRunnable_myRPort1_myImplicitSimpleData2->value )

```

Code example for `Rte.c` in case the [RTE Implementation Plug-In](#) implements the implicit communication:

```

1  #include "Rte_myComponent.h"
2  #include "Rte.h"
3
4  /* SWS_Rte_80006 is implemented by suitable naming of the RTE variables
      */
5  Rte_DE_uint16 Rte_Rips_GlobalCopy_myGlobalData1;
6  Rte_DE_uint32 Rte_Rips_GlobalCopy_myGlobalData2;
7
8  const Rte_CDS_myComponent Rte_Inst_myComponent =
9  {
10     Rte_Rips_myPlugin_IRBufferRef_myComponent_
        myConsumerRunnable_myGlobalData1(),
11     Rte_Rips_myPlugin_IWBufferRef_myComponent_
        myProducerRunnable1_myGlobalData2()
12 };
13
14 TASK(TASK_COOP_10MS)
15 {
16     Rte_Runnable_myComponent_myProducerRunnable1_Start();
17     myProducerRunnable1();
18     (Rte_Rips_myPlugin_IWBufferRef_RteCnvmyComponent_
        RteCnvmyProducerRunnable1_myGlobalData1()->value) =
19     (Rte_Rips_myPlugin_IRBufferRef_RteCnvmyComponent_
        RteCnvmyProducerRunnable1_myGlobalData2()->value)/2;
20     Rte_Runnable_myComponent_myProducerRunnable1_Return();
21     Rips_Flush_Runnable1();

```

```

22  }
23
24  TASK (TASK_PREEMPT_1MS)
25  {
26      Rips_Fill_Runnable1();
27      Rte_Runnable_myComponent_myConsumerRunnable_Start();
28      myConsumerRunnable();
29      Rte_Runnable_myComponent_myConsumerRunnable_Return();
30  }

```

7.3.4.8 Inter Runnable Variables and RTE Implementation Plug-Ins

Besides the fact that `InterRunnableVariables` are used by a SWC internally and use an own set of APIs (i.e. `Rte_IrvIRead`, `Rte_IrvIWrite` and `Rte_IrvIWriteRef`), there is no difference in their implementing code or their need for protection or buffering compared to regular data instances. They shall therefore not be treated differently to regular inter SWC implicit communication. I.e. the `InterRunnableVariable` will also be referenced by a `RIPS FlatInstanceDescriptor` and their access APIs will as well be routed via the same `RTE Implementation Plug-In Services` as regular implicit accesses would be.

There are no specific requirements on `InterRunnableVariables` since those are already covered in the requirements for Implicit and Explicit communication. For instance `[SWS_Rte_70015]`, `[SWS_Rte_70016]`, `[SWS_Rte_70017]`, `[SWS_Rte_70018]`, `[SWS_Rte_70019]`, `[SWS_Rte_70021]`, `[SWS_Rte_70023]`, `[SWS_Rte_70025]`, `[SWS_Rte_70050]`, `[SWS_Rte_70056]`.

7.3.4.9 RTE Implementation Plug-Ins and NvBlockSwComponents

When a `Data Communication Graph` involves a `NvBlockSwComponent` (see also [7.3.4.3](#)), the data gets additionally accessed via the callback functions

- `Rte_GetMirror` (reading)
- `Rte_SetMirror` (writing)
- `Rte_NvMNotifyInitBlock` (writing)

provided by the RTE for the `NvBlock`.

The access to the data shall be considered as an "explicit" like access. Therefore similar protection services and access services are used. In addition the access to the `NvBlock` can be seen as an overlay of `Data Communication Graphs`, the first `Data Communication Graph` described by the `VariableDataPrototype` instances in the `NvBlockSwComponent`'s ports and the `Data Communication Graph` of the whole `ramBlock`.

Please note, that for all of those [Data Communication Graphs](#) individual [RIPS FlatInstanceDescriptors](#) need to be provided.

Further on its not required, that all [Data Communication Graphs](#) overlaying in a [NvBlock](#) are associated to the same [RTE Implementation Plug-In](#) nor are handled by an [RTE Implementation Plug-In](#) at all.

[SWS_Rte_70082] [The associated [RTE Implementation Plug-In](#) shall provide a set of [RteRips_StartRead](#) and [RteRips_StopRead](#) Services for each [Data Communication Graph](#) involving a [NvBlockSwComponent](#), if

- for the related [Data Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled

AND

- for the associated [RTE Implementation Plug-In](#) the [RteRipsGlobal-CopyInstantiationPolicy](#) is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

Thereby

- `<SwcBswI>` is the [SwComponentPrototype](#)'s name of the [NvBlockSwComponent](#),
- `<ExE>` is the name of the callback `GetMirror`,
- `<CGI>` is the name of the *Communication Graph Instance* according to [\[SWS_Rte_70038\]](#).

]([SRS_Rte_00300](#), [SRS_Rte_00301](#))

[SWS_Rte_70083] [The associated [RTE Implementation Plug-In](#) shall provide a set of [RteRips_StartWrite](#) and [RteRips_StopWrite](#) Services for each [Data Communication Graph](#) involving a [NvBlockSwComponent](#), if

- for the related [Data Communication Graph](#) the [RTE Implementation Plug-In](#) support is enabled

AND

- for the associated [RTE Implementation Plug-In](#) the [RteRipsGlobal-CopyInstantiationPolicy](#) is set to `RTE_RIPS_INSTANTIATION_BY_RTE`.

Thereby

- `<SwcBswI>` is the [SwComponentPrototype](#)'s name of the [NvBlockSwComponent](#),
- `<ExE>` is the name of the callbacks `SetMirror` and `NvMNotifyInitBlock`,
- `<CGI>` is the name of the *Communication Graph Instance* according to [\[SWS_Rte_70038\]](#).

]([SRS_Rte_00300](#), [SRS_Rte_00301](#))

[SWS_Rte_70084] [The associated RTE Implementation Plug-In shall provide the `RteRips_Read` Service for each `Data Communication Graph` involving a `NvBlockSwComponent`, if

- for the related `Data Communication Graph` the `RTE Implementation Plug-In` support is enabled

AND

- for the associated RTE Implementation Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`.

Thereby

- `<SwcBswI>` is the `SwComponentPrototype`'s name of the `NvBlockSwComponent`,
- `<ExE>` is the name of the callback `GetMirror`,
- `<CGI>` is the name of the `Communication Graph` Instance according to **[SWS_Rte_70038]**.

](*SRS_Rte_00300*, *SRS_Rte_00301*)

[SWS_Rte_70085] [The associated RTE Implementation Plug-In shall provide a set of `RteRips_Write` Services for each `Data Communication Graph` involving a `NvBlockSwComponents`, if

- for the related `Data Communication Graph` the `RTE Implementation Plug-In` support is enabled

AND

- for the associated RTE Implementation Plug-In the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`.

Thereby

- `<SwcBswI>` is the `SwComponentPrototype`'s name of the `NvBlockSwComponent`,
- `<ExE>` is the name of the callbacks `SetMirror` and `NvMNotifyInitBlock`,
- `<CGI>` is the name of the `Communication Graph` Instance according to **[SWS_Rte_70038]**.

](*SRS_Rte_00300*, *SRS_Rte_00301*, *SRS_Rte_00303*)

For instance for a single data `myNvData` mapped into a `NvBlock` in the `NvBlockSwComponent` `myNvBlockSwc` the associated RTE Implementation Plug-In - when it has `RteRipsGlobalCopyInstantiationPolicy` set to `RTE_RIPS_INSTANTIATION_BY_RTE` - provides the following set of services:

- Rte_Rips_myPlugin_StartRead_myNvBlockSwc_GetMirror_myNvData
- Rte_Rips_myPlugin_StopRead_myNvBlockSwc_GetMirror_myNvData
- Rte_Rips_myPlugin_StartWrite_myNvBlockSwc_SetMirror_myNvData
- Rte_Rips_myPlugin_StopWrite_myNvBlockSwc_SetMirror_myNvData
- Rte_Rips_myPlugin_StartWrite_myNvBlockSwc_NvMNotifyInitBlock_myNvData
- Rte_Rips_myPlugin_StopWrite_myNvBlockSwc_NvMNotifyInitBlock_myNvData

In case the `global copy` is provided by the RTE and `Data Communication Graphs` overlay in the `ramBlock` of a `NvBlockSwComponent` the order in which the `Rte_Rips_StartRead` and `Rte_Rips_StopRead` Services for the different `Data Communication Graphs` are called needs to be defined.

[SWS_Rte_80104] [The RTE Generator shall call the `Rte_Rips_StartRead` and `Rte_Rips_StopRead` Services for overlaid `Data Communication Graphs` in the following order:

1. The `Rte_Rips_StartRead` / `Rte_Rips_StartWrite` Service of a `Data Communication Graph` containing other `Data Communication Graphs` is called **before** the `Rte_Rips_StartRead` / `Rte_Rips_StartWrite` Services of the contained `Data Communication Graphs`.
2. The `Rte_Rips_StopRead` / `Rte_Rips_StopWrite` Service of a `Data Communication Graphs` containing other `Data Communication Graphs` is called **after** the `Rte_Rips_StopRead` / `Rte_Rips_StopWrite` Service of the contained `Data Communication Graphs`.

The calls shall be placed in the callback functions

- `Rte_GetMirror`
- `Rte_SetMirror`
- `Rte_NvMNotifyInitBlock`

belonging to the `ramBlock` of a `NvBlockSwComponent`.] (*SRS_Rte_00300*, *SRS_Rte_00301*)

In case the `global copy` is provided by the RTE Implementation Plug-In it is not useful to call the `Rte_Rips_Read` and `Rte_Rips_Write` Services for the `Data Communication Graphs` which are already contained in another `Data Communication Graph`.

[SWS_Rte_80105] [In case of overlaid `Data Communication Graphs` the RTE Generator shall only call the `Rte_Rips_Read`, `Rte_Rips_DRead` and `Rte_Rips_Write` Services for the `Data Communication Graphs` which are not contained in another `Data Communication Graph` in the callback functions

- [Rte_GetMirror](#)
- [Rte_SetMirror](#)
- [Rte_NvMNotifyInitBlock](#)

belonging to the [ramBlock](#) of a [NvBlockSwComponent](#).] ([SRS_Rte_00300](#), [SRS_Rte_00301](#))

7.3.4.9.1 Example about source code software component with complex call tree and NV data

The example [7.12](#) shows a more complex constellation of implicit communication. That is:

- the software component is delivered as source code and
- the software component does not support multiple instantiation and
- the data writing [RunnableEntity](#) is executed conditionally (e.g. due to a [Swc-ModeSwitchEvent](#)) and
- the data reading [RunnableEntity](#) is executed as a direct function call server and
- writer and reader are called in interrupting tasks and
- the data is part of a [RamBlock](#) of an [NvBlockSwComponent](#) and
- the [NonqueuedReceiverComSpec](#) has [handleNeverReceived](#) set to `TRUE`, the [NonqueuedSenderComSpec](#) does not set any option enforcing a data element status and
- the data is an array.

Example 7.12

Code example for [Rte_Type.h](#) in case the RTE Generator implements the implicit communication:

```
1 typedef uint32 myArrayType[4];
```

Code example for [Rte_DataHandleType.h](#) in case the RTE Generator implements the implicit communication:

```
1 typedef struct
2 {
3     myArrayType value;
4     Std_ReturnType status;
5 } Rte_DES_myArrayType;
6
7 typedef struct
8 {
9     myArrayType value;
```

```

10 } Rte_DE_myArrayType;
11
12 /* NV block type */
13 typedef struct
14 {
15     myArrayType myBlockElement1;
16 } myNvBlockType;
17
18 /* task buffer type for TASK_COOP_10MS */
19
20 typedef struct
21 {
22     Rte_DE_myArrayType myArrayData;
23 } Rte_PerTaskBuffers_TASK_COOP_10MS_Type;
24
25 /* task buffer type for server runnable */
26
27 typedef struct
28 {
29     Rte_DES_myArrayType myArrayData;
30 } Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation_Type;

```

Code example for `Rte_myComponent.h` in case the RTE Generator implements the implicit communication:

```

1 #include "Rte_DataHandleType.h"
2
3 /* task buffer for TASK_COOP_10MS */
4 extern Rte_PerTaskBuffers_TASK_COOP_10MS_Type
5     Rte_PerTaskBuffers_TASK_COOP_10MS;
6
7 /* task buffer for TASK_PREEMPT_1MS */
8
9 extern Rte_PerTaskBuffers_TASK_PREEMPT_1MS_Type
10     Rte_PerTaskBuffers_TASK_PREEMPT_1MS;
11
12 #define Rte_IWriteRef_myProducerRunnable2_myPPort2_myArrayData() ( \
13     (uint32 *) &Rte_PerTaskBuffers_TASK_COOP_10MS.myArrayData.value )
14
15 #define Rte_IWrite_myProducerRunnable2_myPPort2_myArrayData(data) ( \
16     Rte_MemCopy(&Rte_PerTaskBuffers_TASK_COOP_10MS.myArrayData.value, \
17     data, \
18     sizeof data); )
19
20 #define Rte_IRead_myServerRunnable_myRPort2_myArrayData() ( \
21     (const uint32 *) &
22     Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation.
23     myArrayData.value )
24
25 #define Rte_IStatus_myServerRunnable_myRPort2_myArrayData() ( \
26     Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation.myArrayData.
27     status )
28
29 #define Rte_Call_myServerRPort_myOperation() \ (
30     Rte_Call_myComponent_myServerRPort_myOperation() )

```

Code example for `Rte.c` in case the RTE Generator implements the implicit communication:

```

1  #include "Rte_myComponent.h"
2  #include "Rte.h"
3
4  Rte_DES_myArrayType Rte_myArrayData = {{0,1,255,4294967295},
    RTE_E_NEVER_RECEIVED};
5
6  /* RomBlock */
7  const myNvBlockType Rte_RomBlock = {{0,1,255,4294967295}};
8
9  /* task buffer for TASK_COOP_10MS */
10 Rte_PerTaskBuffers_TASK_COOP_10MS_Type
    Rte_PerTaskBuffers_TASK_COOP_10MS;
11
12 /* task buffer for server runnable */
13 Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation_Type \
14   Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation;
15
16 Std_ReturnType Rte_Call_myComponent_myServerRPort_myOperation(void)
17 {
18     Std_ReturnType rtn;
19     Rte_CallHook_myComponent_myServerRPort_myOperation_Start();
20     SuspendOsInterrupts();
21     Rte_MemCopy(&
        Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation.
        myArrayData, \
22     &Rte_myArrayData, \
23     sizeof Rte_myArrayData);
24     ResumeOsInterrupts();
25     Rte_Runnable_myComponent_myServerRunnable_Start()
26     myServerRunnable();
27     Rte_Runnable_myComponent_myServerRunnable_Return()
28     rtn = RTE_E_OK;
29     Rte_CallHook_myComponent_myServerRPort_myOperation_Return();
30     return rtn;
31 }
32
33 Std_ReturnType Rte_GetMirror_myNvBlockSwc_myNvBlockDescriptor(void *
    NvmBuffer)
34 {
35     SuspendOSInterrupts();
36     Rte_MemCopy(&(myNvBlockType *)NvmBuffer->myBlockElement1,
37         &Rte_myArrayData.value,
38         sizeof Rte_myArrayData.value);
39     ResumeOSInterrupts();
40     return RTE_E_OK;
41 }
42
43 Std_ReturnType Rte_NvMNotifyInitBlock_myNvBlockSwc_myNvBlockDescriptor(
    void)
44 {
45     SuspendOSInterrupts();
46     Rte_MemCopy(&Rte_myArrayData.value,
47         &Rte_RomBlock->myBlockElement1,

```

```

48         sizeof Rte_myArrayData.value);
49     ResumeOSInterrupts();
50     return RTE_E_OK;
51 }
52
53 TASK(TASK_COOP_10MS)
54 {
55     Std_ReturnType ret;
56     if (...myProducerRunnable2 execution condition...)
57     {
58         Rte_Runnable_myComponent_myProducerRunnable2_Start();
59         myProducerRunnable2();
60         Rte_Runnable_myComponent_myProducerRunnable2_Return();
61     }
62     ... some unrelated runnables ...
63     if (...myProducerRunnable2 execution condition...)
64     {
65         SuspendOsInterrupts();
66         Rte_MemCopy(&Rte_myArrayData.value, \
67         &Rte_PerTaskBuffers_TASK_COOP_10MS.myArrayData.value, \
68         sizeof Rte_myArrayData.value);
69         Rte_myArrayData.status &= (Std_ReturnType) (~RTE_E_NEVER_RECEIVED)
70         ;
71         ResumeOsInterrupts();
72     }
73 }
74 TASK(TASK_PREEMPT_1MS)
75 {
76     Rte_Runnable_myComponent_myClientRunnable_Start();
77     myClientRunnable(); // will execute
78     Rte_Call_myServerRPort_myOperation()
79     Rte_Runnable_myComponent_myClientRunnable_Return();
80 }

```

The following example 7.13 shows an equivalent implementation of the scenario via an RTE Implementation Plug-In. In this case, there exists additionally a `Rte_Rips_FillFlushRoutine` as `RteRipsFlushRoutineRef` at the `RteEventToTaskMapping` for the RTEEvent activating runnable `myProducerRunnable2`. The `RteRipsPluginFillFlushRoutineFncSymbol` of the `Rte_Rips_FillFlushRoutine` is set to `Rips_Flush_Runnable2`.

Furthermore there exists additionally a `Rte_Rips_FillFlushRoutine` as `RteRipsFillRoutineRef` at the `RteEventToTaskMapping` for the RTEEvent activating runnable `myServerRunnable`.

And finally, the RAM block of `NvBlockDescriptor` `myNvBlockDescriptor` of `NvBlockSwComponent` `myNvBlockSwc` is referenced by a `RIPS FlatInstanceDescriptor` named `myRamBlock`, which references the RTE Implementation Plug-In `myPlugin`.

Example 7.13

Code example for `Rte_Type.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```
1 typedef uint32 myArrayType[4];
```

Code example for `Rte_DataHandleType.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```
1 typedef struct
2 {
3     myArrayType value;
4 } Rte_DE_myArrayType;
5
6 typedef struct
7 {
8     myArrayType value;
9     Std_ReturnType status;
10 } Rte_DES_myArrayType;
11
12 /* NV block type */
13
14 typedef struct
15 {
16     myArrayType myBlockElement1;
17 } myNvBlockType;
18
19 /* wrapper type according SWS_Rte_80079 */
20 typedef Rte_DE_myArrayType Rte_Rips_GlobalCopy_myGlobalData3_Type;
21 typedef Rte_DES_myArrayType Rte_Rips_GlobalCopy_myGlobalData4_Type;
```

Code example for `Rte_myComponent.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```
1 #include "Rte_DataHandleType.h"
2 #include "Rte_Rips_myPlugin_myComponent.h"
3
4 #define Rte_IWriteRef_myProducerRunnable2_myPPort2_myArrayData() ( \
5     Rte_Rips_myPlugin_IWBufferRef_myComponent_myProducerRunnable2_myGlobalData3
6     () )
7
8 #define Rte_IWrite_myProducerRunnable2_myPPort2_myArrayData(data) ( \
9     Rte_MemCopy( \
10    Rte_Rips_myPlugin_IWBufferRef_myComponent_myProducerRunnable2_myGlobalData3
11    (), \
12    data, \
13    sizeof data); )
14
15 #define Rte_IRead_myServerRunnable_myRPort2_myArrayData() ( \
16    (const uint32 *) &Rte_Rips_myPlugin_IRBufferRef_myComponent
17    _myServerRunnable_myGlobalData4()->value )
18
19 #define Rte_IStatus_myServerRunnable_myRPort2_myArrayData() ( \
20    Rte_Rips_myPlugin_IRBufferRef_myComponent
21    _myServerRunnable_myGlobalData4()->status )
22
23 #define Rte_Call_myServerRPort_myOperation() \
24    (Rte_Call_myComponent_myServerRPort_myOperation() )
```


Code example for `Rte.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```
1 #include "Rte_Rips_myPlugin.h"
```

Code example for `Rte.c` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```
1 #include "Rte.h"
2 #include "Rte_Buffers.h"
3 #include "Rte_myComponent.h"
4
5 Rte_DES_myArrayType Rte_myGlobalData4 = {{0,1,255,4294967295},
    RTE_E_NEVER_RECEIVED};
6 Rte_DE_myArrayType Rte_myGlobalData3 = {0,1,255,4294967295};
7
8 /* RomBlock */
9 const myNvBlockType Rte_RomBlock = {{0,1,255,4294967295}};
10
11 Std_ReturnType Rte_Call_myComponent_myServerRPort_myOperation(void)
12 {
13     Std_ReturnType rtn;
14     Rte_CallHook_myComponent_myServerRPort_myOperation_Start();
15     Rips_Fill_Runnable2();
16     Rte_Runnable_myComponent_myServerRunnable_Start();
17     myServerRunnable();
18     Rte_Runnable_myComponent_myServerRunnable_Return();
19     rtn = RTE_E_OK;
20     Rte_CallHook_myComponent_myServerRPort_myOperation_Return();
21     return rtn;
22 }
23
24 Std_ReturnType Rte_GetMirror_myNvBlockSwc_myNvBlockDescriptor(void *
    NvmBuffer)
25 {
26     /* start protection whole ramBlock */
27     Rte_Rips_myPlugin_StartRead_myNvBlockSwc_GetMirror_myRamBlock();
28     /* start protection single data element */
29     Rte_Rips_myPlugin_StartRead_myNvBlockSwc_GetMirror_myGlobalData3();
30     Rte_MemCopy(&((myNvBlockType *)NvmBuffer)->myBlockElement1,
31         &Rte_myGlobalData3, sizeof Rte_myGlobalData3);
32     /* stop protection single data element */
33     Rte_Rips_myPlugin_StopRead_myNvBlockSwc_GetMirror_myGlobalData3();
34     /* stop protection whole ramBlock */
35     Rte_Rips_myPlugin_StopRead_myNvBlockSwc_GetMirror_myRamBlock();
36     return RTE_E_OK;
37 }
38
39 Std_ReturnType Rte_NvMNotifyInitBlock_myNvBlockSwc_myNvBlockDescriptor(
    void)
40 {
41     /* start protection whole ramBlock */
42     Rte_Rips_myPlugin_StartWrite_myNvBlockSwc_GetMirror_myRamBlock();
43     /* start protection single data element */
44     Rte_Rips_myPlugin_StartWrite_myNvBlockSwc_GetMirror_myGlobalData3();
45 }
```

```

46     Rte_MemCopy (&Rte_myGlobalData3,
47                 &Rte_RomBlock->myBlockElement1,
48                 sizeof Rte_myGlobalData3);
49
50     /* stop protection single data element */
51     Rte_Rips_myPlugin_StopWrite_myNvBlockSwc_GetMirror_myGlobalData3();
52     /* start protection single data element */
53     Rte_Rips_myPlugin_StartWrite_myNvBlockSwc_GetMirror_myGlobalData4();
54
55     Rte_MemCopy (&Rte_myGlobalData4.value,
56                 &Rte_RomBlock->myBlockElement1,
57                 sizeof Rte_myGlobalData4.value);
58
59     /* stop protection single data element */
60     Rte_Rips_myPlugin_StopWrite_myNvBlockSwc_GetMirror_myGlobalData4();
61     /* stop protection whole ramBlock */
62     Rte_Rips_myPlugin_StopWrite_myNvBlockSwc_GetMirror_myRamBlock();
63     return RTE_E_OK;
64 }
65
66 TASK (TASK_COOP_10MS)
67 {
68     Std_ReturnType ret;
69     if (...myProducerRunnable2 execution condition...)
70     {
71         Rte_Runnable_myComponent_myProducerRunnable2_Start();
72         myProducerRunnable2();
73         Rte_MemCopy (
74             Rte_Rips_myPlugin_IWBufferRef_myComponent
75             _myProducerRunnable2_myGlobalData4(),
76             Rte_Rips_myPlugin_IWBufferRef_myComponent
77             _myProducerRunnable2_myGlobalData3(),
78             sizeof Rte_myGlobalData4.value);
79         Rte_Rips_myPlugin_IWBufferRef_myComponent
80             _myProducerRunnable2_myGlobalData4()->status
81             &= (Std_ReturnType) (~RTE_E_NEVER_RECEIVED);
82         Rte_Runnable_myComponent_myProducerRunnable2_Return();
83         Rips_Flush_Runnable2();
84     }
85     ... some unrelated runnables ...
86     /* RTE specific buffer handling at the end of the task is inhibited */
87 }
88
89 TASK (TASK_PREEMPT_1MS)
90 {
91     Rte_Runnable_myComponent_myClientRunnable_Start();
92     myClientRunnable(); // will execute
93     Rte_Call_myServerRPort_myOperation()
94     Rte_Runnable_myComponent_myClientRunnable_Return();
95 }

```

Code example for Rte_Buffers.h in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```
1 #include "Rte_DataHandleType.h"
```

```

2  #include "Rte_Rips_myPlugin_Buffers.h"
3
4  /* the mapping according SWS_Rte_80006 below can be omitted, if the RTE
   Generator names the variable Rte_Rips_GlobalCopy_myGlobalData4 */
5  extern Rte_DES_myArrayType Rte_myGlobalData4;
6
7  #define Rte_Rips_GlobalCopy_myGlobalData4 Rte_myGlobalData4
8
9  /* the mapping according SWS_Rte_80006 below can be omitted, if the RTE
   Generator names the variable Rte_Rips_GlobalCopy_myGlobalData3 */
10 extern Rte_DE_myArrayType Rte_myGlobalData3;
11
12 #define Rte_Rips_GlobalCopy_myGlobalData3 Rte_myGlobalData3

```

Code example for `Rte_Rips_myPlugin_myComponent.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```

1  #include "Rte_Buffers.h"
2
3  #define Rte_Rips_myPlugin_IWBufferRef_myComponent
   _myProducerRunnable2_myGlobalData3() \
4   &Rte_PerTaskBuffers_TASK_COOP_10MS.myGlobalData3
5
6  #define Rte_Rips_myPlugin_IWBufferRef_myComponent
   _myProducerRunnable2_myGlobalData4() \
7   &Rte_PerTaskBuffers_TASK_COOP_10MS.myGlobalData4
8
9  #define
   Rte_Rips_myPlugin_IRBufferRef_myComponent_myServerRunnable_myGlobalData4
   () \
10  &Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation.
   myGlobalData4

```

Code example for `Rte_Rips_myPlugin_Buffers.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```

1  #include "Rte_DataHandleType.h"
2
3  /* task buffer type for TASK_COOP_10MS */
4
5  typedef struct
6  {
7      Rte_DE_myArrayType myGlobalData4;
8      Rte_DES_myArrayType myGlobalData3;
9  } Rte_PerTaskBuffers_TASK_COOP_10MS_Type;
10
11 /* task buffer type for server runnable */
12
13 typedef struct
14 {
15     Rte_DES_myArrayType myGlobalData3;
16 } Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation_Type;
17
18 /* task buffer for TASK_COOP_10MS */
19

```

```

20 extern Rte_PerTaskBuffers_TASK_COOP_10MS_Type
    Rte_PerTaskBuffers_TASK_COOP_10MS;
21 /* task buffer for server runnable */
22
23 extern Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation_Type \
24     Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation;

```

Code example for `Rte_Rips_myPlugin.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```

1 #define Rte_Rips_myPlugin_FillEnter_Rips_Fill_Runnable2() \
2     SuspendOSInterrupts()
3 #define Rte_Rips_myPlugin_FillExit_Rips_Fill_Runnable2() \
4     ResumeOSInterrupts()
5 #define Rte_Rips_myPlugin_FlushEnter_Rips_Flush_Runnable2() \
6     SuspendOSInterrupts()
7 #define Rte_Rips_myPlugin_FlushExit_Rips_Flush_Runnable2() \
8     ResumeOSInterrupts()
9 #define Rte_Rips_myPlugin_StartReadCallback_NvM_myRamBlock() \
10    SuspendOSInterrupts()
11 #define Rte_Rips_myPlugin_StopReadCallback_NvM_myRamBlock() \
12    ResumeOSInterrupts()
13 #define Rte_Rips_myPlugin_StartWriteCallback_NvM_myRamBlock() \
14    SuspendOSInterrupts()
15 #define Rte_Rips_myPlugin_StopWriteCallback_NvM_myRamBlock() \
16    ResumeOSInterrupts()

```

Code example for `Rte_Rips_myPlugin.c` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the scenario:

```

1 #include "Rte_Buffers.h"
2
3 /* task buffer for TASK_COOP_10MS */
4 Rte_PerTaskBuffers_TASK_COOP_10MS_Type
5     Rte_PerTaskBuffers_TASK_COOP_10MS;
6
7 /* task buffer for server runnable */
8 Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation_Type \
9     Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation;
10
11 void Rips_Flush_Runnable2(void)
12 {
13     Rte_MemCopy(&Rte_Rips_GlobalCopy_myGlobalData3, \
14         &Rte_PerTaskBuffers_TASK_COOP_10MS.myGlobalData3, \
15         sizeof Rte_Rips_GlobalCopy_myGlobalData3);
16     Rte_MemCopy(&Rte_Rips_GlobalCopy_myGlobalData4, \
17         &Rte_PerTaskBuffers_TASK_COOP_10MS.myGlobalData4, \
18         sizeof Rte_Rips_GlobalCopy_myGlobalData4);
19 }
20
21 void Rips_Fill_Runnable2(void)
22 {
23     Rte_MemCopy(&
24         Rte_PerTaskBuffers_myComponent_myServerRPort_myOperation.
25         myGlobalData3, \
26         &Rte_Rips_GlobalCopy_myGlobalData3, \

```

```
24     sizeof Rte_Rips_GlobalCopy_myGlobalData3);  
25 }
```

7.3.5 Exclusive Areas

7.3.5.1 Exclusive Areas and RTE Implementation Plug-Ins

For [ExclusiveAreas](#) RTE already offers a possibility to configure which protection mechanism shall be used for any given [ExclusiveArea](#). The mechanisms foreseen are described in section [4.2.6.5.1](#). Nevertheless the AUTOSAR standardized configuration does not foresee a detailed specification of the applied mechanism, e.g. a specific spin lock, nor it defines guaranteed optimizations, e.g. omitting the blocking from the highest prior call context or call contexts which are executed exclusively on the whole ECU. Additionally in complex dynamic architectures (like for multi / many core systems) a fine grained selection - usually tool based - of the appropriate blocking mechanism is beneficial to avoid unnecessary block and unblock activity as well as to avoid the unnecessary blocking of cores without interference to the impacted [ExclusiveAreas](#).

To overcome this limitation the [RTE Implementation Plug-In](#) has to choose an appropriate implementation and the RTE has to suspend its related model acceptance checks. As not every [ExclusiveArea](#) will need a treatment beyond RTE internal mechanisms, individual [ExclusiveAreas](#) can be assigned to a specific [RTE Implementation Plug-In](#).

Regarding [ExclusiveAreas](#) there is no difference between source code and object code integrated software components, except that for source code integrated software components the RTE is free to implement the [Rte_Enter](#) and [Rte_Exit](#) API already in the application header file. Therefore the statements in this chapter are valid for both source and object code integrated software components.

There are two kinds of [ExclusiveAreas](#), the ones which can explicitly be entered and left inside an [ExecutableEntity](#) (in [canEnterExclusiveArea](#) role) and the ones which protect the complete [ExecutableEntity](#) (in [runsInsideExclusiveArea](#) role). Related examples are shown in individual chapters.

When invoking the [RTE Implementation Plug-In Service](#) to enter or exit an [ExclusiveArea](#), the RTE Generator has to respect the granularity of the [Rte_Rips_Enter](#) and [Rte_Rips_Exit](#) Services depending on whether the [ExclusiveArea](#) is handled as

- [runsInsideExclusiveArea](#)
- [canEnterExclusiveArea](#)

AND in the second case whether the respective [apiPrinciple](#) is set to

- [perExecutable](#)

OR

- [common](#).

[SWS_Rte_80022] [If an [ExecutableEntity](#) defines a [canEnterExclusiveArea](#) association, the RTE Generator shall call the corresponding [Rte_Rips_Enter](#) and [Rte_Rips_Exit](#) Services inside the belonging [Rte_Enter](#) and [Rte_Exit](#) APIs.] ([SRS_Rte_00302](#))

[SWS_Rte_80023] [If an [ExecutableEntity](#) defines a [runsInsideExclusiveArea](#) association, the RTE shall call the corresponding [Rte_Rips_Enter](#) and [Rte_Rips_Exit](#) Services where the according [RunnableEntity](#) or [BswModuleEntity](#) is called due to the activation of a specific [RTEEvent](#) or [BswEvent](#).] ([SRS_Rte_00302](#))

Please note: If the related event has been mapped as a direct or trusted function call, this can be inside another RTE API. In case the event is mapped to a task it is inside the according task body.

7.3.5.2 Enable RTE Implementation Plug-In support for ExclusiveAreas

[SWS_Rte_80024] [The RTE Generator shall enable the [RTE Implementation Plug-In](#) support for the related [ExclusiveArea](#), if the related [RteExclusiveAreaImplMechanism](#) is set to [RTE_PLUGIN](#).] ([SRS_Rte_00302](#))

[SWS_Rte_CONSTR_80000] [[RTE_PLUGIN](#) in [RteExclusiveAreaImplementation](#) requires the configuration of an [RTE Implementation Plug-In](#) The usage of the enumeration literal [RTE_PLUGIN](#) for the parameter [RteExclusiveAreaImplMechanism](#) requires the configuration of the reference [RteExclusiveAreaResponsibleRipsPluginRef](#) in the owning container [RteExclusiveAreaImplementation](#).] ([SRS_Rte_00302](#))

[SWS_Rte_CONSTR_80001] [[RTE_PLUGIN](#) in [RteBswExclusiveAreaImpl](#) requires the configuration of an [RTE Implementation Plug-In](#) The usage of the enumeration literal [RTE_PLUGIN](#) for the parameter [RteExclusiveAreaImplMechanism](#) requires the configuration of the reference [RteBswExclusiveAreaResponsibleRipsPluginRef](#) in the owning container [RteBswExclusiveAreaImpl](#).] ([SRS_Rte_00302](#))

Please note that [ExclusiveAreas](#) do not have an communication aspect and can not be shared between Software Clusters. Hence, [ExclusiveAreas](#) can only be handled by [Local Software Cluster Communication Plug-Ins](#).

[SWS_Rte_CONSTR_80025]{DRAFT} [RteBswExclusiveAreaResponsibleRipsPluginRef](#) ins only applicable for **Local Software Cluster Communication Plug-Ins** [The reference [RteBswExclusiveAreaResponsibleRipsPluginRef](#) shall only reference a [Local Software Cluster Communication Plug-In](#).] ()

7.3.5.3 Exclusive Areas in Role `canEnterExclusiveArea`

The `ExclusiveAreas` which a software component or Basic Software Module can explicitly enter and exit are referenced in the `ExecutableEntity` property `canEnterExclusiveArea`. The according RTE and SchM APIs only differ in their name, not their content. The examples therefore only show the RTE flavor. The content of the file `Rte_myComponent.h` represents the version for source code integrated software components and Basic Software Modules. The implementation in `Rte.c` represents the version for object code integrated software components and Basic Software Modules. This is only to demonstrate the different implementation flavors.

The following example 7.14 shows an implementation of the `ExclusiveArea` with the RTE Generator where the RTE Generator uses `OS_INTERRUPT_BLOCKING`.

Example 7.14

Code example for `Rte_myComponent.h` in case the RTE Generator implements the `ExclusiveArea`:

```

1  #define Rte_Enter_myExclusiveArea() ( \
2    (Rte_EnterHook_myComponent_myExclusiveArea_Start()), \
3    SuspendOSInterrupts(), \
4    (Rte_EnterHook_myComponent_myExclusiveArea_Return()) )
5
6  #define Rte_Exit_myExclusiveArea() ( \
7    (Rte_ExitHook_myComponent_myExclusiveArea_Start()), \
8    ResumeOSInterrupts(), \
9    (Rte_ExitHook_myComponent_myExclusiveArea_Return()) )

```

Code example for `Rte.c` in case the RTE Generator implements the `ExclusiveArea`:

```

1  #include "Rte_myComponent.h"
2  void Rte_Enter_myComponent_myExclusiveArea(void)
3  {
4      Rte_EnterHook_myComponent_myExclusiveArea_Start();
5      SuspendOSInterrupts();
6      Rte_EnterHook_myComponent_myExclusiveArea_Return();
7  }
8
9  void Rte_Exit_myComponent_myExclusiveArea(void)
10 {
11     Rte_ExitHook_myComponent_myExclusiveArea_Start();
12     ResumeOSInterrupts();
13     Rte_ExitHook_myComponent_myExclusiveArea_Return();
14 }

```

The following example 7.15 shows an equivalent implementation of the `ExclusiveArea` via an RTE Implementation Plug-In.

Example 7.15

Code example for `Rte_myComponent.h` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the [ExclusiveArea](#):

```

1 #include "Rte_Rips_myPlugin_myComponent.h"
2 #define Rte_Enter_myExclusiveArea1() ( \
3     (Rte_EnterHook_myComponent_myExclusiveArea1_Start()), \
4     Rte_Rips_myPlugin_Enter_myComponent_myExclusiveArea1(), \
5     (Rte_EnterHook_myComponent_myExclusiveArea1_Return()) )
6
7 #define Rte_Exit_myExclusiveArea1() ( \
8     (Rte_ExitHook_myComponent_myExclusiveArea1_Start()), \
9     Rte_Rips_myPlugin_Exit_myComponent_myExclusiveArea1(), \
10    (Rte_ExitHook_myComponent_myExclusiveArea1_Return()) )

```

Code example for `Rte.c` in case the RTE Generator redirects towards an [RTE Implementation Plug-In](#) to implement the [ExclusiveArea](#):

```

1 #include "Rte_myComponent.h"
2 void Rte_Enter_myComponent_myExclusiveArea1(void)
3 {
4     Rte_EnterHook_myComponent_myExclusiveArea1_Start();
5     Rte_Rips_myPlugin_Enter_myComponent_myExclusiveArea1();
6     Rte_EnterHook_myComponent_myExclusiveArea1_Return();
7 }
8
9 void Rte_Exit_myComponent_myExclusiveArea1(void)
10 {
11     Rte_ExitHook_myComponent_myExclusiveArea1_Start();
12     Rte_Rips_myPlugin_Exit_myComponent_myExclusiveArea1();
13     Rte_ExitHook_myComponent_myExclusiveArea1_Return();
14 }

```

Code example for `Rte_Rips_myPlugin_myComponent.h` when the Plug-in chooses OS Interrupt suspension to implement the [ExclusiveArea](#):

```

1 #define Rte_Rips_myPlugin_Enter_myComponent_myExclusiveArea1()
   SuspendOSInterrupts()
2 #define Rte_Rips_myPlugin_Exit_myComponent_myExclusiveArea1()
   ResumeOSInterrupts()

```

7.3.5.4 Exclusive Areas in Role `runsInsideExclusiveArea`

The [ExclusiveAreas](#) which enclose the complete [ExecutableEntity](#) of a software component or Basic Software Modules are referenced in the [ExecutableEntity](#) property `runsInsideExclusiveArea`. Such [ExclusiveAreas](#) do not result in the generation of an API, but in protective actions before the [ExecutableEntity](#) starts and after it terminates.

The following example 7.16 shows an implementation of the `ExclusiveArea` where the whole `RunnableEntity` runs inside `ExclusiveArea` and where the RTE Generator uses `OS_INTERRUPT_BLOCKING`.

Example 7.16

Code example for `Rte.c` in case the RTE Generator implements the `ExclusiveArea`:

```
1  #include "Rte.h"
2  TASK(TASK_COOP_10MS)
3  {
4      SuspendOSInterrupts();
5      Rte_Runnable_myComponent_EvMyRunnable10ms_Start();
6      myRunnable();
7      Rte_Runnable_myComponent_EvMyRunnable10ms_Return();
8      ResumeOSInterrupts();
9  }
```

The following example 7.17 shows an equivalent implementation of the `ExclusiveArea` via an RTE Implementation Plug-In:

Example 7.17

Code example for `Rte.c` in case the RTE Generator redirects towards an RTE Implementation Plug-In to implement the `ExclusiveArea`:

```
1  #include "Rte.h"
2  #include "Rte_Rips_myPlugin_myComponent.h"
3  TASK(TASK_COOP_10MS)
4  {
5      Rte_Runnable_myComponent_EvMyRunnable10ms_Start();
6      Rte_Rips_myPlugin_Enter_myComponent_EvMyRunnable10ms_myExclusiveArea
7      ();
8      myRunnable();
9      Rte_Rips_myPlugin_Exit_myComponent_EvMyRunnable10ms_myExclusiveArea
10     ();
11     Rte_Runnable_myComponent_EvMyRunnable10ms_Return();
12 }
```

Code example for `Rte_Rips_myPlugin_myComponent.h` when the Plug-in chooses OS Interrupt suspension to implement the `Exclusive Area`:

```
1  #define
2      Rte_Rips_myPlugin_Enter_myComponent_EvMyRunnable10ms_myExclusiveArea
3      () \
4      SuspendOSInterrupts()
5  #define
6      Rte_Rips_myPlugin_Exit_myComponent_EvMyRunnable10ms_myExclusiveArea
7      () \
8      ResumeOSInterrupts()
```

7.3.6 Modes

7.3.6.1 Modes and Local Software Cluster Communication Plug-In

Without [Local Software Cluster Communication Plug-Ins](#) the protection of the mode queues is a duty of the RTE Generator. Due to the requirements on [mode machine instances](#) and [distributed shared mode queues](#) for queuing and consistent reading of a set of mode values (current mode, previous mode, next mode) via [Rte_Mode](#) APIs, it is very likely that the implementation requires a protection mechanism.

But in case [Local Software Cluster Communication Plug-Ins](#) are applied there is an interest to control the applied protection mechanisms for basically two reasons:

- The applied protection mechanisms shall fit to the overall strategy of protection mechanisms applied for [Communication Graphs](#).
- If [Local Software Cluster Communication Plug-Ins](#) are used to support a scheduling setup which the RTE Generator cannot handle via its implementation, it is consistently required to move also the protection of mode queues to the responsibility of the [Local Software Cluster Communication Plug-Ins](#).

Nevertheless the supporting pattern for those protections deviates from the pattern defined for data communication. There are two rationales for this deviation:

An ECU usually uses a high number of data communications which in turn results in a high frequency of calls to communication APIs. In opposite the number of [mode machine instances](#) is significantly lower. Furthermore modes are not switched such frequently. But on the other hand the implementation of [mode machine instances](#) and [distributed shared mode queues](#) is not purely driven by the accessing [ExecutableEntities](#). Furthermore the requirements to apply mode disablings and to dequeue mode switch notification at the end of transitions result in mode queue accesses in the context of [OsTasks](#).

For this reason the [RTE Implementation Plug-In Service Rte_Rips_EnterModeQueue](#) and [Rte_Rips_ExitModeQueue](#) are designed like exclusive areas without a specific name space for the call context.

7.3.6.2 Modes and Cross Software Cluster Communication Plug-In

In case a [mode switch notification](#) needs to be communicated to another Software Cluster its the duty of the [Cross Software Cluster Communication Plug-In](#) to implement the functionality to cross the Software Cluster borders.

In case the `mode switch notification` is received by the Software Cluster, the regular `Rte_Switch` API is enough to inform the RTE about the ongoing mode switch. The only difference to a mode switch, which is completely locally handled in the `Applicative Software Cluster`, is the fact, that the task activation for mode switch task is coordinated by the `Host Software Cluster` in the background.

In case the mode switch notification is provided by the Software Cluster, the Cross Cluster Communication needs on one hand to be informed about newly enqueued `mode switch notifications`. So as to, the `Rte_Switch` API calls the related `Rte_Rips_Switch` service of the `Cross Software Cluster Communication Plug-In`. When the mode switch is started, it is executed on all the receiving Software Clusters and needs there to be fully processed before the next mode switch can be dequeued. For this purpose, the Software Cluster Connection notifies the RTE via `Rte_Rips_DequeueModeSwitch` service.

7.3.6.3 Enable RTE Implementation Plug-In support for mode machine instances

[SWS_Rte_80082] [The RTE Generator shall enable the `Local Software Cluster Communication Plug-In` support for a `mode machine instance`, if the related `RteModeMachineInstanceConfig` or `RteBswModeMachineInstanceConfig` container contains the reference `RteModeMachineInstanceResponsibleRipsPluginRef`.] (*SRS_Rte_00315*)

[SWS_Rte_CONSTR_80024]{DRAFT} **`RteModeMachineInstanceResponsibleRipsPluginRef` ins only applicable for `Local Software Cluster Communication Plug-Ins`** [The reference `RteModeMachineInstanceResponsibleRipsPluginRef` shall only reference a `Local Software Cluster Communication Plug-In`.] ()

[SWS_Rte_80132] [The RTE Generator shall enable the `Cross Software Cluster Communication Plug-In` support for a `mode machine instance`, if for a `Mode Communication Graph`

- a `FlatInstanceDescriptor` references the `Mode Communication Graph`
- AND
- and the `rtePluginProps.associatedCrossSwClusterComRtePlugin` references the `RteRipsPluginProps` container of the `Cross Software Cluster Communication Plug-In`.

] (*SRS_Rte_00321*)

[SWS_Rte_CONSTR_80026]{DRAFT} **`modeGroup` instance reference for `Rte Implementation Plug-Ins`** [The `RIPS FlatInstanceDescriptor` for a `Mode Communication Graph` shall reference the `modeGroup` instance in the `Abstract-ProvidedPortPrototype`, if the configuration contains the `mode manager` for the `Mode Communication Graph`.] (*SRS_Rte_00321*)

[SWS_Rte_CONSTR_80027]{DRAFT} Valid `modeGroup` instance reference for Rte Implementation Plug-Ins II [The `RIPS FlatInstanceDescriptor` for a `Mode Communication Graph` shall reference the `modeGroup` instance in the `RPortPrototype` at the `CompositionSwComponentType` of the `rootSoftwareComposition` of the `Ecu Extract`, if the configuration contains only the `mode user` for the `Mode Communication Graph`.] (*SRS_Rte_00321*)

Note that [SWS_Rte_CONSTR_80026] and [SWS_Rte_CONSTR_80027] refers to the configuration before the `Cross Software Cluster Communication Plug-In` provides the 'proxy' `mode manager` as described in document [33].

[SWS_Rte_CONSTR_80028]{DRAFT} Valid `modeGroup` instance reference for Rte Implementation Plug-Ins III [The `RIPS FlatInstanceDescriptor` for a `modeGroup` is only applicable, if the `rtePluginProps.associatedCrossSwClusterComRtePlugin` references a `Cross Software Cluster Communication Plug-In`.] (*SRS_Rte_00321*)

7.3.6.4 Cross Software Cluster Communication Plug-In support for mode communication

7.3.6.4.1 Rte_Rips_Switch indication

[SWS_Rte_80133]{DRAFT} [The RTE shall call the `Rte_Rips_Switch` Service in the `Rte_Switch` API of the related `mode manager` of the `mode machine instance`, if the `Cross Software Cluster Communication Plug-In` support for a `Mode Communication Graph` is enabled.] (*SRS_Rte_00321*)

Thereby the parameters are set according to the following requirements:

[SWS_Rte_80134]{DRAFT} [In case the `Rte_Switch` API enqueued into an empty mode queue, the RTE shall pass the current mode of the related `mode machine instance` as parameter `previousmode`, the requested mode as parameter `nextmode`, and `RTE_SWITCH_NOTIFICATION_ENQUEUED_FIRST` as parameter `switchNotificationStatus` to the `Rte_Rips_Switch` Service.] (*SRS_Rte_00321*)

[SWS_Rte_80135]{DRAFT} [In case the `Rte_Switch` API enqueued into a non empty mode queue, the RTE shall pass the requested mode as parameter `nextmode` and `RTE_SWITCH_NOTIFICATION_ENQUEUED_NOT_FIRST` as parameter `switchNotificationStatus` to the `Rte_Rips_Switch` Service.] (*SRS_Rte_00321*)

[SWS_Rte_80136]{DRAFT} [In case the `Rte_Switch` API could not enqueue into the mode queue, the RTE shall pass the requested mode as parameter `nextmode` and `RTE_SWITCH_NOTIFICATION_ENQUEUE_FAILED` as parameter `switchNotificationStatus` to the `Rte_Rips_Switch` Service.] (*SRS_Rte_00321*)

Please note: In case of [SWS_Rte_80134] and [SWS_Rte_80135] it is possible that a mode transition of this `mode machine instance` is ongoing. Therefore the parameter `previousmode` is not reliable since it may change at any time during the

execution of the `Rte_Rips_Switch` Service. Therefore the value of the parameter `previousmode` is implementation specific and will not be evaluated by the `RTE Implementation Plug-In` in case of already ongoing mode switches.

7.3.6.4.2 `Rte_Rips_DequeueModeSwitch` indication

With the `Rte_Rips_DequeueModeSwitch` service the RTE can dequeue the next mode switch from the mode queue at the point in time when the mode switch is finished at all `Software Clusters`. In case the mode providing `Applicative Software Cluster` utilizes multiple mode switch tasks (e.g. in a multi core or mode switch configuration) the `Rte_Rips_DequeueModeSwitch` gets called by the `Cross Software Cluster Communication Plug-In` for each mode switch tasks. It's up on the RTE to decide in which of the calls the real dequeue operation happens. Please note, that the `Rte_Rips_DequeueModeSwitch` service is only applicable in an `Applicative Software Cluster`. In the `Host Software Cluster`, the RTE implements the mode switches on top of the real OS tasks - in which the execution of mode switches in `Applicative Software Clusters` are scheduled. Hence, it is not possible, that a mode switch in another `Software Cluster` is not finished after the mode switch of the `Host Software Cluster` is finished.

[SWS_Rte_70123]{DRAFT} [The `Cross Software Cluster Communication Plug-In` in an `Applicative Software Cluster` shall call the `Rte_Rips_DequeueModeSwitch` Service in a context which behaves identical as any mode switch task w.r.t preemption and priority after the last `on-entry ExecutableEntitys` terminated, if the `Cross Software Cluster Communication Plug-In` support for a `Mode Communication Graph` is enabled in an `Applicative Software Cluster` where the mode is provided to other `Software Clusters`.]([SRS_Rte_00321](#))

[SWS_Rte_80137]{DRAFT} [The RTE shall dequeue the next mode when the `Rte_Rips_DequeueModeSwitch` gets called and

- the last `on-entry ExecutableEntitys` terminated ()
OR if no `on-entry ExecutableEntitys` is configured
- the last `on-transition ExecutableEntitys` terminated
OR if no `on-transition ExecutableEntitys` is configured
- the last `on-exit ExecutableEntitys` terminated (if any is configured)
OR if no `on-exit ExecutableEntitys` is configured
- immediately

]([SRS_Rte_00321](#))

[SWS_Rte_80138]{DRAFT} [In case the `Rte_Rips_DequeueModeSwitch` cannot execute the dequeue operation since still executions of `on-entry ExecutableEntities`, `on-transition ExecutableEntities` or `on-exit ExecutableEntities` are pending the function shall return `RTE_SWITCH_NOTIFICATION_SKIP`.]
(SRS_Rte_00321)

[SWS_Rte_80139]{DRAFT} [In case the `Rte_Rips_DequeueModeSwitch` execute the dequeue operation from the mode queue and no further mode is in the queue the function shall return `RTE_SWITCH_NOTIFICATION_DEQUEUED_LAST`.]
(SRS_Rte_00321)

[SWS_Rte_80140]{DRAFT} [In case the `Rte_Rips_DequeueModeSwitch` execute the dequeue operation from the mode queue and any further mode is in the queue the function shall return `RTE_SWITCH_NOTIFICATION_DEQUEUED_NOT_LAST`.]
(SRS_Rte_00321)

7.3.6.5 Enable RTE Implementation Plug-In support for distributed shared mode queues

[SWS_Rte_80083] [The RTE Generator shall enable the `RTE Implementation Plug-In` support for a `distributed shared mode queue`, if the related `RteDistributedSharedModeQueue` container contains the reference `RteDSMQResponsibleRipsPluginRef`.]
(SRS_Rte_00310)

In case the `mode machine instance` belongs to a `distributed shared mode queue` the participating `mode machine instances` cannot be associated with an `RTE Implementation Plug-In`. Since the `distributed shared mode queue` requires a common queue handling for all `mode machine instances`, a consistent protection mechanism for all `mode machine instances` is required. Therefore the individual assignment of `mode machine instances` to `RTE Implementation Plug-Ins` is not possible.

[SWS_Rte_CONSTR_80012] [`mode machine instance` belonging to a `distributed shared mode queue` is not allowed to be configured for individual `RTE Implementation Plug-In` support In case a `mode machine instance` belongs to a `distributed shared mode queue` the reference `RteModeMachineInstanceResponsibleRipsPluginRef` shall not be configured.]
(SRS_Rte_00310)

Nevertheless, when a `mode machine instance` belongs to a `distributed shared mode queue` which is assigned to an `RTE Implementation Plug-In`, the protection of all accesses to the `mode machine instance` which require protection are implemented via the `RTE Implementation Plug-In`.

7.3.6.6 RTE Implementation Plug-In support for distributed shared mode queues

The RTE Implementation Plug-In support for a distributed shared mode queue has the purpose to connect an external task coordinator functionality implemented as part of the RTE Implementation Plug-In. This enables a well defined ramp-down and ramp-up of the task schedule during a mode switch. Further on such an RTE Implementation Plug-In can actively manage the gap in the periodic schedule in which mode switches are processed. For instances this might be implemented with the means of priority ceiling caused by getting an `OsResource`.

Each mode switch of a mode machine instance belonging to a distributed shared mode queue causes the following four kind of notifications:

1. `Rte_Rips_DsmqSwitch` indicates that a mode switch notification was enqueued or discarded.
2. `Rte_Rips_DsmqTransitionStart` indicates the start of each (non chained) DSMQ transition `OsTask`.
3. `Rte_Rips_DsmqTransitionSync` indicates that DSMQ transition `OsTask` has executed its mapped on-entry `ExecutableEntitys`, on-transition `ExecutableEntitys`, and on-exit `ExecutableEntitys` for this mode switch.
4. `Rte_Rips_DsmqTransitionEnd` indicates the successful completion of the previous mode switch and (if applicable) the enqueueing of the next mode switch.

7.3.6.6.1 DSMQ transition `OsTask` activation

In order to ensure a constant number of notification calls to the RTE Implementation Plug-In for any mode switch following requirement applies:

[SWS_Rte_80125] [The RTE shall always activate all non-chained DSMQ transition `OsTasks` when a new mode transition starts, regardless whether any on-entry `ExecutableEntitys`, on-transition `ExecutableEntitys`, or on-exit `ExecutableEntitys` of the currently switching mode machine instance is mapped to such an `OsTask`.] (*SRS_Rte_00311*)

7.3.6.6.2 `Rte_Rips_DsmqSwitch` indication

[SWS_Rte_80111] [The RTE shall call the `Rte_Rips_DsmqSwitch` Service in the `Rte_Switch` API of the related mode manager of the mode machine instance, if the RTE Implementation Plug-In support for a distributed shared mode queue is enabled.] (*SRS_Rte_00311*)

Thereby the parameters are set according to the following requirements:

[SWS_Rte_80112] [In case the `Rte_Switch` API enqueued into an empty `distributed shared mode queue`, the RTE shall pass the current mode of the related `mode machine instance` as parameter `previousmode`, the requested mode as parameter `nextmode`, and `RTE_DSMQ_ENQUEUED_FIRST` as parameter `dsmqstatus` to the `Rte_Rips_DsmqSwitch` Service.]([SRS_Rte_00311](#))

[SWS_Rte_80113] [In case the `Rte_Switch` API enqueued into a non empty `distributed shared mode queue`, the RTE shall pass the requested mode as parameter `nextmode` and `RTE_DSMQ_ENQUEUED_NOT_FIRST` as parameter `dsmqstatus` to the `Rte_Rips_DsmqSwitch` Service.]([SRS_Rte_00311](#))

[SWS_Rte_80114] [In case the `Rte_Switch` API could not enqueue into the `distributed shared mode queue`, the RTE shall pass the requested mode as parameter `nextmode` and `RTE_DSMQ_ENQUEUE_FAILED` as parameter `dsmqstatus` to the `Rte_Rips_DsmqSwitch` Service.]([SRS_Rte_00311](#))

Please note: In case of [\[SWS_Rte_80113\]](#) and [\[SWS_Rte_80114\]](#) it is possible that a mode transition of this `mode machine instance` is ongoing. Therefore the parameter `previousmode` is not reliable since it may change at any time during the execution of the `Rte_Rips_DsmqSwitch` Service. Therefore the value of the parameter `previousmode` is implementation specific and will not be evaluated by the `RTE Implementation Plug-In`.

7.3.6.6.3 Rte_Rips_DsmqTransitionStart indication

[SWS_Rte_80115] [The RTE shall call the `Rte_Rips_DsmqTransitionStart` Service of the `mode machine instance` related to the to be performed mode switch in each DSMQ transition `OsTask` participating in the `distributed shared mode queue`

- after the RTE examined the mode transition to be performed in this `OsTask` execution and
- before calling any `ExecutableEntity` in this task and
- before any operation on the implicit buffers of this task.

]([SRS_Rte_00311](#))

[SWS_Rte_80116] [The RTE shall pass the mode from which the mode switch will be performed as parameter `previousmode` to the `Rte_Rips_DsmqSwitch` Service.]([SRS_Rte_00311](#))

[SWS_Rte_80117] [The RTE shall pass the mode to which the mode switch will be performed as parameter `nextmode` to the `Rte_Rips_DsmqSwitch` Service.]([SRS_Rte_00311](#))

Thereby the the RTE can assume that the [Rte_Rips_DsmqSwitch](#) Service will not return before all "non-chained" DSMQ transition [OsTasks](#) participating in the [distributed shared mode queue](#) called the [Rte_Rips_DsmqSwitch](#) Service.

[SWS_Rte_70109] [The RTE Implementation Plug-In shall stay in the [Rte_Rips_DsmqSwitch](#) Service until all [Rte_Rips_DsmqSwitch](#) Services of "non-chained" DSMQ transition [OsTasks](#) are entered.]([SRS_Rte_00315](#))

7.3.6.6.4 Rte_Rips_DsmqTransitionSync indication

[SWS_Rte_80118] [The RTE shall call the [Rte_Rips_DsmqTransitionSync](#) Service of the DSMQ transition [OsTask](#)

- after termination of any [on-exit ExecutableEntitys](#), [on-transition ExecutableEntitys](#), and [on-entry ExecutableEntitys](#) in this task
- and after any operation on the implicit buffers of this task,
- before any manipulation of the [distributed shared mode queue](#) (e.g the dequeuing the next transition).

]([SRS_Rte_00311](#))

Thereby the [Rte_Rips_DsmqTransitionSync](#) Service combines two functionalities. On one hand it is a synchronization point between concurrently executed DSMQ transition [OsTasks](#). On the other hand the return value controls when and in which [OsTask](#) the dequeue operation on the [distributed shared mode queue](#) is done.

[SWS_Rte_70115] [The RTE Implementation Plug-In shall return for exactly one [Rte_Rips_DsmqTransitionSync](#) Service TRUE, and for all others (if present) FALSE.]([SRS_Rte_00315](#))

Please note: The return value of [Rte_Rips_DsmqTransitionSync](#) Service is decided at runtime and can change between different mode switches.

[SWS_Rte_80119] [The RTE shall only execute the dequeue operation on the [distributed shared mode queue](#) in the DSMQ transition [OsTasks](#) in which the [Rte_Rips_DsmqTransitionSync](#) Service returned TRUE.]([SRS_Rte_00311](#))

7.3.6.6.5 Rte_Rips_DsmqTransitionEnd indication

[SWS_Rte_80120] [The RTE shall call the [Rte_Rips_DsmqTransitionEnd](#) Service in the DSMQ transition [OsTask](#) in which the dequeue operation is executed (see [\[SWS_Rte_80119\]](#)) after the [distributed shared mode queue](#) has been manipulated and the new mode has been made visible to the mode users, but before the execution of [ModeSwitchAck ExecutableEntitys](#).]([SRS_Rte_00311](#))

[SWS_Rte_80121] [The RTE shall treat the time between the dequeue operation of the current mode switch and the return of the `Rte_Rips_DsmqTransitionEnd` Service of the current mode switch as a critical section. Enqueue operations into this `distributed shared mode queue` occurring during the critical section shall be executed when the critical section is left.]([SRS_Rte_00311](#))

Note: Since the `distributed shared mode queue` is protected by a pair of `Rte_Rips_EnterModeQueue` and `Rte_Rips_ExitModeQueue` Services, **[SWS_Rte_80121]** requires the following sequence:

1. call of `Rte_Rips_EnterModeQueue`
2. manipulation of the `distributed shared mode queue` (set new current mode, dequeue next mode transition)
3. call of `Rte_Rips_DsmqTransitionEnd`
4. call of `Rte_Rips_ExitModeQueue`.

Thereby the parameters are set according to the following requirements:

[SWS_Rte_80122] [In case the `distributed shared mode queue` was emptied by the mode switch, the RTE shall pass `RTE_DSMQ_DEQUEUED_LAST` as parameter `dsmqstatus`, the mode from which the mode switch was performed as parameter `previousmode`, and the mode to which the mode switch was performed as parameter `nextmode` to the `Rte_Rips_DsmqTransitionEnd` Service to the just switched `mode machine instance`.]([SRS_Rte_00311](#))

[SWS_Rte_80123] [In case the `distributed shared mode queue` was not emptied by the mode switch, the RTE shall pass `RTE_DSMQ_DEQUEUED_NOT_LAST` as parameter `dsmqstatus`, the mode from which the next mode switch will be performed as parameter `previousmode`, and the mode to which the next mode switch will be performed as parameter `nextmode` to the `Rte_Rips_DsmqTransitionEnd` Service related to the next to be switched `mode machine instance`.]([SRS_Rte_00311](#))

[SWS_Rte_80124] [In case the `distributed shared mode queue` was not emptied by the mode switch, the RTE shall activate the non chained DSMQ transition `OsTasks` participating in the `distributed shared mode queue` after the `Rte_Rips_DsmqTransitionEnd` Service returned.]([SRS_Rte_00311](#))

7.3.7 Parameters

7.3.7.1 Enable RTE Implementation Plug-In support for Parameter Communication Graphs

According Document [8] a `Parameter Communication Graph` gets assigned to an `RTE Implementation Plug-In` with a `FlatInstanceDescriptor` that points on one hand to the instance of a `ParameterDataPrototype` and on the

other hand points via `FlatInstanceDescriptor.rtePluginProps.associatedCrossSwClusterComRtePlugin` to the container `RteRipsPluginProps`.

Please note, `Parameter Communication Graphs` only support `RTE Implementation Plug-Ins` for `Cross Cluster Communication`!

[SWS_Rte_80127]{DRAFT} [The RTE Generator shall enable the `RTE Implementation Plug-In` support for `Cross Cluster Communication` for a `Parameter Communication Graph`, if a `FlatInstanceDescriptor` with `rtePluginProps.associatedCrossSwClusterComRtePlugin` references the `Parameter Communication Graph`.] (*SRS_Rte_00319*)

Please note:

Thereby the `FlatInstanceDescriptor`'s `target` is the `parameter`.

In this document those specific `FlatInstanceDescriptors` are called `RIPS FlatInstanceDescriptor`.

[SWS_Rte_CONSTR_80020]{DRAFT} A `Parameter Communication Graph` is handled by at most one `RTE Implementation Plug-In` [A `Parameter Communication Graph` shall be referenced by at most one `RIPS FlatInstanceDescriptors`] (*SRS_Rte_00319*)

[SWS_Rte_CONSTR_80021]{DRAFT} Valid `parameter` instance reference for `Rte Implementation Plug-Ins I` [The `RIPS FlatInstanceDescriptor` for a `Parameter Communication Graph` shall reference the `parameter` instance in the `PPortPrototype` of the `ParameterSwComponentType`, if the `Parameter Communication Graphs` contains a `PPortPrototype`.] (*SRS_Rte_00319*)

[SWS_Rte_CONSTR_80022]{DRAFT} Valid `parameter` instance reference for `Rte Implementation Plug-Ins II` [The `RIPS FlatInstanceDescriptor` for a `Parameter Communication Graph` shall reference the `parameter` instance in the `RPortPrototype` at the `CompositionSwComponentType` of the `rootSoftwareComposition` of the `Ecu Extract`, if the `Parameter Communication Graphs` contains NOT any `PPortPrototype`.] (*SRS_Rte_00319*)

[SWS_Rte_CONSTR_80023]{DRAFT} Valid `parameter` instance reference for `Rte Implementation Plug-Ins III` [

For the `RIPS FlatInstanceDescriptor` of a `Parameter Communication Graph` shall only use the `FlatInstanceDescriptor.rtePluginProps.associatedCrossSwClusterComRtePlugin` reference to assign the `RteRipsPluginProps` container.] (*SRS_Rte_00319*)

[SWS_Rte_70142]{DRAFT} [The associated `RTE Implementation Plug-In` shall implement the provision of access to the `parameter` instance by other `Software Clusters` for the related `Parameter Communication Graphs` if the `Parameter Communication Graphs` contains a `PPortPrototype`.] (*SRS_Rte_00319*)

[SWS_Rte_70120]{DRAFT} [The associated RTE Implementation Plug-In shall implement the access to the parameter instance of another Software Clusters for the related [Parameter Communication Graphs](#) if the [Parameter Communication Graphs](#) does not contain any [PPortPrototype](#).]([SRS_Rte_00319](#))

[SWS_Rte_70121]{DRAFT} [The RTE Generator shall treat [RIPS FlatInstanceDescriptors](#) of a [Parameter Communication Graphs](#) as regular AUTOSAR [FlatInstanceDescriptors](#), independent of their special meaning for RTE Implementation Plug-In support.]([SRS_Rte_00319](#))

Besides the RTE Implementation Plug-In related special meaning, the [RIPS FlatInstanceDescriptors](#) keep their AUTOSAR meaning. This especially means that also [RIPS FlatInstanceDescriptors](#) can lead to entries in the [McSupport-Data](#) as described in section 4.2.9.4. This has the intended side effect that the globally unique names used for RTE Implementation Plug-In can be kept identical to the names visible in a MCD tool. Further information is provided in section 7.3.12.2.

7.3.7.2 Instantiation of parameter

The RTE Implementation Plug-In interface assumes that the RTE implements per [Parameter Communication Graphs](#) containing a [PPortPrototype](#) exactly one constant variable that holds the value of the parameter. This constant variable is called [parameter instance](#).

[SWS_Rte_80130]{DRAFT} [The RTE shall provide exactly one [parameter instance](#) for each [Parameter Communication Graphs](#) containing a [PPortPrototype](#) if the [Parameter Communication Graphs](#) is assigned to an RTE Implementation Plug-In.]([SRS_Rte_00319](#))

Please note that the RTE Generator still has the freedom to decide about the naming of the [parameter instance](#) as well as to group [parameter instances](#) in RTE specific structures. In this case the requirement [SWS_Rte_80131] ensures the accessibility by a defined name.

[SWS_Rte_80154]{DRAFT} [When the RTE provides an [parameter instance](#) for a [Parameter Communication Graph](#) it shall use the [Implementation-DataType](#) applicable for the parameter in the [PPortPrototype](#).]([SRS_Rte_00300](#), [SRS_Rte_00301](#))

7.3.8 Compatibility Mode

7.3.8.1 Detection of source code vs. object code software components

AUTOSAR provides means to describe the delivery content of a software component. It also describes the different behavior in case of source code and object code deliveries. But what is missing there is a rule how to detect the kind of delivery out of the

component description. Thereby [SWS_Rte_80045] shall ensure a consistent behavior of RTE Generator and RTE Implementation Plug-Ins.

[SWS_Rte_80045] [The Rte Generator and the RTE Implementation Plug-Ins shall discover a source code delivery of a software component, if the according SwcImplementation mentions at least one codeDescriptor.artifactDescriptor category set to SWSRC and none of category SWOBJ.] (SRS_Rte_00316)

Note: In all other cases the software component is delivered as object code.

7.3.8.2 Compatibility Mode and RTE Implementation Plug-Ins

The usage of the RTE Implementation Plug-In Services by the RTE is transparent for the software component. When a RTE has to support compatibility mode, e.g. due to an object code delivered software component, the RTE Implementation Plug-In Services are used either in the real RTE API C-functions or in the component data structure only.

As a consequence, applying RTE Implementation Plug-Ins does not impact the *contract phase*.

Nevertheless the RTE Implementation Plug-Ins has to consider the usage of the Rte_Rips_IRBufferRef and Rte_Rips_IWBufferRef Services for the initialization of the handles in the component data structure.

[SWS_Rte_70108] [In case an Atomic Software Component requires compatibility mode due to object code integration (see [SWS_Rte_80045]) or the software component supports multiple instantiation, the associated RTE Implementation Plug-In shall implement all Rte_Rips_IRBufferRef and Rte_Rips_IWBufferRef Services for every instance of this Atomic Software Component in a way that those services can be used as static initializer.] (SRS_Rte_00306, SRS_Rte_00301)

7.3.9 Client Server Communication

7.3.9.1 Enable RTE Implementation Plug-In support for client server Communication

In case a Client Server Communication enabling of the RTE Implementation Plug-In support is done as follows:

[SWS_Rte_80067] [The RTE Generator shall enable the RTE Implementation Plug-In support for a Client Server Communication Graph, if a FlatInstanceDescriptor with rtePluginProps references the Client Server Communication Graph.] (SRS_Rte_00312)

Please note: Thereby the FlatInstanceDescriptor's target is the ClientServerOperation.

In contrast to [Data Communication Graphs](#), [Client Server Communication Graphs](#) only support either a [Local Software Cluster Communication Plug-In](#) for transformer handling or a [Cross Software Cluster Communication Plug-In](#) for the communicate to other Software Clusters.

[SWS_Rte_CONSTR_80004] [A [Client Server Communication Graph](#) is handled by at most one [RTE Implementation Plug-In](#) In the case that a [Client Server Communication Graph](#) is referenced by several [RIPS FlatInstanceDescriptors](#), all those [RIPS FlatInstanceDescriptors](#) shall reference via [FlatInstanceDescriptor.rtePluginProps.associatedRtePlugin](#) the same [RteRipsPluginProps](#) container.]([SRS_Rte_00312](#))

[SWS_Rte_CONSTR_80005] [Valid [operation](#) instance reference for [Rte Implementation Plug-Ins](#) I The [RIPS FlatInstanceDescriptor](#) for a [Client Server Communication Graph](#) shall reference the [ClientServerOperation](#) instance in the [AbstractProvidedPortPrototype](#), if the configuration contains only the Server or the Clients and Server for the [Client Server Communication Graph](#).]([SRS_Rte_00312](#))

[SWS_Rte_CONSTR_80006] [Valid [operation](#) instance reference for [Rte Implementation Plug-Ins](#) II The [RIPS FlatInstanceDescriptor](#) for a [Client Server Communication Graph](#) shall reference the [ClientServerOperation](#) instance in the [RPortPrototype](#), if the configuration contains only the Clients for the [Client Server Communication Graph](#).]([SRS_Rte_00312](#))

[SWS_Rte_CONSTR_80204]{DRAFT} [Cross Software Cluster Communication Plug-In](#) supports asynchronous Client Server Communication only I [The [RIPS FlatInstanceDescriptor](#) for a [Client Server Communication Graph](#) referencing [Cross Software Cluster Communication Plug-In](#) is only applicable, if all clients invoke the server asynchronously via [AsynchronousServerCallPoint](#) .]([SRS_Rte_00312](#))

[SWS_Rte_CONSTR_80205]{DRAFT} [Cross Software Cluster Communication Plug-In](#) supports asynchronous Client Server Communication only I [A configuration where the [RIPS FlatInstanceDescriptor](#) for a [Client Server Communication Graph](#) references a given [ClientServerOperation](#) on which both synchronous and asynchronous [ServerCallPoints](#) apply is invalid .]([SRS_Rte_00312](#))

7.3.10 Trigger Communication

7.3.10.1 Enable RTE Implementation Plug-In support for triggers

In case a Trigger Communication uses data transformation, enabling of the [RTE Implementation Plug-In](#) support is done as follows:

[SWS_Rte_80102] [The RTE Generator shall enable the RTE Implementation Plug-In support for a Trigger Communication Graph, if a FlatInstanceDescriptor with rtePluginProps references the Trigger Communication Graph.](SRS_Rte_00317)

Please note: Thereby the FlatInstanceDescriptor's target is the trigger.

[SWS_Rte_80145]{DRAFT} [The RTE Generator shall enable the RTE Implementation Plug-In support for Software Cluster Local Communication for a Trigger Communication Graph, if a FlatInstanceDescriptor with rtePluginProps.associatedRtePlugin references the Trigger Communication Graph.](SRS_Rte_00317)

[SWS_Rte_80146]{DRAFT} [The RTE Generator shall enable the RTE Implementation Plug-In support for Cross Cluster Communication for a Trigger Communication Graph, if a FlatInstanceDescriptor with rtePluginProps.associatedCrossSwClusterComRtePlugin references the Trigger Communication Graph.](SRS_Rte_00317)

In contrast to Data Communication Graphs, Trigger Communication Graphs only support either a Local Software Cluster Communication Plug-In for transformer handling or a Cross Software Cluster Communication Plug-In for the communicate to other Software Clusters.

[SWS_Rte_CONSTR_80014] [A Trigger Communication Graph is handled by at most one RTE Implementation Plug-In In the case that a Trigger Communication Graph is referenced by several RIPS FlatInstanceDescriptors, all those RIPS FlatInstanceDescriptors shall reference via FlatInstanceDescriptor.rtePluginProps.associatedRtePlugin the same RteRipsPluginProps container.](SRS_Rte_00317)

[SWS_Rte_CONSTR_80015] [Valid trigger instance reference for Rte Implementation Plug-Ins I The RIPS FlatInstanceDescriptor for a Trigger Communication Graph shall reference the trigger instance in the AbstractProvidedPortPrototype, if the configuration contains only the trigger source or the trigger sink(s) and trigger source for the Trigger Communication Graph.](SRS_Rte_00317)

[SWS_Rte_CONSTR_80016] [Valid trigger instance reference for Rte Implementation Plug-Ins II The RIPS FlatInstanceDescriptor for a Trigger Communication Graph shall reference the trigger instance in the RPortPrototype, if the configuration contains only the trigger sink for the Trigger Communication Graph.](SRS_Rte_00317)

[SWS_Rte_CONSTR_80017] [Valid trigger instance reference for Rte Implementation Plug-Ins III The RIPS FlatInstanceDescriptor for a Trigger Communication Graph is only applicable, if

- the trigger communication configures a transformer according [SWS_Rte_08794] (inter ECU),

OR

- the trigger communication occurs cross Software Clusters.

]([SRS_Rte_00317](#))

7.3.10.2 Trigger and Cross Software Cluster Communication Plug-In

In case a `trigger` needs to be communicated to another Software Cluster its the duty of the `Cross Software Cluster Communication Plug-In` to implement the functionality to cross the Software Cluster borders.

In case the `trigger` is received by the Software Cluster, the regular `Rte_Trigger` API is enough to inform the RTE about the raised trigger. The only difference to a trigger, which is completely locally handled in the `Applicative Software Cluster`, is the fact, that the task activation for tasks executing `triggered ExecutableEntitys` is coordinated by the `Host Software Cluster` in the background.

In case the `trigger` is provided by the Software Cluster, the Cross Cluster Communication needs on one hand to be informed about newly raised triggers. So as to, the `Rte_Trigger` API calls the related `Rte_Rips_Trigger` service of the `Cross Software Cluster Communication Plug-In`.

For any `trigger` is provided by a `Applicative Software Cluster`, the `Host Software Cluster` gets also informed about the raised triggers. This enables the `Host Software Cluster` to activate all tasks executing `triggered ExecutableEntitys`. In case triggers needs to be queued, the queue is configured and implemented in the RTE of the `Host Software Cluster`.

7.3.10.2.1 Rte_Rips_Trigger indication

[SWS_Rte_80147]{DRAFT} [The RTE shall call the `Rte_Rips_Trigger` Service in the `Rte_Trigger` API of the related `trigger source`, if the `Cross Software Cluster Communication Plug-In` support for a `Trigger Communication Graph` is enabled.]([SRS_Rte_00317](#))

[SWS_Rte_CONSTR_80029]{DRAFT} **Trigger queue is only supported in Host Software Cluster** [The configuration of a trigger queue according [[SWS_Rte_07087](#)] for a `trigger` communicated between Software Clusters is only supported in the `Host Software Cluster`.]([SRS_Rte_00317](#))

Please note, that in the context of [[SWS_Rte_CONSTR_80029](#)] the `Host Software Cluster` might require or provide the `trigger`.

7.3.11 Transformers

7.3.11.1 Handling of DataTransformation for Data Communication Graphs

[SWS_Rte_80074] [The RTE Generator shall inhibit the call of the transformers (4.10.1) and the creation of the belonging transformer buffer (4.10.3) for a Data Communication Graph, if

- the Software Cluster Local Communication support is enabled on it,
AND
- a transformation is configured according [SWS_Rte_08794] or [SWS_Rte_08105].

](SRS_Rte_00312)

Instead of the RTE now the RTE Implementation Plug-In has the duty to call the belonging transformers in the correct order. Nevertheless carving out this functionality into an RTE Implementation Plug-In supports sophisticated buffer reuse optimizations relying on the precise scheduling scenario as well as the distinct transfer of the transformer calls in specific call contexts.

Thereby the RTE Implementation Plug-In Services Rte_Rips_Read, Rte_Rips_DRead and Rte_Rips_Write are called in the context of the related Rte_Read, Rte_DRead and Rte_Write APIs.

[SWS_Rte_70089] [The RTE Implementation Plug-In assigned to a Data Communication Graph shall call transformers behaving functionally correctly according to section (4.10.1). This includes the handling of the transformerError and return value described in section 7.2.4.5.](SRS_Rte_00312)

7.3.11.2 Handling of Client Server Communication Graphs and Trigger Communication Graphs

[SWS_Rte_80068] [The RTE Generator shall inhibit the call of the transformers (4.10.1) and the creation of the belonging transformer buffer (4.10.3) for a Client Server Communication Graph and Trigger Communication Graph, if

- the Software Cluster Local Communication support is enabled on it
AND
- a transformation is configured according [SWS_Rte_08794] or [SWS_Rte_08105].

](SRS_Rte_00312, SRS_Rte_00317)

On the client / trigger source side the RTE calls the according Rte_Rips_Invoke service in the context of the belonging RTE API (Rte_Call or Rte_Trigger). In

case of `AsynchronousServerCallPoints` and `AsynchronousServerCallResultPoints` the RTE calls the `Rte_Rips_ReturnResult` service from the `Rte_Result` API. In case of `SynchronousServerCallPoints` the RTE might call the `Rte_Rips_ReturnResult` service from the `Rte_Call` API.

On the client side the RTE Implementation Plug-In calls the `ASCR runnable` instead of the RTE.

On the server side the RTE Implementation Plug-In calls the `server runnable` respectively the `hard error runnable` instead of the RTE.

On the trigger sink side the RTE Implementation Plug-In calls the `triggered runnable` instead of the RTE.

In order to support the use case, that these `server runnables`, `hard error runnables`, `ASCR runnables` and `triggered runnables` in turn invoke an RTE API which is not handled by any RTE Implementation Plug-In at all, it is required, that the call of these `RunnableEntity`s occurs in a defined and predictable call context.

Therefore the according `OperationInvokedEvents`, `AsynchronousServerCallReturnsEvents` and `TransformerHardErrorEvents` are still mapped with `RteEventToTaskMappings` either to an `OsTask` or to a direct or trusted function call. But in addition those `RteEventToTaskMappings` shall define an `RteRipsInvocationHandlerRef`.

[SWS_Rte_CONSTR_80009] [Mandatory `Rte_Rips_InvocationHandler` in case of transformers In the case a `server runnable`, `hard error runnable`, `ASCR runnable` or `triggered runnable` invoked by an RTE Implementation Plug-In handles the transformers the belonging `RteEventToTaskMapping` shall define an `RteRipsInvocationHandlerRef`.] (*SRS_Rte_00312*, *SRS_Rte_00317*)

[SWS_Rte_80069] [The RTE Generator shall inhibit the call of the `server runnables`, `hard error runnables`, `ASCR runnables` and `triggered runnables` in case the related `Client Server Communication Graph` or `Trigger Communication Graph` is assigned to an RTE Implementation Plug-In.] (*SRS_Rte_00312*, *SRS_Rte_00317*)

[SWS_Rte_80070] [The RTE Generator shall call the configured `Rte_Rips_InvocationHandler` at the configured position in task or via a direct or trusted function call. The call shall be unconditional.] (*SRS_Rte_00312*, *SRS_Rte_00317*)

[SWS_Rte_70079] [The RTE Implementation Plug-In assigned to a `Client Server Communication Graph` or `Trigger Communication Graph` shall call the `server runnable` respectively the `triggered runnable` in the context of the `Rte_Rips_InvocationHandler` configured for the `RteRipsInvocationHandlerRef` belonging to the `server runnable` and `triggered runnable`.] (*SRS_Rte_00312*, *SRS_Rte_00317*)

[SWS_Rte_02321] [The RTE Implementation Plug-In assigned to a Client Server Communication Graph shall call the hard error runnable in the context of the RteRips_InvocationHandler configured for the RteRipsInvocationHandlerRef belonging to the hard error runnable.](SRS_Rte_00312, SRS_Rte_00317)

[SWS_Rte_02322] [The RTE Implementation Plug-In assigned to a Client Server Communication Graph shall call the ASCR runnable in the context of the RteRips_InvocationHandler configured for the RteRipsInvocationHandlerRef belonging to the ASCR runnable.](SRS_Rte_00312, SRS_Rte_00317)

Instead of the RTE now the RTE Implementation Plug-In has the duty to call the belonging transformers in the correct order. Nevertheless carving out this functionality into an RTE Implementation Plug-In enables support for sophisticated buffer reuse optimizations relying on the precise scheduling scenario as well as the distinct transfer of the transformer calls in specific call contexts.

[SWS_Rte_70080] [The RTE Implementation Plug-In assigned to a Client Server Communication Graph or Trigger Communication Graph shall call transformers behaving functionally correctly according to section (4.10.1).](SRS_Rte_00312, SRS_Rte_00317)

[SWS_Rte_70081] [The RTE Implementation Plug-In assigned to a Client Server Communication Graph or Trigger Communication Graph shall create the belonging transformer buffers with sufficient size according to section (4.10.3).](SRS_Rte_00312, SRS_Rte_00317)

7.3.12 Measurement

In general the usage of RTE Implementation Plug-Ins does not fundamentally change the general functionality to support Measurement as described in section 4.2.9.2.

7.3.12.1 Measurement on Data Communication Graphs

The only impact occurs when the RTE Implementation Plug-In instantiates the global copy as described in section 7.3.4.5. In this case the RTE Generator is not able to provide the McDataInstance.symbol for the described McDataInstances in the McSupportData.

[SWS_Rte_80073] [The RTE Generator shall inhibit the export of McDataInstance.symbol attributes for McDataInstances belonging to Data Communication Graphs associated to an RTE Implementation Plug-In where the RteRipsGlobalCopyInstantiationPolicy is set to RTE_RIPS_INSTANTIATION_BY_PLUGIN.](SRS_Rte_00153, SRS_Rte_00303)

In this case it is the responsibility of the associated RTE Implementation Plug-In to provide the `symbol` information.

[SWS_Rte_70086] [The associated RTE Implementation Plug-In shall enrich the *McSupportData* provided by the RTE Generator with the *McDataInstance.symbol* information in case

- `swCalibrationAccess` is set to `readOnly` or `readWrite` for the Data Communication Graph

AND

- the `RteRipsGlobalCopyInstantiationPolicy` is set to `RTE_RIPS_INSTANTIATION_BY_PLUGIN`.

](*SRS_Rte_00153*, *SRS_Rte_00303*)

Please note: To implement **[SWS_Rte_70086]** the RTE Implementation Plug-In tooling can use the `McDataInstance.flatMapEntry` reference to the according `RIPS FlatInstanceDescriptor` to identify the *McDataInstances* relevant for a Data Communication Graph.

7.3.12.2 Measurement on Parameter Communication Graphs

Another impact occurs when the `parameter instance` as described in section 7.3.7.2 can not be provided by the RTE Generator since the parameter is provided by another Software Cluster. In this case the RTE Generator is not able to provide the `McDataInstance.symbol` for the described *McDataInstances* in the *McSupportData*.

[SWS_Rte_80153]{DRAFT} [The RTE Generator shall inhibit the export of `McDataInstance.symbol` attributes for *McDataInstances* belonging to *Parameter Communication Graphs* associated to an RTE Implementation Plug-In if the *Parameter Communication Graphs* contains NOT any `PPortPrototype`.

](*SRS_Rte_00153*, *SRS_Rte_00319*)

In this case it is the responsibility of the associated RTE Implementation Plug-In of the other Software Cluster to provide the `symbol` information.

7.3.13 Inter-Partition communication

In general the RTE Implementation Plug-Ins can be applied to *Communication Graphs* crossing partition borders. This would mean, that an RTE Implementation Plug-In implementation is executed on different cores or capable of supporting different ASIL levels.

Nevertheless currently no support for explicit life-cycle handling of those different partitions is standardized. Therefore as a prerequisite all partitions affecting one [RTE Implementation Plug-In](#) need to have the same life-cycle. For instance this excludes the usage of individual termination and restart of partitions.

[SWS_Rte_CONSTR_80010] [Partitions shall have the same life-cycle All partitions affecting the same [RTE Implementation Plug-In](#) shall have the same life-cycle.] ([SRS_Rte_00307](#), [SRS_Rte_00309](#))

[SWS_Rte_80077] [The Rte shall support the implementation of [Communication Graphs](#) with inter-partition-communication handled by an [RTE Implementation Plug-In](#).] ([SRS_Rte_00307](#), [SRS_Rte_00309](#))

Please note: [\[SWS_Rte_80077\]](#) includes inter-partition-communication between multiple cores as well as inter-partition-communication for the separation of different ASIL levels.

Thereby it is the responsibility of the [RTE Implementation Plug-In](#) to check, whether it can handle the according configuration.

[SWS_Rte_70093] [The [RTE Implementation Plug-In](#) shall reject configurations which cannot be implemented by the [RTE Implementation Plug-In](#).] ([SRS_Rte_00307](#), [SRS_Rte_00309](#))

7.3.14 Bypass Support

When using [RTE Implementation Plug-Ins](#) in combination with Bypass Support (see section [4.9](#)) the following principles and restrictions apply.

7.3.14.1 Component wrapper method

The *Component wrapper method* is not impacted by the usage of [RTE Implementation Plug-Ins](#)

7.3.14.2 Direct buffer access method

When using the *Direct buffer access method* the RTE Generator can not describe the buffers when the [RTE Implementation Plug-In](#) implements the implicit communication in a [Data Communication Graph](#).

[SWS_Rte_70094] [The [RTE Implementation Plug-In](#) shall generate the [McSupportData](#) for the [implicit communication buffers](#) when *Direct buffer access method* is selected as defined in section [4.9.3](#).] ([SRS_Rte_00244](#))

7.3.14.3 Extended buffer access method

In case the *Extended buffer access method* is selected (see section 4.9.4), the responsibility is shared between the RTE and the RTE Implementation Plug-In. For `rptPreparationLevels` greater than `rptLevel1` the RTE implementation and the implementation of the RTE Implementation Plug-In would suffer from a lot of cross dependencies due to the required RP enabler flags.

Therefore those configurations are currently not supported in a standardized manner.

[SWS_Rte_CONSTR_80011] [Limitation on RTE Implementation Plug-In support for `rptPreparationLevels` Data Communication Graphs with `rptPreparationLevels` greater than `rptLevel1` shall not be assigned to an RTE Implementation Plug-In.] (*SRS_Rte_00244*)

Except for implicit communication the bypass support is implemented by the RTE Generator as it is defined in section 4.9.4:

API Class	<code>rptLevel1</code>
Explicit S/R	RTE
Implicit S/R	RTE Implementation Plug-In
C/S	RTE
Mode	RTE
Trigger	No
Explicit IRV	RTE
Implicit IRV	RTE Implementation Plug-In

Table 7.4: Table of API classes and responsibility of implementation

[SWS_Rte_70095] [The RTE Implementation Plug-In shall implement the bypass support for implicit communication as specified in section 4.9.4.3.3, if the *Extended buffer access method* is configured and if `rptLevel1` is selected for the Data Communication Graph] (*SRS_Rte_00244*)

7.3.15 Activation of RTEEvents and BswEvents

Basically the usage of RTE Implementation Plug-Ins does not replace the RTE internal mechanism of RTEEvents and BswEvents triggering. But the chapter 4.2.3 still leaves some freedom when an RTE activates a sequence of ExecutableEntitys exactly in a OsTask. But for the interaction with RTE Implementation Plug-Ins some additional definitions are required in order to preserve certain sequences. In the case RTEEvents and BswEvents for ExecutableEntitys, which do have the same activation condition, are mapped to an OsTask, an unintended out of order execution shall be prevented. For instance such identical activation condition can be

- a set of ExternalTriggerOccurredEvents connected to the same trigger source or

- a set of `SwcModeSwitchEvent` with the same `activation`, `modes`, and connected to the same mode manager.

For illustration assume the following set-up:

- position 1, Run1, condition A
- position 2, Run2, condition A
- position 3, Run3, condition B
- position 4, Run4, condition B
- position 5, Run5, condition A

In the case the `OsTask` has also mapped `RTEEvents` and `BswEvents` with other activation conditions, it is possible that the `OsTask` is already running when the other activation condition occurs.

Assume now that the `OsTask` was started due to condition A and now condition B is fulfilled right after the execution sequence has passed already Run3. In this case Run4 might be executed before Run3. But for a stable interference calculation and the deterministic scheduling of `Rte_Rips_FillFlushRoutine` Services such a situation needs to be avoided.

[SWS_Rte_80076] [The RTE shall preserve the order of execution of `ExecutableEntities` mapped to the same `OsTask` after the common activation condition occurred for all kinds of `RTEEvents` and `BswEvents`.

Thereby the order of execution is given by the `RtePositionInTask` and `RteBswPositionInTask` parameter values.]([SRS_Rte_00301](#))

[SWS_Rte_82017]{DRAFT} [When a `Client Server Communication Graph` is associated to a `Cross Software Cluster Communication Plug-In`, the RTE shall support the mapping of `AsynchronousServerCallReturnsEvents` and `OperationInvokedEvents` to periodically activated `OsTasks`. In this case the `Cross Software Cluster Communication Plug-In` calls the according `RunnableEntity` via the `Rte_Rips_InvocationHandler` but its guaranteed for the `Cross Software Cluster Communication Plug-In` that the related invocation handler gets called cyclically.]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

[SWS_Rte_82018]{DRAFT} [When a `Data Communication Graph` is associated to a `Cross Software Cluster Communication Plug-In`, the RTE shall support the mapping of `DataReceivedEvents` to periodically activated `OsTasks`. In this case the RTE shall check the activation of the according `DataReceivedEvent` with the related `Rte_Rips_DataIsUpdated_EventActivation` service.]([SRS_Rte_00306](#), [SRS_Rte_00301](#))

8 RTE ECU Configuration

The RTE provides the glue layer between the AUTOSAR software-components and the Basic Software thus enabling several AUTOSAR software-components to be integrated on one ECU. The RTE layer is shown in figure 8.1.

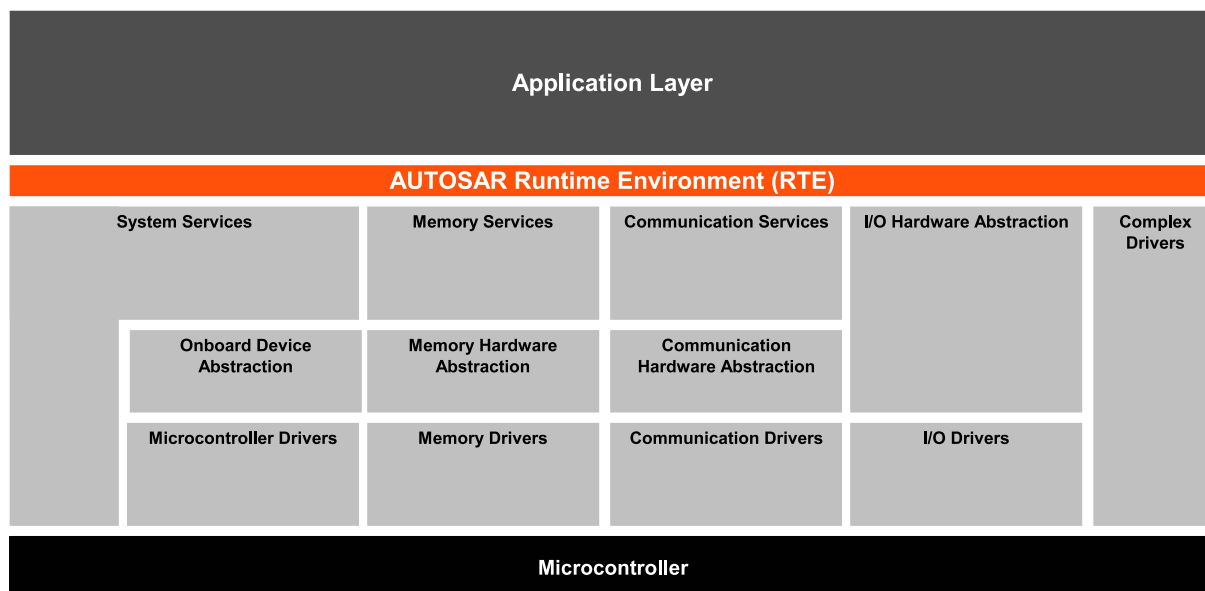


Figure 8.1: ECU Architecture RTE

The overall structure of the RTE configuration parameters is shown in figure 8.2. It has to be distinguished between the configuration parameters for the RTE generator and the configuration parameters for the generated RTE itself.

Most of the information needed to generate an RTE is already available in the ECU Extract of the System Description [8]. From this extract also the links to the AUTOSAR software-component descriptions and ECU Resource description are available. So only additional information not covered by the three aforementioned formats needs to be provided by the ECU Configuration description.

To additionally allow the most flexibility and freedom in the implementations of the RTE, only configuration parameters which are common to all implementations are standardized in the ECU Configuration Parameter definition. Any additional configuration parameters which might be needed to configure a full functional RTE have to be specified using the vendor specific parameter definition mechanism described in the ECU Configuration specification document [5].

8.1 RTE Module Configuration

Figure 8.2 shows the module configuration of the Rte and its sub-containers.

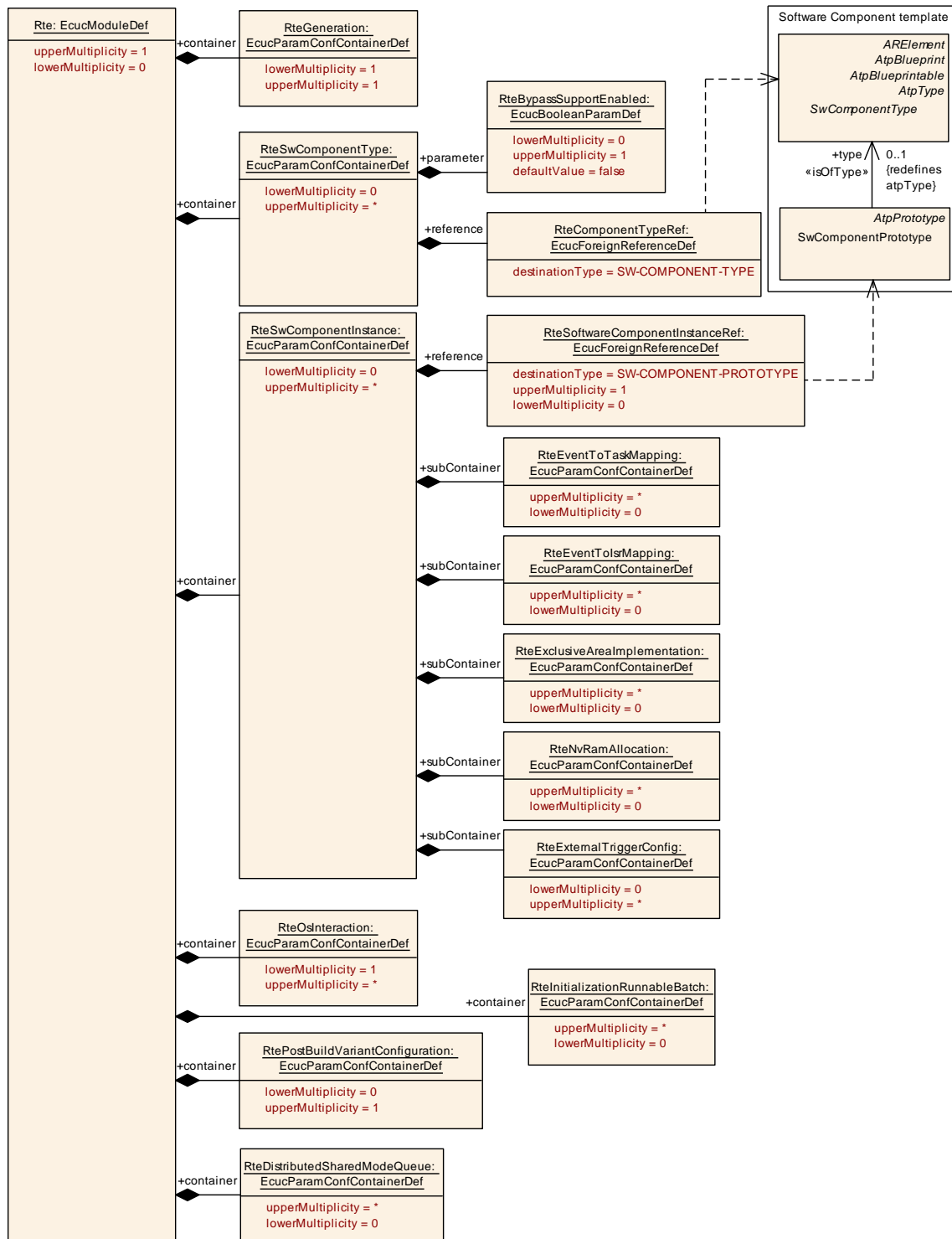


Figure 8.2: RTE configuration overview

Module SWS Item	ECUC_Rte_09000	
Module Name	Rte	
Module Description	Configuration of the Rte (Runtime Environment) module.	
Post-Build Variant Support	true	
Supported Config Variants	VARIANT-POST-BUILD, VARIANT-PRE-COMPILE	
Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteBswGeneral	1	General configuration parameters of the Bsw Scheduler section.
RteBswModuleInstance	0..*	Represents one instance of a Bsw-Module configured on one ECU.
RteDistributedSharedMode Queue	0..*	This container holds the configuration of a distributed shared mode queue.
RteExclusiveAccess Optimization	0..*	Configuration of the optimized access behavior to be generated. In other words, access shall be mutually exclusive. How this is realized e.g. non preemptive task mapping, exclusive areas, mode management, exclusive access during ECU startup and shutdown or scheduling in exclusive time slots is up to the ECU integrator.
RteGeneration	1	This container holds the parameters for the configuration of the RTE Generation.
RteImplicitCommunication	0..*	Configuration of the Implicit Communication behavior to be generated.
RteInitializationBehavior	1..*	Specifies the initialization strategy for variables allocated by RTE with the purpose to implement VariableDataPrototypes. The container defines a set of RteSectionInitializationPolicys and one RteInitializationStrategy which is applicable for this set.
RteInitializationRunnable Batch	0..*	This container corresponds to an Rte_Init_<shortName of this container> function invoking the mapped RunnableEntities.
RteOsInteraction	1..*	Interaction of the Rte with the Os.
RtePostBuildVariant Configuration	0..1	Specifies the PostbuildVariantSets for each of the PostBuild configurations of the RTE.
RteRips	0..1	This container provides the configuration of the Rte Implementation Plug-In support by RTE. If the container is NOT defined, the support for Rte Implementation Plug-Ins (RIPS) is globally disabled.
RteSwComponentInstance	0..*	Representation of one SwComponentPrototype located on the to be configured ECU. All subcontainer configuration aspects are in relation to this SwComponentPrototype. The RteSwComponentInstance can be associated with either a AtomicSwComponentType or ParameterSwComponentType.
RteSwComponentType	0..*	Representation of one SwComponentType for the base of all configuration parameter which are affecting the whole type and not a specific instance.

8.1.1 RTE Configuration Version Information

In order to identify the RTE Configuration version a dedicated RTE code has been generated from the RTE Configuration information may contain one or more `DOC-REVISION` elements in the `ECUC-MODULE-CONFIGURATION-VALUES` element of the RTE Configuration (see example 8.1).

[SWS_Rte_05184] [The `REVISION-LABEL` shall be parsed according to the rules defined in the Generic Structure Template [10] for `RevisionLabelString` allowing to parse the three version informations for AUTOSAR:

- major version: first part of the `REVISION-LABEL`
- minor version: second part of the `REVISION-LABEL`
- patch version: third part of the `REVISION-LABEL`
- optional fourth part shall be used for documentation purposes in the Basic Software Module Description (see section 3.4.4)

If the parsing fails all three version numbers shall be set to zero.] ([SRS_Rte_00233](#))

[SWS_Rte_05185] [If there are several `DOC-REVISION` elements in the input `ECUC-MODULE-CONFIGURATION-VALUES` the newest according to the `DATE` shall be taken into account.

If the search for the newest `DOC-REVISION` fails three version numbers shall be set to zero.] ([SRS_Rte_00233](#))

Example 8.1

```
<AUTOSAR xmlns="http://autosar.org/4.0.0" xmlns:xsi="http://www.w3.org
/2001/XMLSchema-instance" xsi:schemaLocation="http://autosar.org
/4.0.0_AUTOSAR.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Rte_Example</SHORT-NAME>
      <ELEMENTS>
        <ECUC-MODULE-CONFIGURATION-VALUES>
          <SHORT-NAME>Rte_Configuration</SHORT-NAME>
          <ADMIN-DATA>
            <DOC-REVISIONS>
              <DOC-REVISION>
                <REVISION-LABEL>2.1.34</REVISION-LABEL>
                <DATE>2009-05-09T00:00:00.0Z</DATE>
              </DOC-REVISION>
              <DOC-REVISION>
                <REVISION-LABEL>2.1.35</REVISION-LABEL>
                <DATE>2009-06-21T09:30:00.0Z</DATE>
              </DOC-REVISION>
            </DOC-REVISIONS>
          </ADMIN-DATA>
          <DEFINITION-REF DEST="ECUC-MODULE-DEF">/AUTOSAR/Rte</
            DEFINITION-REF>
        </CONTAINERS>
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```



```
<!-- ... -->
</CONTAINERS>
</ECUC-MODULE-CONFIGURATION-VALUES>
</ELEMENTS>
</AR-PACKAGE>
</AR-PACKAGES>
</AUTOSAR>
```

8.2 RTE Generation Parameters

The parameters in the container `RteGeneration` are used to configure the RTE generator. They all need to be defined during pre-compile time.

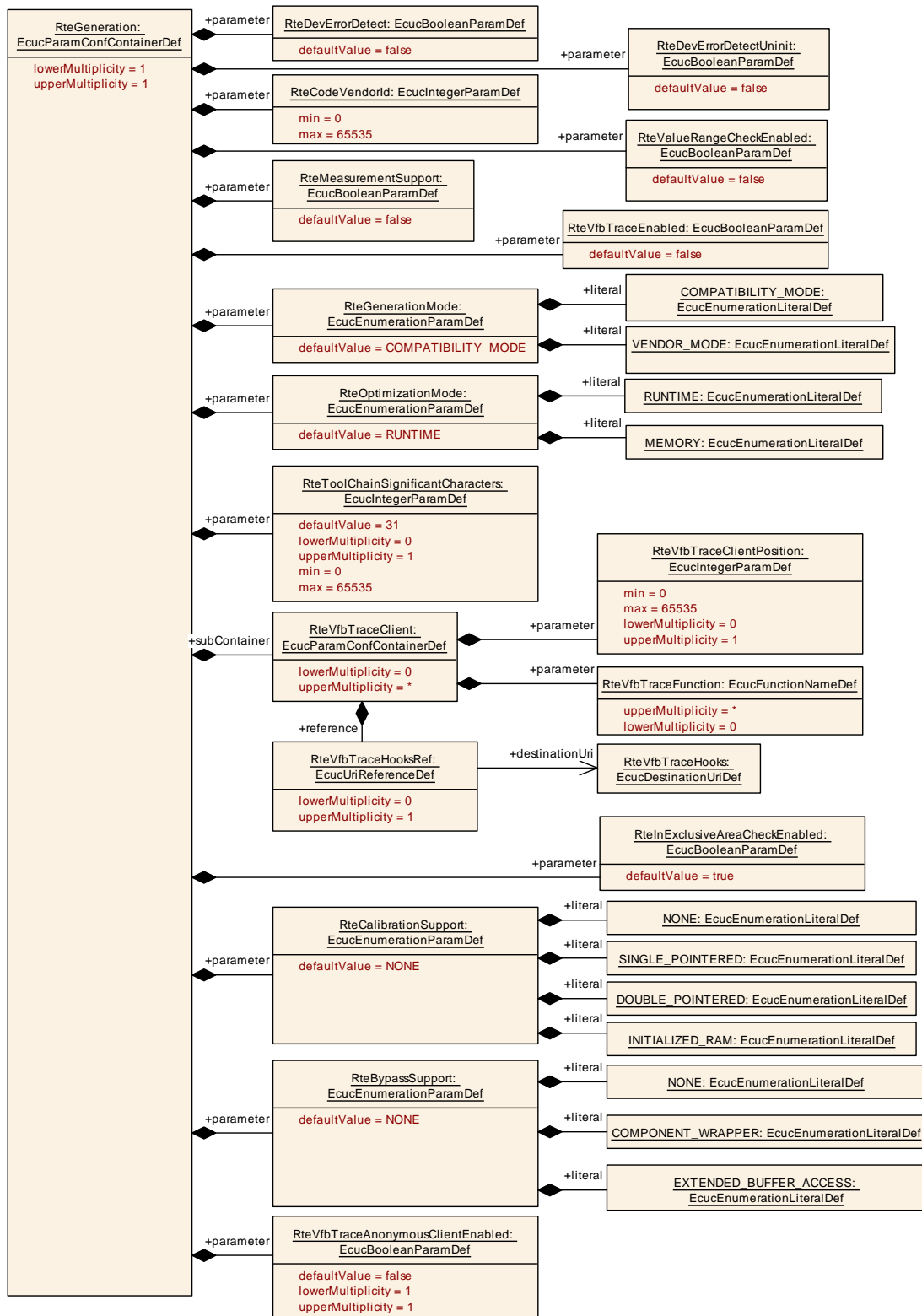


Figure 8.3: RTE generation parameters

SWS Item	[ECUC_Rte_09009]
Container Name	RteGeneration
Parent Container	Rte

Description	This container holds the parameters for the configuration of the RTE Generation.
Configuration Parameters	

Name	RteBypassSupport [ECUC_Rte_09113]		
Parent Container	RteGeneration		
Description	General switch to enable and select the bypass support method.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	COMPONENT_WRAPPER		
	EXTENDED_BUFFER_ACCESS		
	NONE		
Default Value	NONE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteCalibrationSupport [ECUC_Rte_09007]		
Parent Container	RteGeneration		
Description	The RTE generator shall have the option to switch off support for calibration for generated RTE code. This option shall influence complete RTE code at once.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	DOUBLE_POINTERED		
	INITIALIZED_RAM		
	NONE		
	SINGLE_POINTERED		
Default Value	NONE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteCodeVendorId [ECUC_Rte_09086]		
Parent Container	RteGeneration		
Description	Holds the vendor ID of the generated Rte code.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteDevErrorDetect [ECUC_Rte_09008]		
Parent Container	RteGeneration		
Description	Switches the development error detection and notification on or off. <ul style="list-style-type: none"> • true: detection and notification is enabled. • false: detection and notification is disabled. 		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteDevErrorDetectUninit [ECUC_Rte_09085]		
Parent Container	RteGeneration		
Description	The Rte shall detect if it is started when its APIs are called, and the BSW Scheduler shall check if it is initialized when its APIs are called.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteGenerationMode [ECUC_Rte_09010]		
Parent Container	RteGeneration		
Description	Switch between the two available generation modes of the RTE generator.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	COMPATIBILITY_MODE		
	VENDOR_MODE		
Default Value	COMPATIBILITY_MODE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteInExclusiveAreaCheckEnabled [ECUC_Rte_09126]		
Parent Container	RteGeneration		
Description	Enables the check for RTE_E_IN_EXCLUSIVE_AREA (for blocking APIs).		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	true		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteMeasurementSupport [ECUC_Rte_09011]		
Parent Container	RteGeneration		
Description	The RTE generator shall have the option to switch off support for measurement for generated RTE code. This option shall influence complete RTE code at once.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteOptimizationMode [ECUC_Rte_09012]		
Parent Container	RteGeneration		
Description	Switch between the two available optimization modes of the RTE generator.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	MEMORY		
	RUNTIME		
Default Value	RUNTIME		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	RteToolChainSignificantCharacters [ECUC_Rte_09013]		
Parent Container	RteGeneration		
Description	If present, the RTE generator shall provide the list of C RTE identifiers whose name is not unique when only the first RteToolChainSignificantCharacters characters are considered.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default Value	31		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	RteValueRangeCheckEnabled [ECUC_Rte_09014]		
Parent Container	RteGeneration		
Description	If set to true the RTE generator shall enable the value range checking for the specified VariableDataPrototypes.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteVfbTraceAnonymousClientEnabled [ECUC_Rte_09163]		
Parent Container	RteGeneration		
Description	The RTE generator shall globally enable VFB trace functions without client prefix when RteVfbTraceAnonymousClientEnabled is set to "true".		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteVfbTraceEnabled [ECUC_Rte_09015]		
Parent Container	RteGeneration		
Description	The RTE generator shall globally enable VFB tracing when RteVfbTrace is set to "true".		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteVfbTraceClient	0..*	The RTE shall add the VFB Trace client with the ShortName of this container as the client's prefix.

[SWS_Rte_CONSTR_03870] [In case that [RteDevErrorDetectUninit](#) is configured to true, [RteDevErrorDetect](#) shall be configured to true.]()

SWS Item	[ECUC_Rte_09164]
Container Name	RteVfbTraceClient
Parent Container	RteGeneration

Description	The RTE shall add the VFB Trace client with the ShortName of this container as the client's prefix.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteVfbTraceClientPosition [ECUC_Rte_09174]		
Parent Container	RteVfbTraceClient		
Description	Defines the position within all trace clients at which to call the trace functions of this trace client. The bigger the number the later the start trace functions and the sooner the stop trace functions will be called.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteVfbTraceFunction [ECUC_Rte_09017]		
Parent Container	RteVfbTraceClient		
Description	The RTE generator shall enable VFB tracing for a given hook function when its name starts with the string configured here. Example: If Rte_Dbg_WriteHook_i2 is configured, Rte_Dbg_WriteHook_i1_p1_a_Start will be enabled.		
Multiplicity	0..*		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteVfbTraceHooksRef [ECUC_Rte_09175]		
Parent Container	RteVfbTraceClient		
Description	Reference to the container in the VFB Trace client's configuration to which the RTE shall add the descriptions of the trace hooks created for this client.		
Multiplicity	0..1		
Type	Reference to destinationUri [RteVfbTraceUriDefSet/RteVfbTraceHooks]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

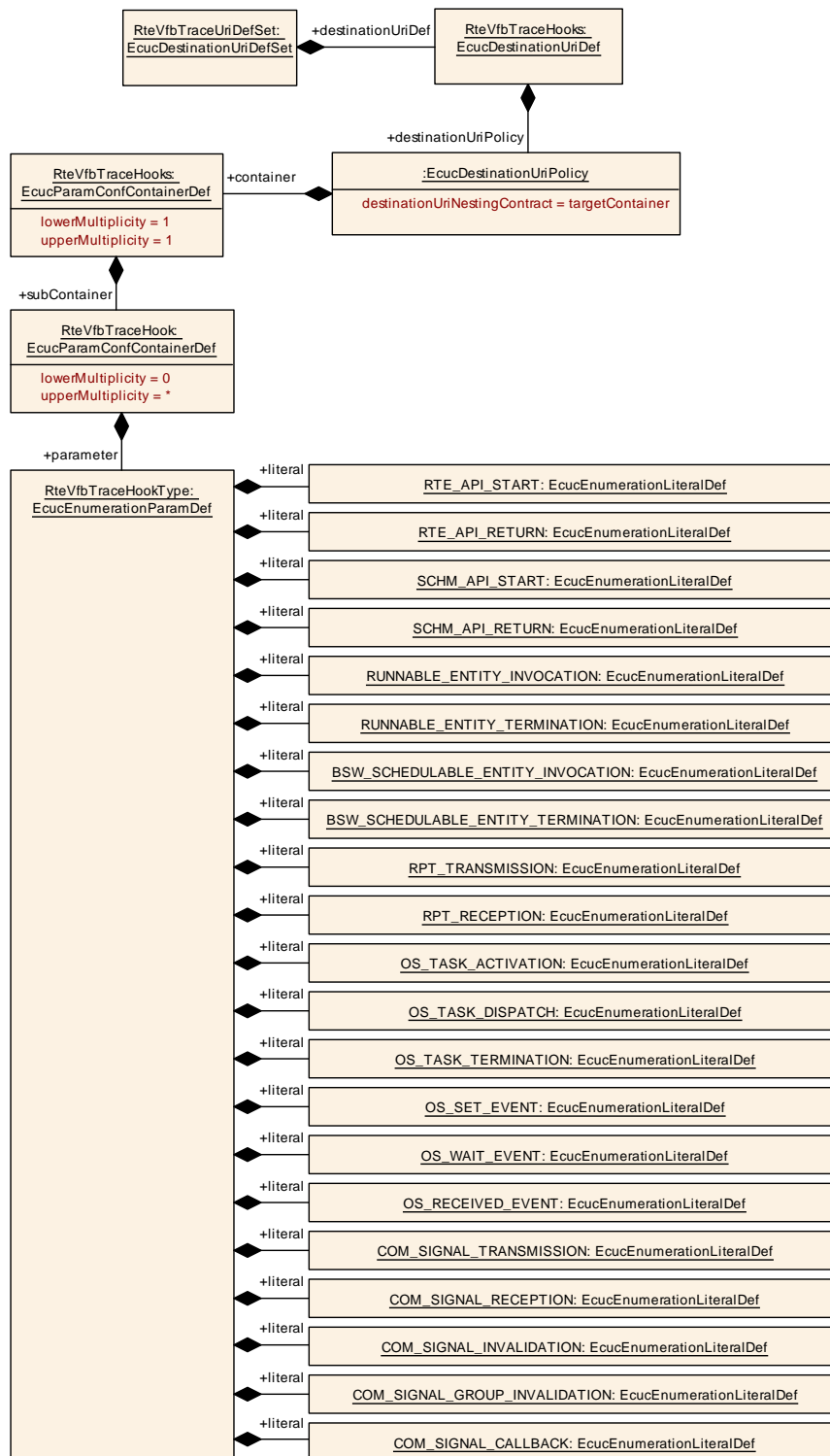


Figure 8.4: RTE VFB Trace Hook

SWS Item	ECUC_Rte_09176
EcucDestinationUriDefSet Name	RteVfbTraceUriDefSet
Description	RteVfbTraceUriDefSet
Included EcucDestinationUriDefs	
Name	Description
RteVfbTraceHooks	RteVfbTraceHooks

SWS Item	[ECUC_Rte_09177]
EcucDestinationUriDef Name	RteVfbTraceHooks
Destination Uri Definition Set	RteVfbTraceUriDefSet
Description	RteVfbTraceHooks
destinationUriNesting Contract	targetContainer
Configuration Parameters	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteVfbTraceHooks	1	This container defines the parent container to which all trace hook containers are added.

SWS Item	[ECUC_Rte_09179]
Container Name	RteVfbTraceHooks
Destination Uri Definition	RteVfbTraceHooks
Description	This container defines the parent container to which all trace hook containers are added.
Configuration Parameters	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteVfbTraceHook	0..*	This container represents a specific VFB Trace hook. Its ShortName equals the hook function's C symbol.

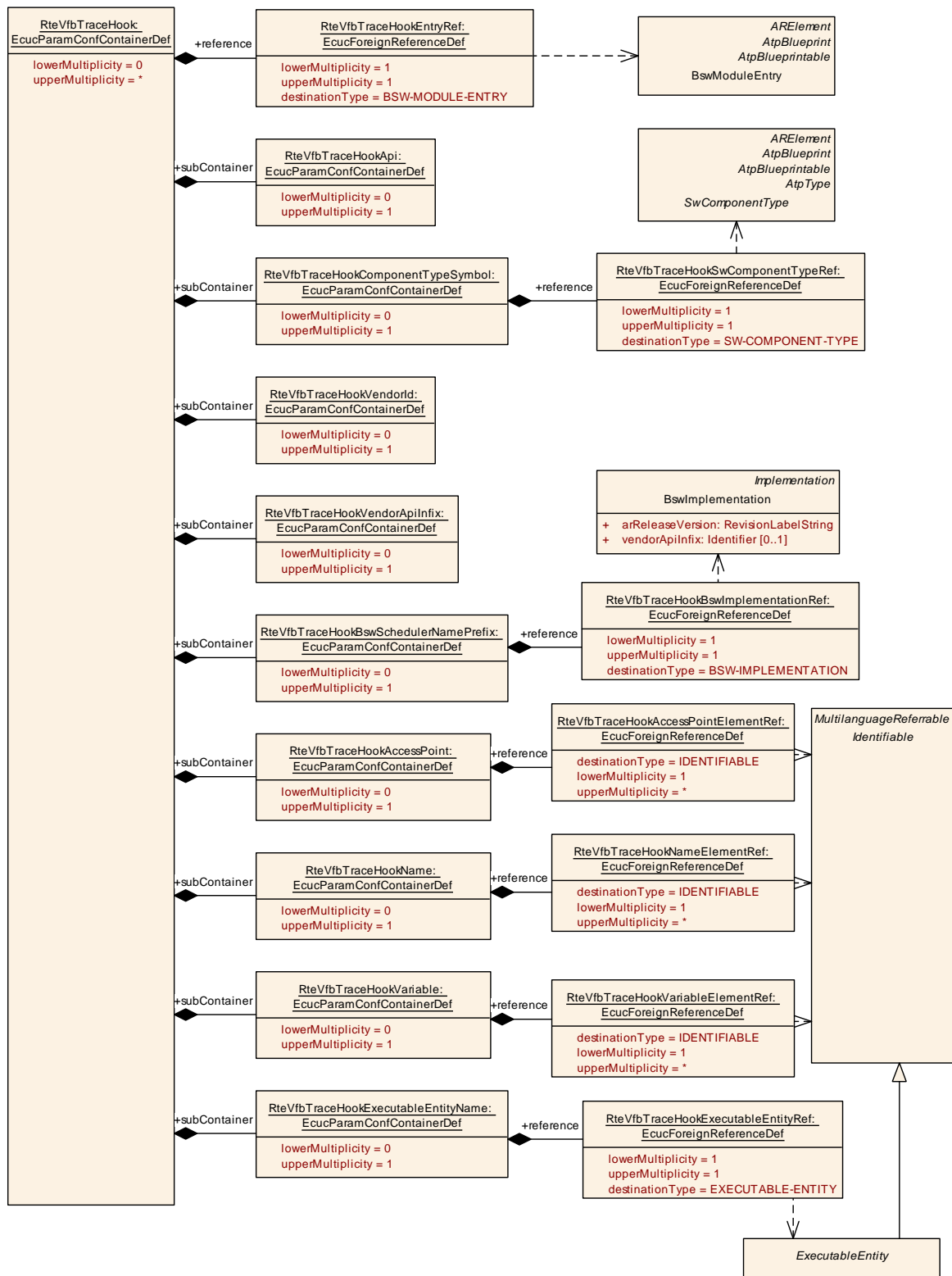


Figure 8.5: RTE VFB Trace Hook Part 1

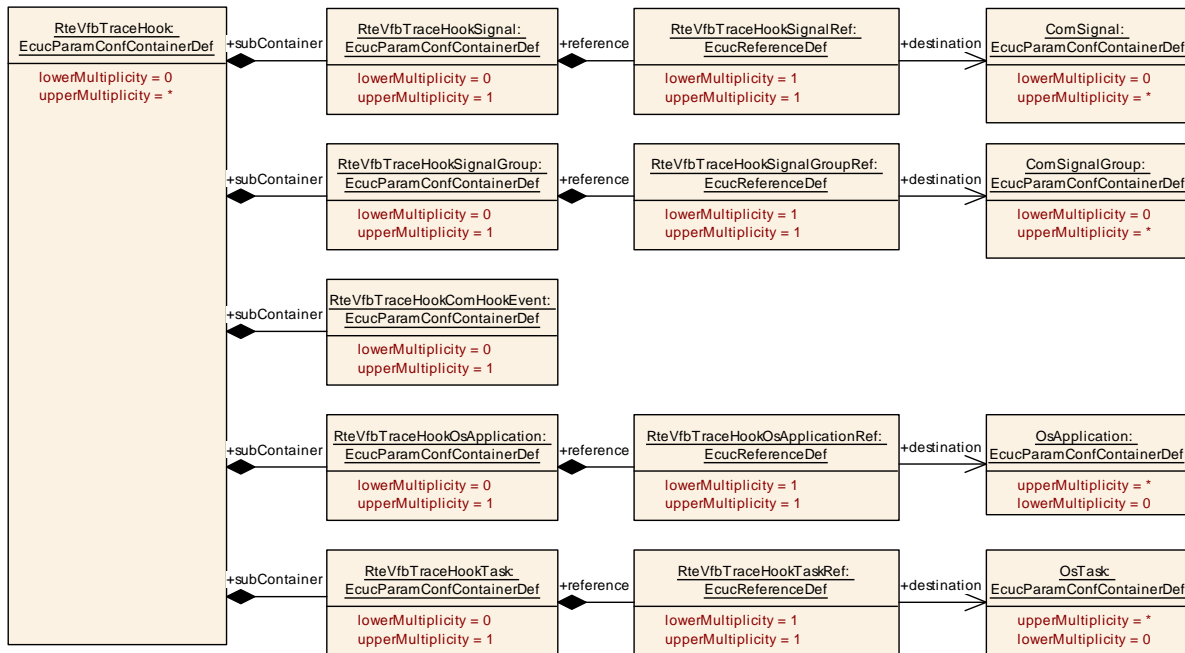


Figure 8.6: RTE VFB Trace Hook Part 2

SWS Item	[ECUC_Rte_09180]		
Container Name	RteVfbTraceHook		
Parent Container	RteVfbTraceHooks		
Description	This container represents a specific VFB Trace hook. Its ShortName equals the hook function's C symbol.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Configuration Parameters			

Name	RteVfbTraceHookType [ECUC_Rte_09181]	
Parent Container	RteVfbTraceHook	
Description	This specifies the type of the hook.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	BSW_SCHEDULABLE_ENTITY_INVOCATION	The hook called just before execution of a BSW Schedulable entry starts via its entry point
	BSW_SCHEDULABLE_ENTITY_TERMINATION	The hook called immediately after execution returns to BSW Scheduler code from a BSW Schedulable Entity
	COM_SIGNAL_CALLBACK	The hook called on entry to the COM call-back
	COM_SIGNAL_GROUP_INVALIDATION	The hook called just before Com_InvalidateSignalGroup is invoked

Post-Build Variant Value	COM_SIGNAL_INVALIDATION	The hook called just before Com_InvalidateSignal is invoked
	COM_SIGNAL_RECEPTION	The hook called after return from Com_ReceiveSignal, Com_ReceiveDynSignal or Com_ReceiveSignalGroupArray
	COM_SIGNAL_TRANSMISSION	The hook called just before Com_SendSignal, Com_SendDynSignal or Com_SendSignalGroupArray is invoked
	OS_RECEIVED_EVENT	The hook called immediately after generated RTE code returns from waiting on an event
	OS_SET_EVENT	The hook called immediately before generated RTE code attempts to set an OS Event
	OS_TASK_ACTIVATION	The hook called immediately prior to the activation of a task containing runnable entities
	OS_TASK_DISPATCH	The hook called immediately an RTE generated task (containing runnable entities) has commenced execution
	OS_TASK_TERMINATION	The hook called immediately prior to an RTE generated task (containing runnable entities) terminating execution
	OS_WAIT_EVENT	The hook called immediately before generated RTE code attempts to wait on an OS Event
	RPT_RECEPTION	The hook called before copying the received RP global buffer to the RTE API's OUT buffer or return value
	RPT_TRANSMISSION	The hook called before the transmission of an RP global buffer
	RTE_API_RETURN	The hook called before an API call returns control to a SwComponent
	RTE_API_START	The hook called when an API call is made by a SwComponent
	RUNNABLE_ENTITY_INVOCATION	The hook called just before execution of a runnable entry starts via its entry point
	RUNNABLE_ENTITY_TERMINATION	The hook called immediately after execution returns to RTE code from a runnable entity
	SCHM_API_RETURN	The hook called just before an API call returns control to a Basic Software Module
	SCHM_API_START	The hook called when an API call is made by a Basic Software Module
	false	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteVfbTraceHookEntryRef [ECUC_Rte_09182]		
Parent Container	RteVfbTraceHook		
Description	Reference to the BswModuleEntry of this VFB Trace hook in the BSWMD of the generated RTE		
Multiplicity	1		
Type	Foreign reference to BSW-MODULE-ENTRY		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteVfbTraceHookAccessPoint	0..1	In case of an RTE API Trace hook the ShortName of this container is the Access Point name part of the VFB Trace hook (<ap> in SWS_Rte).
RteVfbTraceHookApi	0..1	In case of a BSW Scheduler API Trace hook or RTE API Trace hook the ShortName of this container is the API name part of the VFB Trace hook (<api> in SWS_Rte).
RteVfbTraceHookBswSchedulerNamePrefix	0..1	In case of a BSW Scheduler API Trace hook or BSW Schedulable Entities Trace hook the ShortName of this container is the BSW Scheduler Name Prefix name part of the VFB Trace hook (<bsnp> in SWS_Rte).
RteVfbTraceHookComHookEvent	0..1	In case of a COM Trace hook the ShortName of this container is the COM hook event part of the VFB Trace hook (<Event> in SWS_Rte).
RteVfbTraceHookComponentTypeSymbol	0..1	In case of an RTE API Trace hook, Runnable Entity Trace hook or RPT Trace hook the ShortName of this container is the component type symbol name part of the VFB Trace hook (<cts> in SWS_Rte).
RteVfbTraceHookExecutableEntityName	0..1	In case of a Runnable Entity Trace hook or BSW Schedulable Entities Trace hook the ShortName of this container is the Executable Entity name part of the VFB Trace hook (<reName> or <entityName> in SWS_Rte).
RteVfbTraceHookName	0..1	In case of a BSW Scheduler API Trace hook the ShortName of this container is the "Name provided by the API" name part of the VFB Trace hook (<name> in SWS_Rte).
RteVfbTraceHookOsApplication	0..1	In case of an OS Trace hook the ShortName of this container is the application name part of the VFB Trace hook (<application> in SWS_Rte).

RteVfbTraceHookSignal	0..1	In case of a COM Trace hook the ShortName of this container is the COM signal name part of the VFB Trace hook (<signalName> in SWS_Rte).
RteVfbTraceHookSignal Group	0..1	In case of a COM Trace hook the ShortName of this container is the COM signal group name part of the VFB Trace hook (<signalGroupName> in SWS_Rte).
RteVfbTraceHookTask	0..1	In case of an OS Trace hook the ShortName of this container is the task name part of the VFB Trace hook (<task> in SWS_Rte).
RteVfbTraceHook Variable	0..1	In case of an RPT Trace hook the ShortName of this container is the "identifying name of the RP global buffer" name part of the VFB Trace hook (in SWS_Rte).
RteVfbTraceHookVendor ApiInfix	0..1	In case of a BSW Scheduler API Trace hook or BSW Schedulable Entities Trace hook the ShortName of this container is the optional VendorApiInfix name part of the VFB Trace hook (<ai> in SWS_Rte).
RteVfbTraceHookVendor Id	0..1	In case of a BSW Scheduler API Trace hook or BSW Schedulable Entities Trace hook the ShortName of this container is the optional VendorId name part of the VFB Trace hook (<vi> in SWS_Rte).

SWS Item	[ECUC_Rte_09190]		
Container Name	RteVfbTraceHookAccessPoint		
Parent Container	RteVfbTraceHook		
Description	In case of an RTE API Trace hook the ShortName of this container is the Access Point name part of the VFB Trace hook (<ap> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteVfbTraceHookAccessPointElementRef [ECUC_Rte_09191]		
Parent Container	RteVfbTraceHookAccessPoint		
Description	Reference to the elements from which the Access Point was derived. Number and type of the referenced objects depend on the API.		
Multiplicity	1..*		
Type	Foreign reference to IDENTIFIABLE		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

SWS Item	[ECUC_Rte_09183]		
Container Name	RteVfbTraceHookApi		
Parent Container	RteVfbTraceHook		
Description	In case of a BSW Scheduler API Trace hook or RTE API Trace hook the ShortName of this container is the API name part of the VFB Trace hook (<api> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Configuration Parameters

No Included Containers

SWS Item	[ECUC_Rte_09186]		
Container Name	RteVfbTraceHookBswSchedulerNamePrefix		
Parent Container	RteVfbTraceHook		
Description	In case of a BSW Scheduler API Trace hook or BSW Schedulable Entities Trace hook the ShortName of this container is the BSW Scheduler Name Prefix name part of the VFB Trace hook (<bsnp> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Configuration Parameters

Name	RteVfbTraceHookBswImplementationRef [ECUC_Rte_09187]		
Parent Container	RteVfbTraceHookBswSchedulerNamePrefix		
Description	Reference to the BswImplementation from which the BSW Scheduler Name Prefix was derived		
Multiplicity	1		
Type	Foreign reference to BSW-IMPLEMENTATION		
Post-Build Variant Value	false		

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

SWS Item	[ECUC_Rte_09202]		
Container Name	RteVfbTraceHookComHookEvent		
Parent Container	RteVfbTraceHook		
Description	In case of a COM Trace hook the ShortName of this container is the COM hook event part of the VFB Trace hook (<Event> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Configuration Parameters

No Included Containers

SWS Item	[ECUC_Rte_09184]		
Container Name	RteVfbTraceHookComponentTypeSymbol		
Parent Container	RteVfbTraceHook		
Description	In case of an RTE API Trace hook, Runnable Entity Trace hook or RPT Trace hook the ShortName of this container is the component type symbol name part of the VFB Trace hook (<cts> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Configuration Parameters

Name	RteVfbTraceHookSwComponentTypeRef [ECUC_Rte_09185]		
Parent Container	RteVfbTraceHookComponentTypeSymbol		
Description	Reference to the SwComponentType from which the component type symbol was derived		
Multiplicity	1		
Type	Foreign reference to SW-COMPONENT-TYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Scope / Dependency	scope: local
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No Included Containers

SWS Item	[ECUC_Rte_09196]		
Container Name	RteVfbTraceHookExecutableEntityName		
Parent Container	RteVfbTraceHook		
Description	In case of a Runnable Entity Trace hook or BSW Schedulable Entities Trace hook the ShortName of this container is the Executable Entity name part of the VFB Trace hook (<reName> or <entityName> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteVfbTraceHookExecutableEntityRef [ECUC_Rte_09197]		
Parent Container	RteVfbTraceHookExecutableEntityName		
Description	Reference to the Executable Entity from which the Runnable Entity or BSW Schedulable Entity name was derived		
Multiplicity	1		
Type	Foreign reference to EXECUTABLE-ENTITY		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

SWS Item	[ECUC_Rte_09192]		
Container Name	RteVfbTraceHookName		
Parent Container	RteVfbTraceHook		
Description	In case of a BSW Scheduler API Trace hook the ShortName of this container is the "Name provided by the API" name part of the VFB Trace hook (<name> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteVfbTraceHookNameElementRef [ECUC_Rte_09193]		
Parent Container	RteVfbTraceHookName		
Description	Reference to the elements from which the "Name provided by the API" was derived. Number and type of the referenced objects depend on the API.		
Multiplicity	1..*		
Type	Foreign reference to IDENTIFIABLE		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

SWS Item	[ECUC_Rte_09203]		
Container Name	RteVfbTraceHookOsApplication		
Parent Container	RteVfbTraceHook		
Description	In case of an OS Trace hook the ShortName of this container is the application name part of the VFB Trace hook (<application> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteVfbTraceHookOsApplicationRef [ECUC_Rte_09204]		
Parent Container	RteVfbTraceHookOsApplication		
Description	Reference to the OsApplication from which the application name was derived		
Multiplicity	1		
Type	Reference to OsApplication		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

SWS Item	[ECUC_Rte_09198]		
Container Name	RteVfbTraceHookSignal		
Parent Container	RteVfbTraceHook		
Description	In case of a COM Trace hook the ShortName of this container is the COM signal name part of the VFB Trace hook (<signalName> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteVfbTraceHookSignalRef [ECUC_Rte_09199]		
Parent Container	RteVfbTraceHookSignal		
Description	Reference to the ComSignal from which the signal name was derived		
Multiplicity	1		
Type	Reference to ComSignal		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

SWS Item	[ECUC_Rte_09200]		
Container Name	RteVfbTraceHookSignalGroup		
Parent Container	RteVfbTraceHook		
Description	In case of a COM Trace hook the ShortName of this container is the COM signal group name part of the VFB Trace hook (<signalGroupName> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteVfbTraceHookSignalGroupRef [ECUC_Rte_09201]		
Parent Container	RteVfbTraceHookSignalGroup		
Description	Reference to the ComSignalGroup from which the signal group name was derived		
Multiplicity	1		
Type	Reference to ComSignalGroup		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

SWS Item	[ECUC_Rte_09205]		
Container Name	RteVfbTraceHookTask		
Parent Container	RteVfbTraceHook		
Description	In case of an OS Trace hook the ShortName of this container is the task name part of the VFB Trace hook (<task> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Configuration Parameters

Name	RteVfbTraceHookTaskRef [ECUC_Rte_09206]		
Parent Container	RteVfbTraceHookTask		
Description	Reference to the OsTask from which the task name was derived		
Multiplicity	1		
Type	Reference to OsTask		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

SWS Item	[ECUC_Rte_09194]		
Container Name	RteVfbTraceHookVariable		
Parent Container	RteVfbTraceHook		

Description	In case of an RPT Trace hook the ShortName of this container is the "identifying name of the RP global buffer" name part of the VFB Trace hook (in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteVfbTraceHookVariableElementRef [ECUC_Rte_09195]		
Parent Container	RteVfbTraceHookVariable		
Description	Reference to the elements from which the "identifying name of the RP global buffer" was derived. Number and type of the referenced objects depend on the API.		
Multiplicity	1..*		
Type	Foreign reference to IDENTIFIABLE		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

SWS Item	[ECUC_Rte_09189]		
Container Name	RteVfbTraceHookVendorApiInfix		
Parent Container	RteVfbTraceHook		
Description	In case of a BSW Scheduler API Trace hook or BSW Schedulable Entities Trace hook the ShortName of this container is the optional VendorApiInfix name part of the VFB Trace hook (<ai> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

No Included Containers

SWS Item	[ECUC_Rte_09188]		
Container Name	RteVfbTraceHookVendorId		
Parent Container	RteVfbTraceHook		
Description	In case of a BSW Scheduler API Trace hook or BSW Schedulable Entities Trace hook the ShortName of this container is the optional VendorId name part of the VFB Trace hook (<vi> in SWS_Rte).		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			
No Included Containers			

8.3 RTE PreBuild configuration

In order to support PreBuild configuration variation of the Rte input (see also section 4.7) the container [EcucVariationResolver](#) is providing a set of references to [Pre-definedVariant](#). These define values for [SwSystemconst](#).

Note that the information for the [EcucVariationResolver](#) is provided in the [EcuC](#) part of the ECU Configuration, since it does not only influence the Rte but also many other BSW Modules.

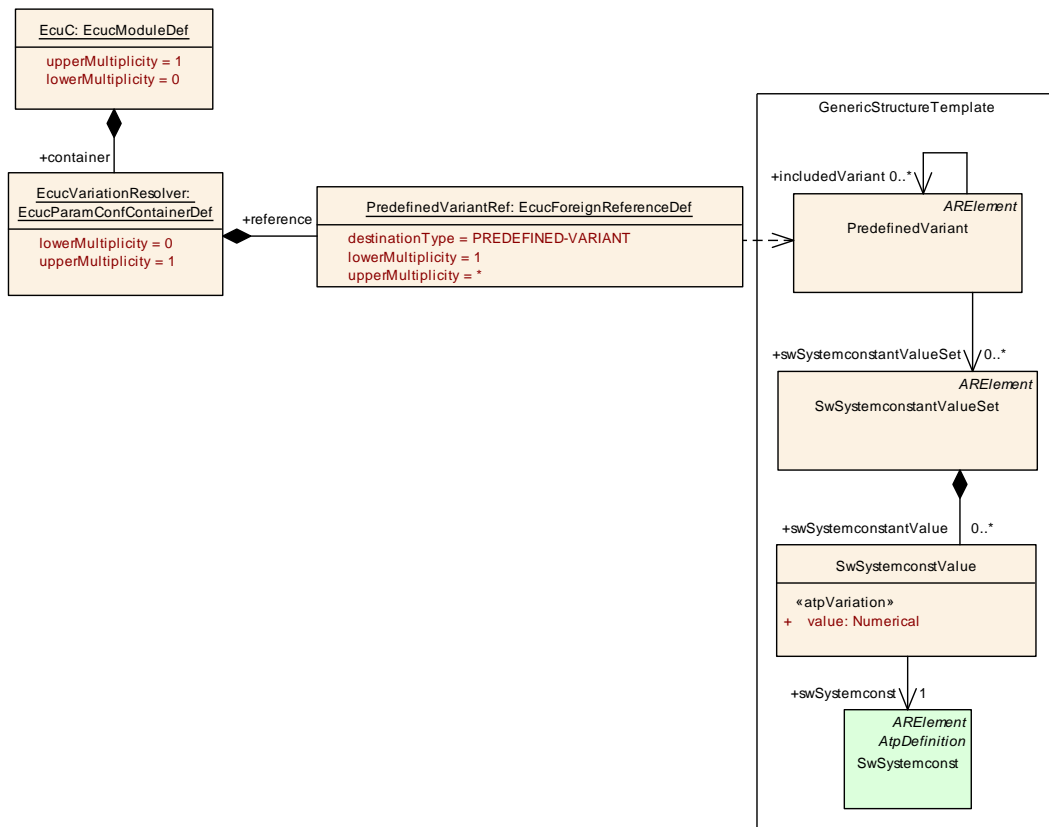


Figure 8.7: RTE PreBuild configuration

SWS Item	[ECUC_EcuC_00009]
Container Name	EcucVariationResolver
Parent Container	EcuC
Description	Collection of PredefinedVariant elements containing definition of values for SwSystemconst which shall be applied when resolving the variability during ECU Configuration.
Configuration Parameters	

Name	PredefinedVariantRef [ECUC_EcuC_00010]		
Parent Container	EcucVariationResolver		
Description			
Multiplicity	1..*		
Type	Foreign reference to PREDEFINED-VARIANT		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

8.4 RTE PostBuild configuration

In order to support PostBuild configuration variation of the generated Rte (see also section 4.7) the container `RtePostBuildVariantConfiguration` is used. Each instance of `RtePostBuildUsedPredefinedVariant` inside this container specifies *one* PostBuild variant of the generated Rte. The `shortName` of the `RtePostBuildUsedPredefinedVariant` specifies the variant name.

The actual values for the `PostBuildVariantCriterion` are defined in a two step approach:

1. The reference `RtePostBuildUsedPredefinedVariant` collects the `PredefinedVariant` elements.
2. Each `PredefinedVariant` element collects a set of `PostBuildVariantCriterionValueSet`.
3. Each `PostBuildVariantCriterionValueSet` defines the `PostBuildVariantCriterionValues` for a set of `PostBuildVariantCriterion`.

The basic idea is that

- the `PostBuildVariantCriterionValueSet` can be provided by sub-system engineer,
- the `PredefinedVariant` can be designed by the Ecu integrator.

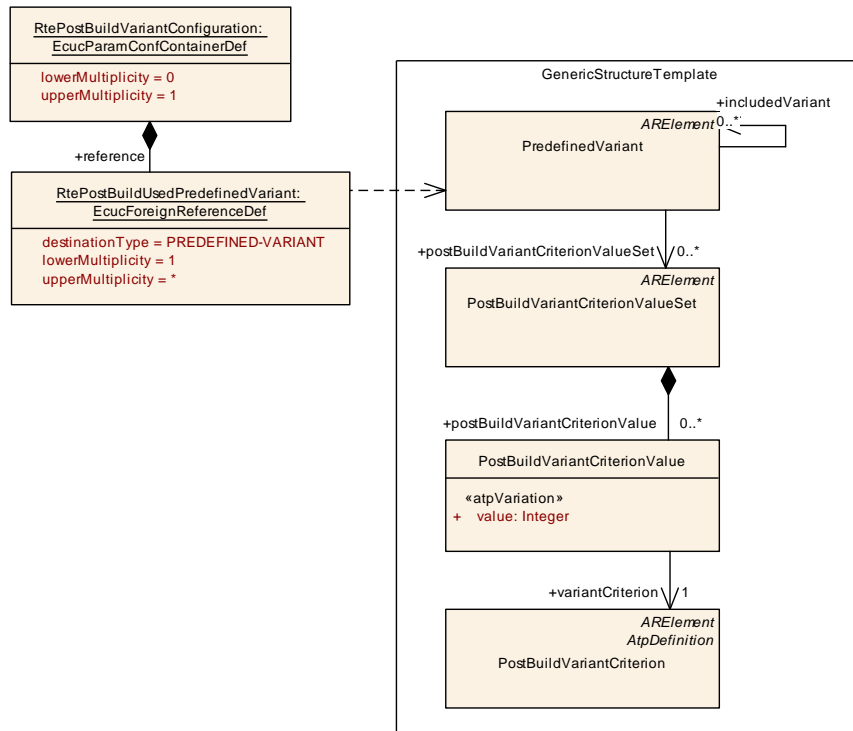


Figure 8.8: RTE PostBuild configuration

SWS Item	[ECUC_Rte_09084]
Container Name	RtePostBuildVariantConfiguration
Parent Container	Rte
Description	Specifies the PostbuildVariantSets for each of the PostBuild configurations of the RTE.
Configuration Parameters	

Name	RtePostBuildUsedPredefinedVariant [ECUC_Rte_09083]		
Parent Container	RtePostBuildVariantConfiguration		
Description	Reference to the PredefinedVariant element which defines the values for PostBuildVariationCriterion elements. The shortName of the referenced PredefinedVariant defines the name of the RtePostBuildVariant.		
Multiplicity	1..*		
Type	Foreign reference to PREDEFINED-VARIANT		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	—	
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	—	
	Post-build time	X	VARIANT-POST-BUILD

Scope / Dependency	scope: local
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No Included Containers

8.5 Handling of Software Component Instances

When entities of Software-Components are to be configured there is the need to actually address the instances of the `AtomicSwComponentType`. Since the Ecu Extract of System Description contains a flat view on the Ecu's Software-Components [8] the `SwComponentPrototypes` in the Ecu Extract already represent the instances of the Software Components.

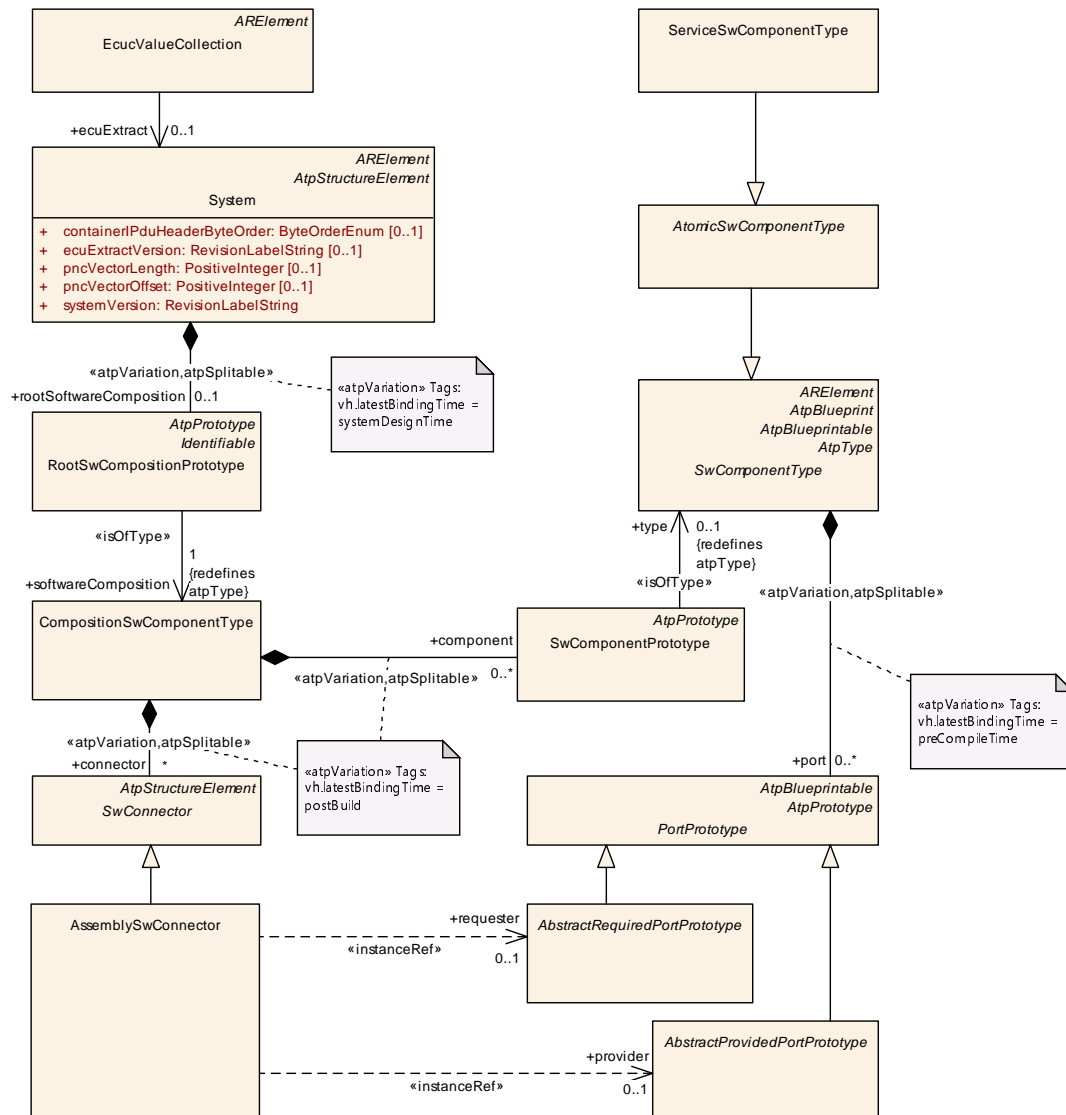


Figure 8.9: Services in the ECU Configuration

SWS Item	[ECUC_Rte_09005]
Container Name	RteSwComponentInstance
Parent Container	Rte

Description	<p>Representation of one SwComponentPrototype located on the to be configured ECU. All subcontainer configuration aspects are in relation to this SwComponentPrototype.</p> <p>The RteSwComponentInstance can be associated with either a AtomicSwComponentType or ParameterSwComponentType.</p>
Configuration Parameters	

Name	RteSoftwareComponentInstanceRef [ECUC_Rte_09004]		
Parent Container	RteSwComponentInstance		
Description	Reference to a SwComponentPrototype.		
Multiplicity	0..1		
Type	Foreign reference to SW-COMPONENT-PROTOTYPE		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteEventToIsrMapping	0..*	Maps a RunnableEntity onto one OsIsr based on the activating ExternalTriggerOccurredEvent.
RteEventToTaskMapping	0..*	Maps an instance of a RunnableEntity onto one OsTask based on the activating RTEEvent. In the case of a RunnableEntity executed via a direct or trusted function call this RteEventToTaskMapping is still specified but no RteMappedToTask element is included. The RtePositionInTask parameter is necessary to provide an ordering of events invoked by the same RTE API.
RteExclusiveArea Implementation	0..*	Specifies the implementation to be used for the data consistency of this ExclusiveArea.
RteExternalTriggerConfig	0..*	Defines the configuration of External Trigger Event Communication for Software Components
RteInternalTriggerConfig	0..*	Defines the configuration of Inter Runnable Triggering for Software Components
RteModeMachine InstanceConfig	0..*	Defines the configuration of RTE assigned (SWS_Rte_07533) mode machine instances.
RteNvRamAllocation	0..*	Specifies the relationship between the AtomicSwComponentType's NVRAMMapping / NVRAM needs and the NvM module configuration.

The container `RteSwComponentInstance` collects all the configuration information related to one specific instance of a `AtomicSwComponentType`. The individual aspects will be described in the next sections.

8.5.1 RTE Event to task/ISR mapping

One of the major fragments of the RTE configuration is the mapping of AUTOSAR Software-Components' `RunnableEntity`s to OS Tasks or ISRs. The parameters defined to achieve this are shown in figure 8.10 and figure 8.11.

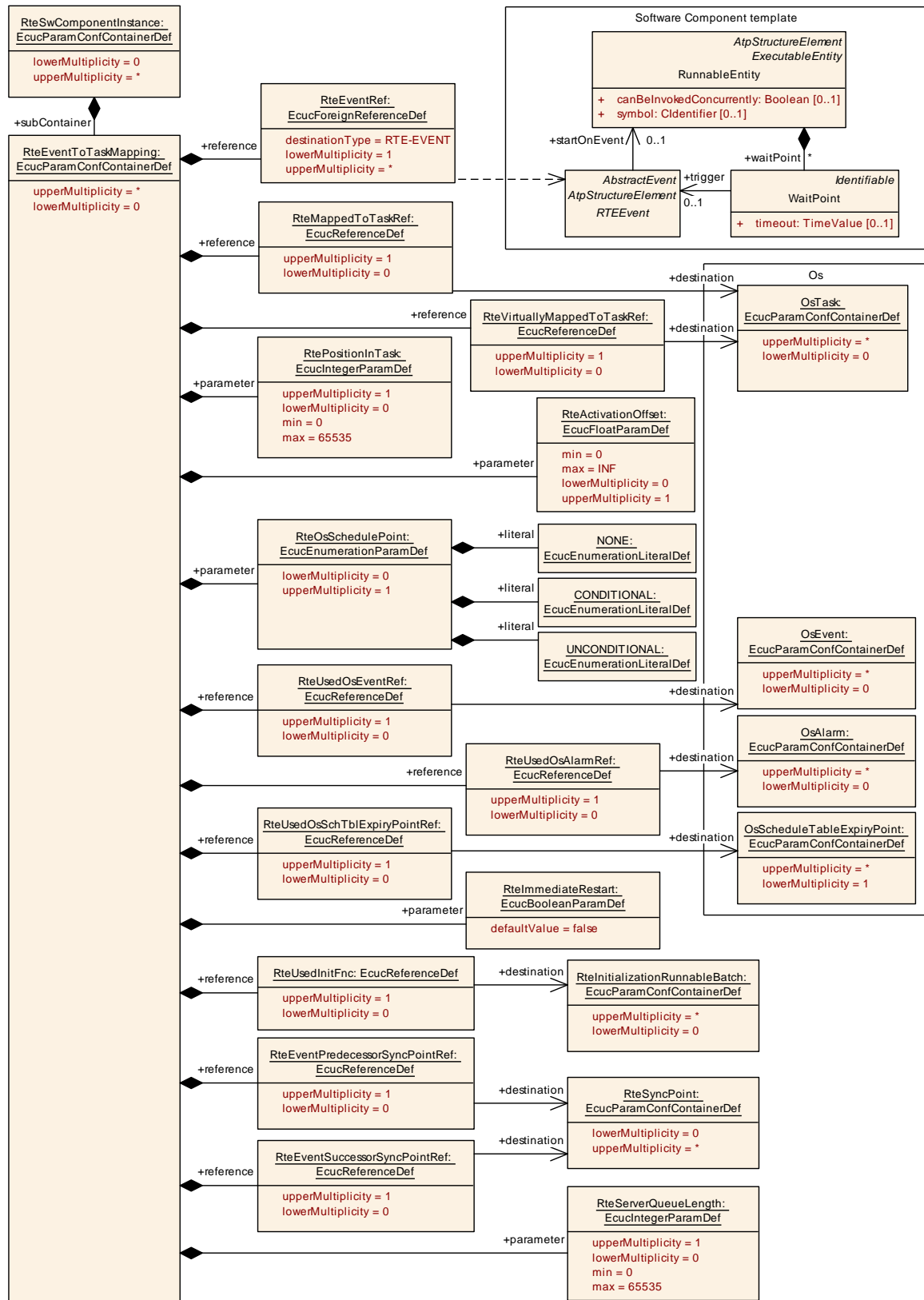


Figure 8.10: RTE Event to task mapping

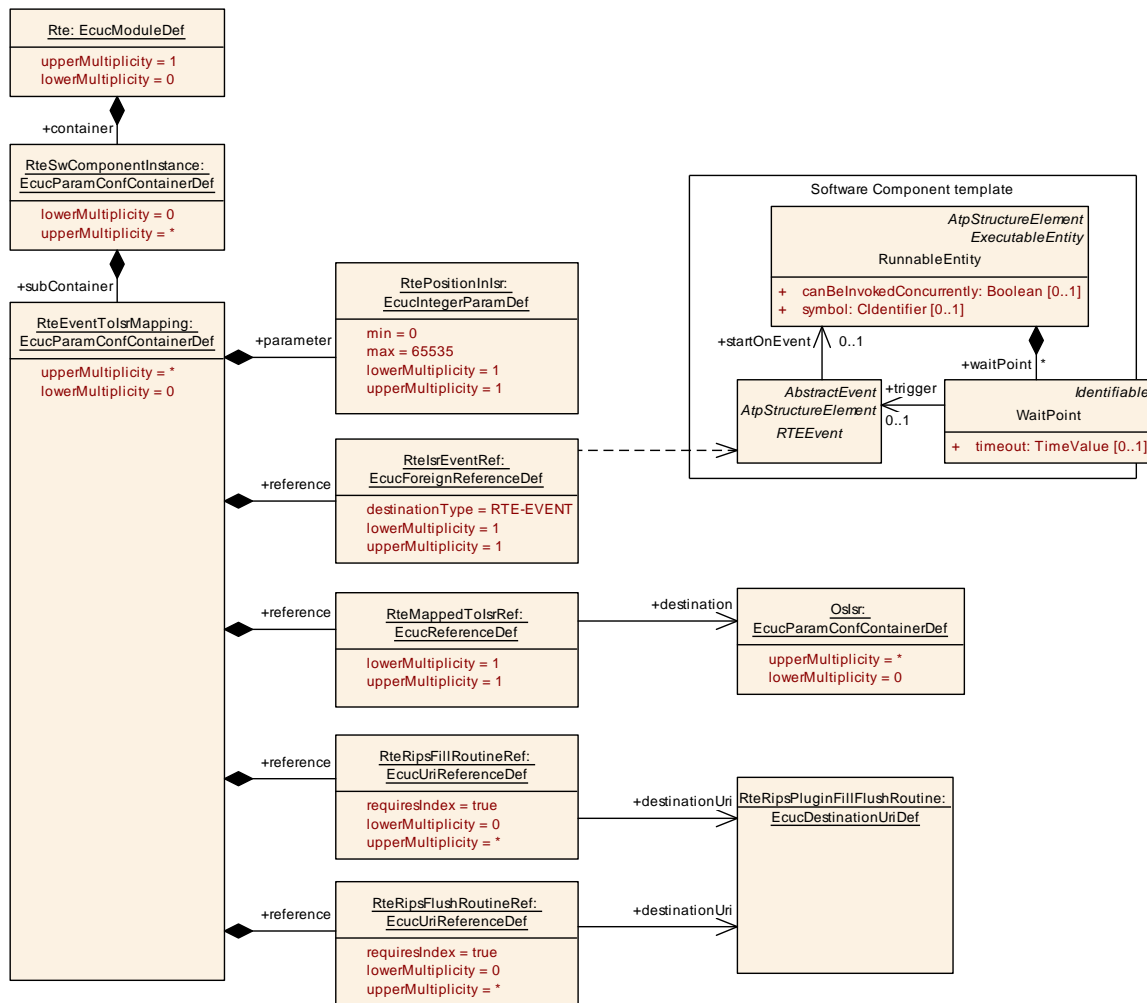


Figure 8.11: RTE Event to ISR mapping

The mapping is based on the [RTEEvent](#) because it is the source of the activation. For each [RunnableEntity](#) which belongs to an AUTOSAR Software-Component instance mapped on the ECU there needs to be a mapping container specifying how this [RunnableEntity](#) activation shall be handled.

[SWS_Rte_07843] [The RTE Generator shall reject configurations where the same [RTEEvent](#) instance which can start a [RunnableEntity](#) is mapped to tasks multiple times.] ()

[SWS_Rte_03630] [The RTE Generator shall reject configurations where the same [RTEEvent](#) instance which can start a [RunnableEntity](#) is mapped to [RteInitializationRunnableBatches](#) multiple times.] ([SRS_Rte_00240](#))

[SWS_Rte_03631] [The RTE Generator shall reject configurations where the same [RTEEvent](#) instance which can start a [RunnableEntity](#) is mapped to both a task and an [RteInitializationRunnableBatch](#) with the exception of [SwcModeSwitchEvents](#) with [activation = onEntry](#) and referring to the [initialMode](#).] ([SRS_Rte_00240](#))

In order to specify different `RtePositionInTask` values for on-entry `ExecutableEntity`s for the `initialMode` in the context of a `RteInitializationRunnableBatch` and in the context of a transition of a mode machine instance (e.g. task context of all on-entry `ExecutableEntity`s, on-transition `ExecutableEntity`s, and on-exit `ExecutableEntity`s of the same core local mode user group), two `RteEventToTaskMapping` containers are required for these `SwcModeSwitchEvents`.

Having the same `RteEventToTaskMapping` container to map such a `SwcModeSwitchEvent` instance (with `activation = onEntry` and referring to the `initialMode`) to both an `OsTask` container and a `RteInitializationRunnableBatch` container, the same `RtePositionInTask` value will be specified for both cases. This is useful if a separate `RteInitializationRunnableBatch` is created for each initial mode machine instance to handle the initial mode transitions as the relative ordering of the mapped events stays the same.

Having two separate `RteEventToTaskMapping` containers to map such a `SwcModeSwitchEvent` (with `activation = onEntry` and referring to the `initialMode`) allows using two different `RtePositionInTask` values for the mapped `OsTask` container and the mapped `RteInitializationRunnableBatch` container. This is useful if the `RteInitializationRunnableBatch` container has other mapped `RTE-Events/BswEvents`.

[SWS_Rte_03632] [The RTE Generator shall reject configurations where a `SwcModeSwitchEvent` with `activation = onEntry` referring to the `initialMode` is mapped to an `RteInitializationRunnableBatch` container via an `RteEventToTaskMapping` if the `SwcModeSwitchEvent`'s mode references a synchronized mode group.] (*SRS_Rte_00240*)

Rationale: Synchronized mode groups are initialized with the SchM by the `SchM_Init()` call and are allowed to perform mode switches even before the RTE is started by `Rte_Start()` call. Having the aforementioned `SwcModeSwitchEvents` of a synchronized mode group mapped to such `RteInitializationRunnableBatch` would not guarantee either that the triggered `RunnableEntity` instance is executed or it is executed according to the mode switch semantics while making the configuration more complex than necessary.

8.5.1.1 Evaluation and execution order

Another important parameter is the `RtePositionInTask` which provides an order of `RunnableEntity`s within the associated `OsTask`. When the task is executed periodically the `RtePositionInTask` parameter defines the order of execution within the task. When the task is used to define a context for event activated `RunnableEntity`s the `RtePositionInTask` parameter defines the order of evaluation which actual `RunnableEntity` shall be executed. Thus providing means to define a deterministic delay between the beginning of execution of the task and the actual execution of the `RunnableEntity`'s code.

In case of `triggered` `runnables`, `on-entry ExecutableEntities`, `on-transition ExecutableEntities`, `on-exit ExecutableEntities`, and `ModeSwitchAck ExecutableEntities` the `RtePositionInTask` parameter defines the order of evaluation which actual `RunnableEntity` shall be executed. All other parameters or references are not required.

8.5.1.2 Direct and trusted function call

[SWS_Rte_06798] [If the `ExecutableEntity` is a `server ExecutableEntity`, `triggered ExecutableEntity`, `on-entry ExecutableEntity`, `on-transition ExecutableEntity`, `on-exit ExecutableEntity`, or a `ModeSwitchAck ExecutableEntity` and shall be executed in the context of the caller (i.e. using a direct or trusted function call) then the element `RteEventToTaskMapping` or `RteBswEventToTaskMapping` still shall be provided to indicate that this `RTEEvent` / `BswEvent` has been considered in the mapping.]()

In case of `server ExecutableEntities` its not possible that several servers get invoked by the same API call. Therefore, no further parameters in the `RteEventToTaskMapping` or `RteBswEventToTaskMapping` associated to the `RTEEvent` / `BswEvent` are required to configure the direct or trusted function call for `server ExecutableEntities`.

[SWS_Rte_06799] [For directly invoked `server ExecutableEntities` no further parameters or references are required, in particular `RteMappedToTaskRef` and `RtePositionInTask` are omitted.]()

In case of `ExecutableEntities` which are not `server ExecutableEntities` it is possible that several `ExecutableEntities` get invoked by the same API call when direct or trusted function call configuration is used. Thereby the `RteMappedToTaskRef` / `RteBswMappedToTaskRef` is omitted. However the order of invocation needs to be configured with the `RtePositionInTask` and `RteBswPositionInTask` parameters.

[SWS_Rte_06800] [For directly invoked `triggered ExecutableEntity`, `on-entry ExecutableEntity`, `on-transition ExecutableEntity`, `on-exit ExecutableEntity`, or a `ModeSwitchAck ExecutableEntity` the `RtePositionInTask` and `RteBswPositionInTask` parameter respectively is required to indicate the order of invocation.]()

The invocation context for an `ExecutableEntity` can be either a task or a function call. For `ExecutableEntities` invoked from an `OsTasks` then **[SWS_Rte_CONSTR_09082]** means that all mapped `ExecutableEntities` must have unique values for the task to ensure predictable generation of the task body. In the case of `RTEEvents` or `BswEvents` invoked by direct invocation from an RTE-generated API function then **[SWS_Rte_CONSTR_09082]** means that all events invoked by the calling function must have unique values to ensure predictable generation of the calling API.

[SWS_Rte_CONSTR_09082] `RtePositionInTask` and `RteBswPositionInTask` values shall be unique in a particular context [`RtePositionInTask` and `RteBswPositionInTask` shall have unique values for any particular task in the case `RTEEvents` and `BswEvents` are mapped to `OsTasks` and shall have unique values for any particular scope of direct invocation in the case that a direct or trusted function call is configured.]()

Concerning the mapping of several `operations` to the same `server runnables` see [SWS_Rte_08001].

Example 8.2

BSW module `BswA` defines `BswModuleEntity` `BswA_ProcessBigBang` triggered by `BswExternalTriggerOccurredEvent` `Ev_BswA_ProcessBigBang`

Software component `SwcA` defines `RunnableEntity` `SwcA_Run_BigBang` triggered by `ExternalTriggerOccurredEvent` `Ev_SwcA_Run_BigBang`

Software component `SwcB` defines `RunnableEntity` `SwcB_Run_BigBang` triggered by `ExternalTriggerOccurredEvent` `Ev_SwcB_Run_BigBang`

All required `Triggers` are connected to one common synchronized `Trigger`.

Scenario A

A configuration:

`Ev_BswA_ProcessBigBang` is mapped to `OsTask` `T_BIG_BANG` with `RtePositionInTask` = 1

`Ev_SwcA_Run_BigBang` is mapped to `OsTask` `T_BIG_BANG` with `RtePositionInTask` = 2

`Ev_SwcB_Run_BigBang` is mapped to `OsTask` `T_BIG_BANG` with `RtePositionInTask` = 3

results in `Rte` code where the `ExecutableEntitys` are called in the context of the `OsTask` `T_BIG_BANG` in the order:

1. `Ev_BswA_ProcessBigBang`
2. `Ev_SwcA_Run_BigBang`
3. `Ev_SwcB_Run_BigBang`

In addition [SWS_Rte_CONSTR_09082] is fulfilled even if the `RtePositionInTask` values 1, 2, 3 are used for other `RteEventToTaskMappings` mapping to other `OsTask` or configuring a direct function call.

Scenario B

A configuration:

Ev_BswA_ProcessBigBang is not mapped to any `OsTask` and `RtePositionInTask = 1`

Ev_SwcA_Run_BigBang is not mapped to any `OsTask` and `RtePositionInTask = 2`

Ev_SwcB_Run_BigBang is not mapped to any `OsTask` and `RtePositionInTask =` results in Rte code where the `ExecutableEntity`s are called in the context of the issuing Trigger API, e.g `SchM_Trigger` which invokes the `ExecutableEntity`s in the order:

1. Ev_BswA_ProcessBigBang
2. Ev_SwcA_Run_BigBang
3. Ev_SwcB_Run_BigBang

8.5.1.3 Schedule Points

In order to allow explicit calls to the Os scheduler in an non-preemptive scheduling setup, the configuration element `RteOsSchedulePoint` shall be used.

[SWS_Rte_05113] [The RTE Generator shall create an unconditional call to the Os API *Schedule* after the execution call of the `RunnableEntity` if the `RteOsSchedulePoint` configuration parameter is set to `UNCONDITIONAL`. In the generated code the call to the Os API *Schedule* shall always be performed, even when the `RunnableEntity` itself has not been executed (called).]()

Since the execution of a `RunnableEntity` may be performed (e.g. due to mode dependent scheduling) the call of the Os API *Schedule* without any `RunnableEntity` execution in between might occur. In order to prohibit such a call chain the `CONDITIONAL` schedule point is available.

[SWS_Rte_05114] [The RTE Generator shall create a conditional call to the Os API *Schedule* after the execution call of the `RunnableEntity` if the `RteOsSchedulePoint` configuration parameter is set to `CONDITIONAL`. In the generated code the call to the Os API *Schedule* shall be omitted when there was already a call to the Os API *Schedule* before without any `RunnableEntity` execution in between.]()

[SWS_Rte_07042] [The Os API *Schedule* according [SWS_Rte_05113] and [SWS_Rte_05114] shall be called after the data written with implicit write access by the `RunnableEntity` are propagated to other `RunnableEntity`s as specified in [SWS_Rte_07021], [SWS_Rte_03957], [SWS_Rte_07041] and [SWS_Rte_03584]]()

[SWS_Rte_07043] [The Os API *Schedule* according [SWS_Rte_05113] and [SWS_Rte_05114] shall be called before the `preemption area` specific buffer used for a implicit read access of the successor `RunnableEntity` are filled with actual data by a copy action according [SWS_Rte_07020].]()

[SWS_Rte_05115] [The RTE Generator shall create no call to the Os API *Schedule* after the execution of the *RunnableEntity* if the *RteOsSchedulePoint* configuration parameter is not present or is set to *NONE*.]()

[SWS_Rte_01373] [The RTE Generator shall support the independent setting of *RteOsSchedulePoint* for *RteEventToTaskMappings* that map the same *RunnableEntity*.](*SRS_Rte_00018*)

8.5.1.4 Timeprotection support

[SWS_Rte_07801] [If *RteMappedToTaskRef* is configured but *RteVirtuallyMappedToTaskRef* is not configured, the RTE shall implement/evaluate the *RTEEvent* that activates the *RunnableEntity* and execute the *RunnableEntity* in the *OsTask* referenced by *RteMappedToTaskRef*.]()

[SWS_Rte_07802] [If both *RteMappedToTaskRef* and *RteVirtuallyMappedToTaskRef* are configured, the RTE shall implement/evaluate the *RTEEvent* that activates the *RunnableEntity* in the *OsTask* referenced by *RteVirtuallyMappedToTaskRef* but execute the *RunnableEntity* in the *OsTask* referenced by *RteMappedToTaskRef*. The RTE shall implement this by an activation of the *OsTask* referenced by *RteMappedToTaskRef* when the *RTEEvent* is evaluated as "TRUE" in the *OsTask* referenced by *RteVirtuallyMappedToTaskRef*.](*SRS_Rte_00193*)

[SWS_Rte_07803] [The RTE shall reject the configuration if *RteMappedToTaskRef* is not configured but *RteVirtuallyMappedToTaskRef* is configured.](*SRS_Rte_00018*)

8.5.1.5 Os Interaction

When an *OsEvent* is used to activate the *OsTask* the reference *RteUsedOsEventRef* specifies which *OsEvent* is used.

When an *OsAlarm* is used to implement a *TimingEvent* or a *BackgroundEvent* the reference *RteUsedOsAlarmRef* specifies which *OsAlarm* is used.

[SWS_Rte_07806] [If *RteUsedOsAlarmRef* is configured and *RteEventRef* references a *TimingEvent* the RTE shall implement the *TimingEvent* with the *OsAlarm* referenced by *RteUsedOsAlarmRef*.](*SRS_Rte_00232*)

[SWS_Rte_07179] [If *RteUsedOsAlarmRef* is configured and *RteEventRef* references a *BackgroundEvent* the RTE shall implement the *BackgroundEvent* with the *OsAlarm* referenced by *RteUsedOsAlarmRef*.]()

When an *OsScheduleTableExpiryPoint* is used to implement a *TimingEvent* or a *BackgroundEvent* the reference *RteUsedOsSchTblExpiryPointRef* specifies which *OsScheduleTableExpiryPoint* is used.

[SWS_Rte_07807] [If `RteUsedOsSchTblExpiryPointRef` is configured and `RteEventRef` references a `TimingEvent` the RTE shall implement the `TimingEvent` with the `OsScheduleTableExpiryPoint` referenced by `RteUsedOsSchTblExpiryPointRef`.] (*SRS_Rte_00232*)

[SWS_Rte_07180] [If `RteUsedOsSchTblExpiryPointRef` is configured and `RteEventRef` references a `BackgroundEvent` the RTE shall implement the `BackgroundEvent` with the `OsScheduleTableExpiryPoint` referenced by `RteUsedOsSchTblExpiryPointRef`.] ()

If neither `RteUsedOsSchTblExpiryPointRef` nor `RteUsedOsAlarmRef` are configured and `RteEventRef` references a `TimingEvent` the RTE is free to implement the `TimingEvent` with the `OsAlarm` or `OsScheduleTableExpiryPoint` of its choice.

[SWS_Rte_07808] [The RTE shall reject the configuration if both `RteUsedOsAlarmRef` and `RteUsedOsSchTblExpiryPointRef` are configured.] (*SRS_Rte_00018*)

[SWS_Rte_07809] [The RTE shall reject the configuration if `RteUsedOsAlarmRef` or `RteUsedOsSchTblExpiryPointRef` is configured and `RteEventRef` doesn't reference a `TimingEvent` or a `BackgroundEvent`.] (*SRS_Rte_00018*)

8.5.1.6 Background activation

If neither `RteUsedOsSchTblExpiryPointRef` nor `RteUsedOsAlarmRef` is configured and `RteEventRef` references a `BackgroundEvent` the `RteMappedToTaskRef` has to reference the `OsTask` used for *Background* activation of *RunnableEntities* and *Basic Software Schedulable Entities* on the related CPU core where the partition of the software component is mapped.

The `OsTask` used for `BackgroundEvent` triggering has to have the lowest priority on the core. There can only be one 'Background' `OsTask` per CPU core.

[SWS_Rte_07181] [The RTE shall reject the configuration if

- `RteEventRef` references a `BackgroundEvent` and
- neither `RteUsedOsAlarmRef` nor `RteUsedOsSchTblExpiryPointRef` are configured and
- if `RteMappedToTaskRef` reference an `OsTask` which has not the lowest priority of the core.

] (*SRS_Rte_00018*)

8.5.1.7 Constraints

There are some constraints which do apply when actually mapping the `RunnableEntity` to an `OsTask`:

[SWS_Rte_05082] [The following restrictions apply to `RTEEvents` which are used to activate `RunnableEntity`. `OsEvents` that are used to `wakeUpFromWaitPoint` shall not be included in the mapping.](/)

When a `wakeUpFromWaitPoint` is occurring the `RunnableEntity` resumes its execution in the context of the originally activated `OsTask`.

One major constraint is posed by the `canBeInvokedConcurrently` attribute of each `RunnableEntity` because data consistency issues have to be considered.

[SWS_Rte_05083] [The RTE Generator shall reject configurations where a `RunnableEntity` has its `canBeInvokedConcurrently` attribute set to *false*, and this `RunnableEntity` is mapped to different tasks which can preempt each other.](/)

[SWS_Rte_07229] [To evaluate **[SWS_Rte_05083]** in case of `triggered runnables` which are activated by a direct or trusted function call (**[SWS_Rte_07214]**, **[SWS_Rte_07224]** and **[SWS_Rte_07554]**) the `OsTask` (context of the caller) is defined by the `RunnableEntity`'s containing the activating `InternalTriggeringPoint` or `ExternalTriggeringPoint`.](*SRS_Rte_00162*, *SRS_Rte_00163*, *SRS_Rte_00230*)

[SWS_Rte_07155] [To evaluate **[SWS_Rte_05083]** in case of `on-entry ExecutableEntities`, `on-transition ExecutableEntities`, `on-exit ExecutableEntities`, and `ModeSwitchAck ExecutableEntities` which are activated by a direct or trusted function call the `OsTask` (context of the caller) is defined by the `RunnableEntity`'s containing the activating `ModeSwitchPoint`.](*SRS_Rte_00143*, *SRS_Rte_00144*)

[SWS_Rte_CONSTR_03873] [All `OperationInvokedEvents`/`BswOperationInvokedEvents` which are activating the same `server ExecutableEntity` shall be mapped by at most one `RteEventToTaskMapping`/`RteBswEventToTaskMapping` which references an `OsTask`.](*SRS_Rte_00019*, *SRS_Rte_00033*)

Note: This shall ensure that direct or trusted function calls and server serialization can be mixed for the same `server ExecutableEntity`. But the server serialization can only be configured at exactly one `RtePositionInTask`/`RteBswPositionInTask`.

[SWS_Rte_CONSTR_03874] [A `RteEventToTaskMapping`/`RteBswEventToTaskMapping` shall only own more than one `RteEventRef`/`RteBswEventRef` reference if all owned `RteEventRefs`/`RteBswEventRefs` refer to `OperationInvokedEvents`/`BswOperationInvokedEvents` which in turn are triggering the same `server ExecutableEntity`.](*SRS_Rte_00019*, *SRS_Rte_00033*)

SWS Item	[ECUC_Rte_09020]
Container Name	RteEventToTaskMapping
Parent Container	RteSwComponentInstance

Description	Maps an instance of a RunnableEntity onto one OsTask based on the activating RTEEvent. In the case of a RunnableEntity executed via a direct or trusted function call this RteEventToTaskMapping is still specified but no RteMappedToTask element is included. The RtePositionInTask parameter is necessary to provide an ordering of events invoked by the same RTE API.
Configuration Parameters	

Name	RteActivationOffset [ECUC_Rte_09018]		
Parent Container	RteEventToTaskMapping		
Description	Activation offset in seconds.		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. INF]		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteImmediateRestart [ECUC_Rte_09092]		
Parent Container	RteEventToTaskMapping		
Description	<p>When RteImmediateRestart is set to true the RunnableEntity shall be immediately re-started after termination if it was activated by this RTEEvent while it was already started.</p> <p>This parameter shall not be set to true when the mapped RTEEvent refers to a RunnableEntity which minimumStartInterval attribute is > 0.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteOsSchedulePoint [ECUC_Rte_09022]		
Parent Container	RteEventToTaskMapping		
Description	<p>Introduce a schedule point by explicitly calling Os Schedule service after the execution of the ExecutableEntity. The Rte generator is allowed to optimize several consecutive calls to Os schedule into one single call if the ExecutableEntity executions in between have been skipped.</p> <p>The absence of this parameter is interpreted as "NONE".</p> <p>It shall be considered an invalid configuration if the task is preemptable and the value of this parameter is not set to "NONE" or the parameter is absent.</p>		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	CONDITIONAL	A Schedule Point shall be introduced at the end of the execution of this ExecutableEntity. The Schedule Point can be skipped if several Schedule Points would be called without any ExecutableEntity execution in between.	
	NONE	No Schedule Point shall be introduced at the end of the execution of this ExecutableEntity.	
	UNCONDITIONAL	A Schedule Point shall always be introduced at the end of the execution of this ExecutableEntity.	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	RtePositionInTask [ECUC_Rte_09023]		
Parent Container	RteEventToTaskMapping		
Description	<p>Each RunnableEntity mapped to an OsTask has a specific position within the task execution. For periodic activation this is the order of execution. For event driver activation this is the order of evaluation which actual RunnableEntity has to be executed. In case of direct or trusted function calls this parameter is necessary to provide an ordering of events when several ExecutableEntities are invoked by the same RTE API.</p>		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		

Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteServerQueueLength [ECUC_Rte_09133]		
Parent Container	RteEventToTaskMapping		
Description	Specifies the length of the queue for the server call serialization. This value overwrites the queueLength specified at the ServerComSpec.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteEventPredecessorSyncPointRef [ECUC_Rte_09128]		
Parent Container	RteEventToTaskMapping		
Description	<p>The RteEventPredecessorSyncPointRef is necessary to provide a cross core synchronization in case of RteEvents triggered by the same event source but mapped to tasks belonging to different partitions on different cores.</p> <p>The synchronization point must be reached by all referencing RteEvents before the execution in all related tasks is continued.</p> <p>In case of RteEventPredecessorSyncPointRef the RunnableEntity activated by the mapped RteEvent is executed after the synchronization point is passed.</p>		
Multiplicity	0..1		
Type	Reference to RteSyncPoint		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteEventRef [ECUC_Rte_09019]		
Parent Container	RteEventToTaskMapping		
Description	Reference to the description of the RTEEvent which is pointing to the RunnableEntity being mapped. This allows a fine grained mapping of RunnableEntites based on the activating RTEEvent.		
Multiplicity	1..*		
Type	Foreign reference to RTE-EVENT		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteEventSuccessorSyncPointRef [ECUC_Rte_09129]		
Parent Container	RteEventToTaskMapping		
Description	<p>The RteEventSuccessorSyncPointRef is necessary to provide a cross core synchronization in case of RteEvents triggered by the same event source but mapped to tasks belonging to different partitions on different cores.</p> <p>The synchronization point must be reached by all referencing RteEvents before the execution in all related tasks is continued.</p> <p>In case of RteEventSuccessorSyncPointRef the RunnableEntity activated by the mapped RteEvent is executed before the synchronization point is entered.</p>		
Multiplicity	0..1		
Type	Reference to RteSyncPoint		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteMappedToTaskRef [ECUC_Rte_09021]		
Parent Container	RteEventToTaskMapping		
Description	<p>Reference to the OsTask the RunnableEntity activated by the RteEventRef is mapped to.</p> <p>If no reference to the OsTask is specified the RunnableEntity shall be executed via a direct or trusted function call.</p> <p>The fact that no reference to an OsTask is specified for a RunnableEntity does not necessarily imply that every RTE generator has to support the implementation of this RunnableEntity as a direct or trusted function call. The standard set of use cases for direct or trusted function calls that has to be supported by every RTE generator is explicitly stated as requirements in this document. For further optimization RTE vendors are free to support additional scenarios of direct or trusted function call implementations that are not explicitly required in this document.</p>		
Multiplicity	0..1		
Type	Reference to OsTask		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsFillRoutineRef [ECUC_Rte_89005]		
Parent Container	RteEventToTaskMapping		
Description	Reference to a Buffer-Fill Routine implemented by an RTE Implementation Plug-In. This routine gets invoked directly before the ExecutableEntity is started. Attributes: requiresIndex=true		
Multiplicity	0..*		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPluginFillFlush Routine]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsFlushRoutineRef [ECUC_Rte_89006]		
Parent Container	RteEventToTaskMapping		
Description	Reference to a Buffer-Flush Routine implemented by an RTE Implementation Plug-In. This routine gets invoked directly after the ExecutableEntity has terminated. Attributes: requiresIndex=true		
Multiplicity	0..*		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPluginFillFlush Routine]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsInvocationHandlerRef [ECUC_Rte_89008]		
Parent Container	RteEventToTaskMapping		
Description	Reference to a Buffer-Fill Routine implemented by an RTE Implementation Plug-In. This routine gets invoked directly before the ExecutableEntity is started.		
Multiplicity	0..1		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsInvocationHandler]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteUsedInitFnc [ECUC_Rte_09116]		
Parent Container	RteEventToTaskMapping		
Description	The RunnableEntity is executed during initialization in the context of the Rte_Init_<InitContainer> function.		
Multiplicity	0..1		
Type	Reference to RteInitializationRunnableBatch		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteUsedOsAlarmRef [ECUC_Rte_09024]		
Parent Container	RteEventToTaskMapping		
Description	If an OsAlarm is used to activate the OsTask this RteEvent is mapped to it shall be referenced here.		
Multiplicity	0..1		
Type	Reference to OsAlarm		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteUsedOsEventRef [ECUC_Rte_09025]		
Parent Container	RteEventToTaskMapping		
Description	If an OsEvent is used to activate the OsTask this RteEvent is mapped to it shall be referenced here.		
Multiplicity	0..1		
Type	Reference to OsEvent		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteUsedOsSchTblExpiryPointRef [ECUC_Rte_09026]		
Parent Container	RteEventToTaskMapping		
Description	If an OsScheduleTableExpiryPoint is used to activate the OsTask this RteEvent is mapped to it shall be referenced here.		
Multiplicity	0..1		
Type	Reference to OsScheduleTableExpiryPoint		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteVirtuallyMappedToTaskRef [ECUC_Rte_09027]		
Parent Container	RteEventToTaskMapping		
Description	Optional reference to an OsTask where the activation of this RteEvent shall be evaluated. The actual execution of the Runnable Entity shall happen in the OsTask referenced by RteMappedToTaskRef.		
Multiplicity	0..1		
Type	Reference to OsTask		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.5.2 Rte Os Interaction

This section contains configuration items which are closely related to the interaction of the Rte with the Os.

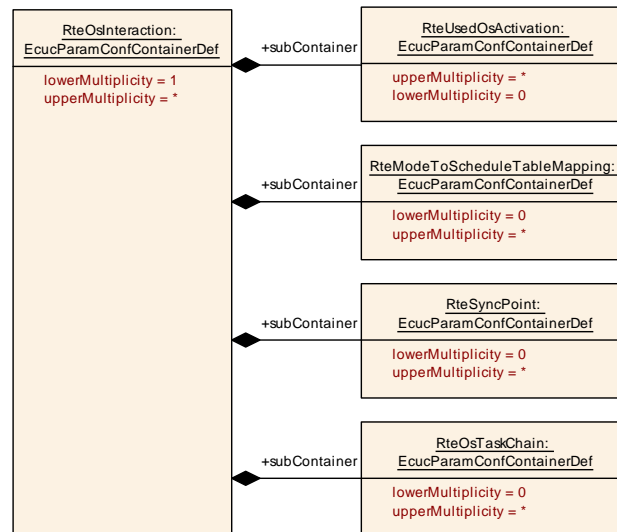


Figure 8.12: Specification of the Rte/Os Interaction

SWS Item	[ECUC_Rte_09059]
Container Name	RteOsInteraction
Parent Container	Rte
Description	Interaction of the Rte with the Os.
Configuration Parameters	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteModeToScheduleTableMapping	0..*	Provides configuration input in which Modes of a ModeDeclarationGroupPrototype of a Mode Manager a OsScheudleTable shall be active. The Mode Manager is either specified as a SwComponentPrototype (RteModeSchtblMapSwc) or as a BSW-Module (RteModeSchtblMapBsw).
RteOsTaskChain	0..*	This container holds the configuration of one task chain configuration.
RteSyncPoint	0..*	<p>The RteSyncPoint is necessary to provide an cross core synchronization in case of RteEvents triggered by the same event source but mapped to tasks belonging to different partitions on different cores.</p> <p>The synchronization point must be reached by all referencing RteEvents before the execution in all related tasks is continued.</p> <p>In case of Rte(Bsw)EventSuccessorSyncPointRef the ExecutableEntity activated by the mapped event is executed before the synchronization point is entered.</p> <p>In case of Rte(Bsw)EventPredecessorSyncPointRef the ExecutableEntity activated by the mapped event is executed after the synchronization point is passed.</p>
RteUsedOsActivation	0..*	Attributes used in the activation of OsTasks and Runnable Entities.

8.5.2.1 Activation using Os features

This is a collection of possible ways how the Rte might utilize Os to achieve various activation scenarios. The used Os objects are referenced in these configuration entities.

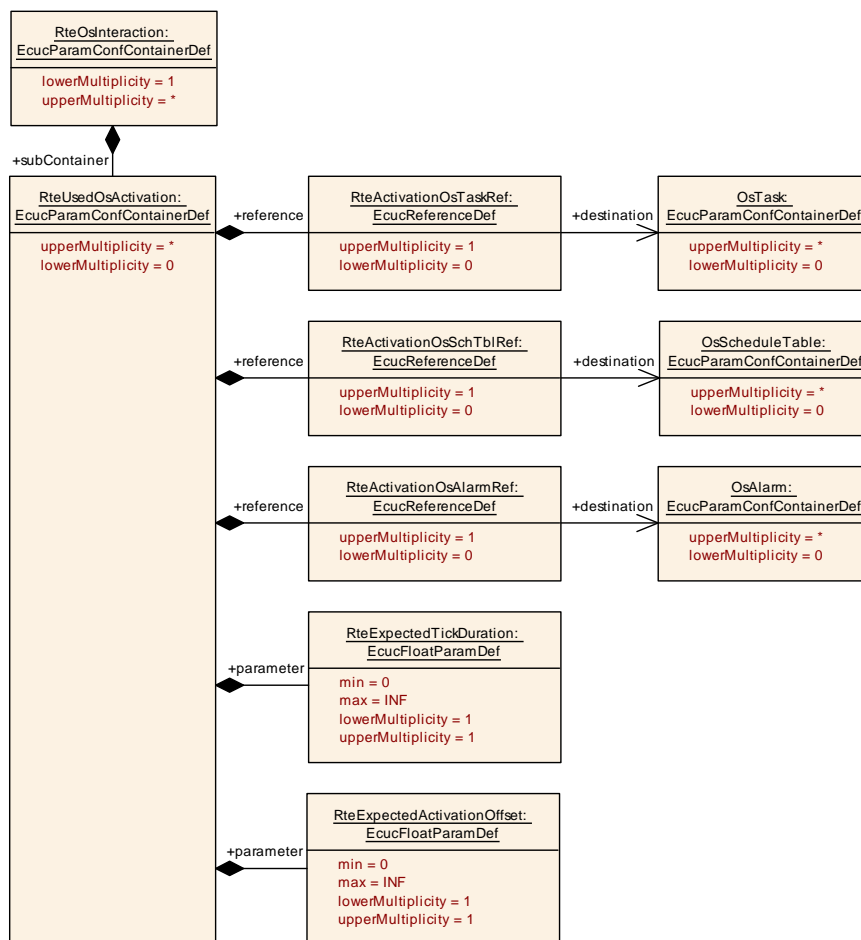


Figure 8.13: Configuration how activation is implemented

SWS Item	[ECUC_Rte_09060]
Container Name	RteUsedOsActivation
Parent Container	RteOsInteraction
Description	Attributes used in the activation of OsTasks and Runnable Entities.
Configuration Parameters	

Name	RteExpectedActivationOffset [ECUC_Rte_09048]	
Parent Container	RteUsedOsActivation	
Description	Activation offset in seconds. Important: This is a requirement from the Rte towards the Os/Mcu setup. The Rte Generator shall assume this activation offset to be fulfilled.	
Multiplicity	1	
Type	EcucFloatParamDef	
Range	[0 .. INF]	

Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteExpectedTickDuration [ECUC_Rte_09049]		
Parent Container	RteUsedOsActivation		
Description	<p>The expected tick duration in seconds which shall be configured to drive the OsScheduleTables or OsAlarm.</p> <p>Important: This is a requirement from the Rte towards the Os/Mcu setup. The Rte Generator shall assume this tick duration to be fulfilled.</p>		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	[0 .. INF]		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteActivationOsAlarmRef [ECUC_Rte_09045]		
Parent Container	RteUsedOsActivation		
Description	Reference to an OsAlarm.		
Multiplicity	0..1		
Type	Reference to OsAlarm		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteActivationOsSchTblRef [ECUC_Rte_09046]		
Parent Container	RteUsedOsActivation		
Description	Reference to an OsScheduleTable.		
Multiplicity	0..1		
Type	Reference to OsScheduleTable		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteActivationOsTaskRef [ECUC_Rte_09047]		
Parent Container	RteUsedOsActivation		
Description	Reference to an OsTask.		
Multiplicity	0..1		
Type	Reference to OsTask		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.5.2.2 Modes and Schedule Tables

Optional configuration of the Rte to support the mapping of modes and Os' schedule tables.

[SWS_Rte_05146] [The referenced schedule table of [RteModeScheduleTableRef](#) shall be activated if one of the modes referenced in [RteModeSchtblMapModeDeclarationRef](#) is active in the `mode machine instances` from the references of

- [RteModeSchtblMapSwc](#) or
- [RteModeSchtblMapBsw](#).

]()

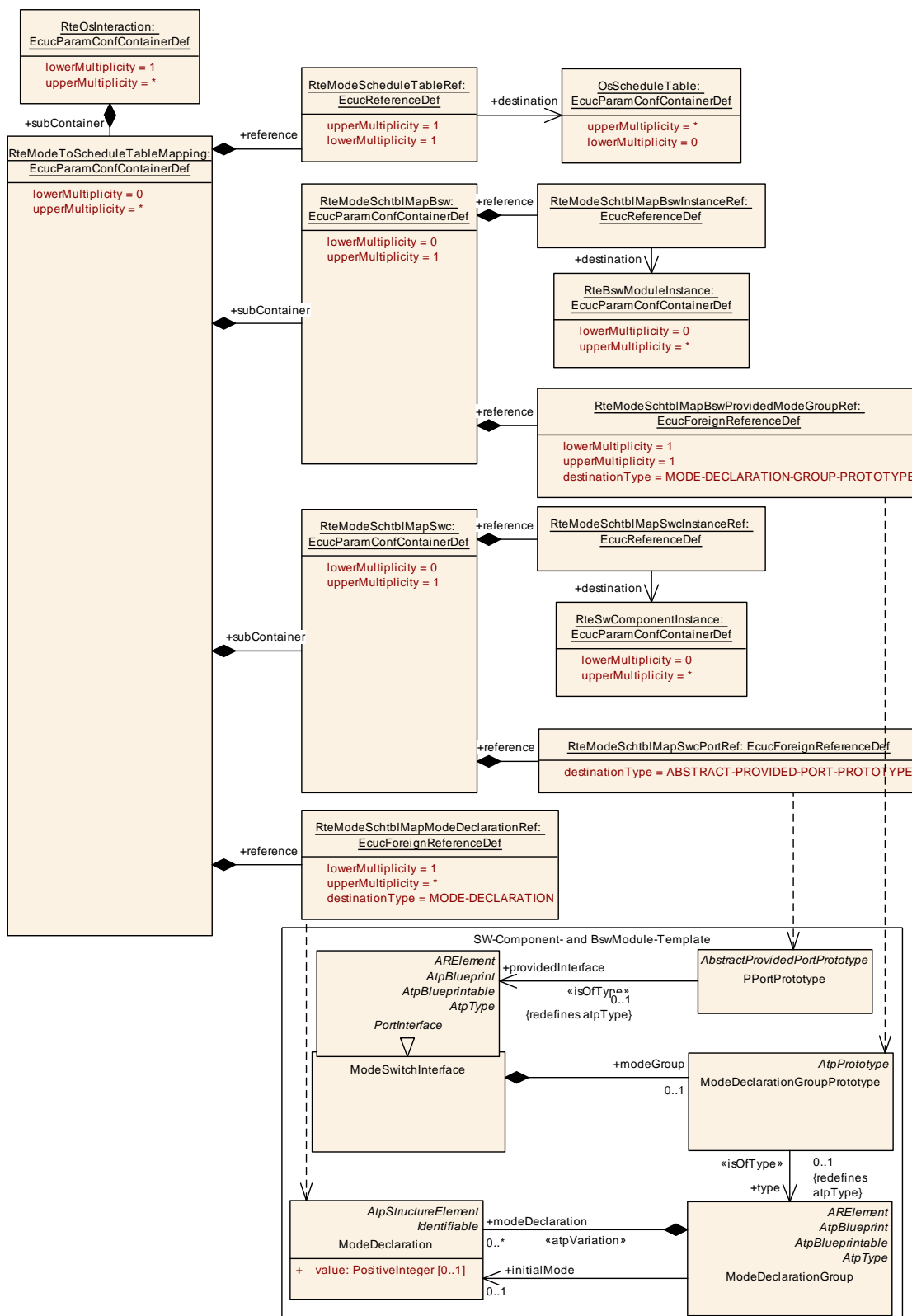


Figure 8.14: Configuration how modes are interacting with schedule tables

[SWS_Rte_02759] [RTE shall reject a configuration, if the [RteModeSchtblMapSwcPortRef:EcucForeignReferenceDef](#) does not reference a [PPortPrototype](#) or [PRPortPrototype](#) of the type of an [ModeSwitchInterface](#).]()

[SWS_Rte_02760] [RTE shall reject a configuration, if the [ModeDeclarationGroupPrototype](#) referenced by a [RteModeSchtblMapBswProvidedModeGroupRef:EcucForeignReferenceDef](#) is not in the role of a [providedModeGroup](#).]()

SWS Item	[ECUC_Rte_09058]
Container Name	RteModeToScheduleTableMapping
Parent Container	RteOsInteraction
Description	Provides configuration input in which Modes of a ModeDeclarationGroupPrototype of a Mode Manager a OsScheudleTable shall be active. The Mode Manager is either specified as a SwComponentPrototype (RteModeSchtblMapSwc) or as a BSW-Module (RteModeSchtblMapBsw).
Configuration Parameters	

Name	RteModeScheduleTableRef [ECUC_Rte_09050]		
Parent Container	RteModeToScheduleTableMapping		
Description	Reference to the OsScheduleTable which shall be active in the specified RteModeSchblMapModeDeclarationRefs.		
Multiplicity	1		
Type	Reference to OsScheduleTable		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteModeSchtblMapModeDeclarationRef [ECUC_Rte_09054]		
Parent Container	RteModeToScheduleTableMapping		
Description	Reference to the ModeDeclarations.		
Multiplicity	1..*		
Type	Foreign reference to MODE-DECLARATION		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteModeSchtblMapBsw	0..1	Specifies an instance of a ModeDeclarationGroupPrototype of a Bsw-Module.
RteModeSchtblMapSwc	0..1	Specifies an instance of a ModeDeclarationGroupPrototype of a SwComponentPrototype.

SWS Item	[ECUC_Rte_09055]
Container Name	RteModeSchtblMapSwc
Parent Container	RteModeToScheduleTableMapping
Description	Specifies an instance of a ModeDeclarationGroupPrototype of a SwComponentPrototype.
Configuration Parameters	

Name	RteModeSchtblMapSwcInstanceRef [ECUC_Rte_09056]		
Parent Container	RteModeSchtblMapSwc		
Description	Reference to an instance specification of a SwComponentPrototype.		
Multiplicity	1		
Type	Reference to RteSwComponentInstance		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteModeSchtblMapSwcPortRef [ECUC_Rte_09057]		
Parent Container	RteModeSchtblMapSwc		
Description	Reference to the PPortPrototype of a SwComponentPrototype.		
Multiplicity	1		
Type	Foreign reference to ABSTRACT-PROVIDED-PORT-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

SWS Item	[ECUC_Rte_09051]
Container Name	RteModeSchtblMapBsw
Parent Container	RteModeToScheduleTableMapping
Description	Specifies an instance of a ModeDeclarationGroupPrototype of a Bsw-Module.
Configuration Parameters	

Name	RteModeSchtblMapBswInstanceRef [ECUC_Rte_09052]		
Parent Container	RteModeSchtblMapBsw		
Description	Reference to an instance specification of a Bsw-Module.		
Multiplicity	1		
Type	Reference to RteBswModuleInstance		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteModeSchtblMapBswProvidedModeGroupRef [ECUC_Rte_09053]		
Parent Container	RteModeSchtblMapBsw		
Description	Reference to an instance of a ModeDeclarationGroupPrototype of a Bsw-Module.		
Multiplicity	1		
Type	Foreign reference to MODE-DECLARATION-GROUP-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.5.3 Exclusive Area implementation

The RTE Generator can be configured to implement a different data consistency mechanism for each [ExclusiveArea](#) defined for an AUTOSAR software-component.

In figure 8.15 the configuration of the actually selected data consistency mechanism is shown.

[SWS_Rte_CONSTR_03510] Exclude usage of OS_SPINLOCK in RteExclusiveAreaImplementation [The usage of the enumeration literal `OS_SPINLOCK` for the parameter `RteExclusiveAreaImplMechanism` shall be excluded if the parameter `RteExclusiveAreaImplMechanism` is used in the context of the container `RteExclusiveAreaImplementation`.]()

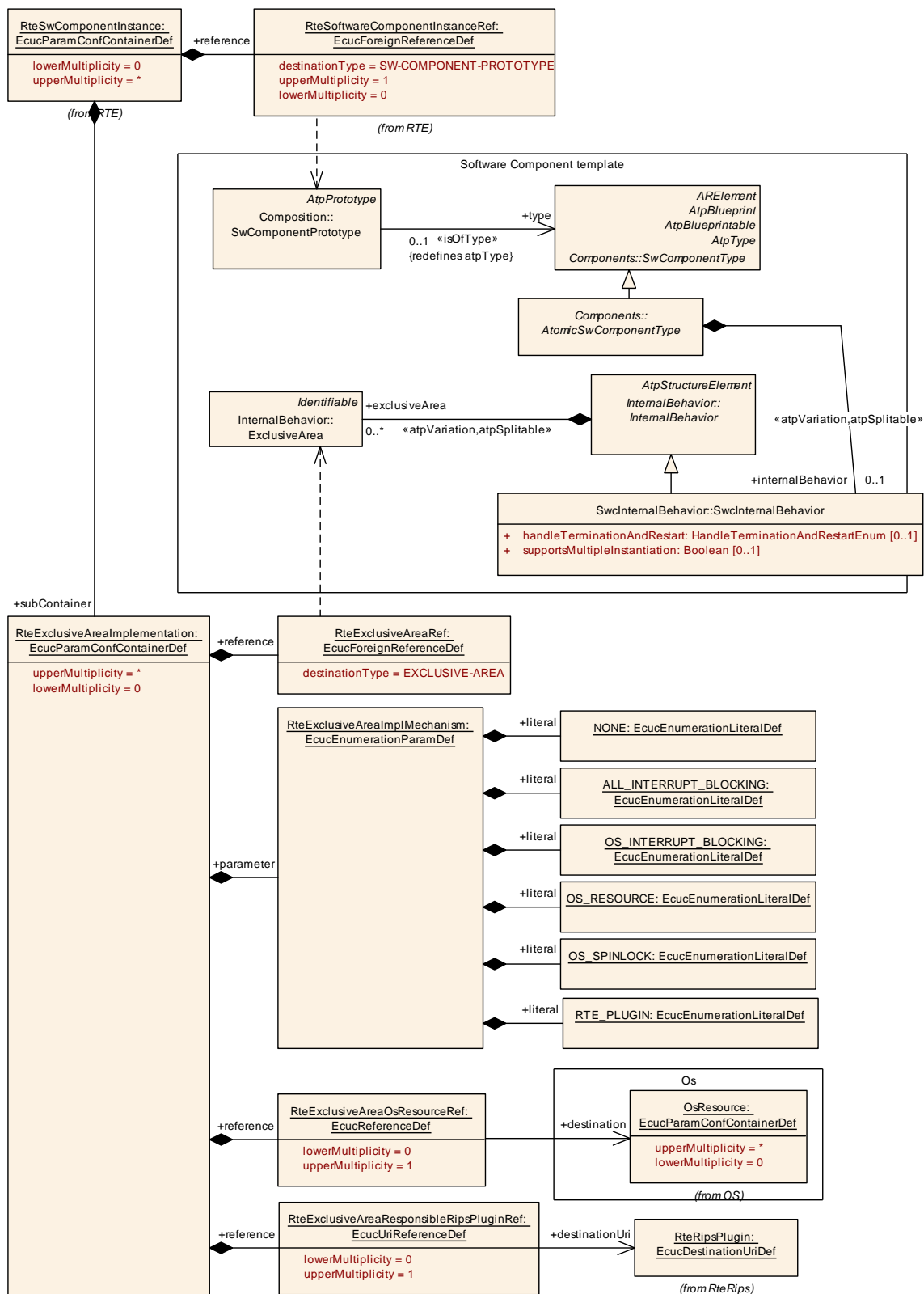


Figure 8.15: Configuration of the **ExclusiveArea** implementation

SWS Item	[ECUC_Rte_09030]
Container Name	RteExclusiveAreaImplementation

Parent Container	RteSwComponentInstance
Description	Specifies the implementation to be used for the data consistency of this ExclusiveArea.
Configuration Parameters	

Name	RteExclusiveAreaImplMechanism [ECUC_Rte_09029]		
Parent Container	RteExclusiveAreaImplementation		
Description	To be used implementation mechanism for the specified ExclusiveArea.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	ALL_INTERRUPT_BLOCKING		
	NONE		
	OS_INTERRUPT_BLOCKING		
	OS_RESOURCE		
	OS_SPINLOCK		
	RTE_PLUGIN	RTE Implementation Plug-in	
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteExclusiveAreaOsResourceRef [ECUC_Rte_09031]		
Parent Container	RteExclusiveAreaImplementation		
Description	Optional reference to an OsResource in case RteExclusiveAreaImplMechanism is configured to OS_RESOURCE for this ExclusiveArea.		
Multiplicity	0..1		
Type	Reference to OsResource		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteExclusiveAreaRef [ECUC_Rte_09032]		
Parent Container	RteExclusiveAreaImplementation		
Description	Reference to the ExclusiveArea.		
Multiplicity	1		
Type	Foreign reference to EXCLUSIVE-AREA		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteExclusiveAreaResponsibleRipsPluginRef [ECUC_Rte_89010]		
Parent Container	RteExclusiveAreaImplementation		
Description	Optional reference to the configuration container of the RTE Implementation Plug-in implementing the ExclusiveArea. It's required in case RteExclusiveAreaImplMechanism is configured to RTE_PLUGIN for this ExclusiveArea.		
Multiplicity	0..1		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPlugin]		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

8.5.4 NVRam Allocation

The configuration of the NVRam access does involve several templates, because it closes the gap between the AUTOSAR software-components, the NVRAM Manager Services and the BSW Modules.

In figure 8.16 the related information from the AUTOSAR Software Component Template is shown.

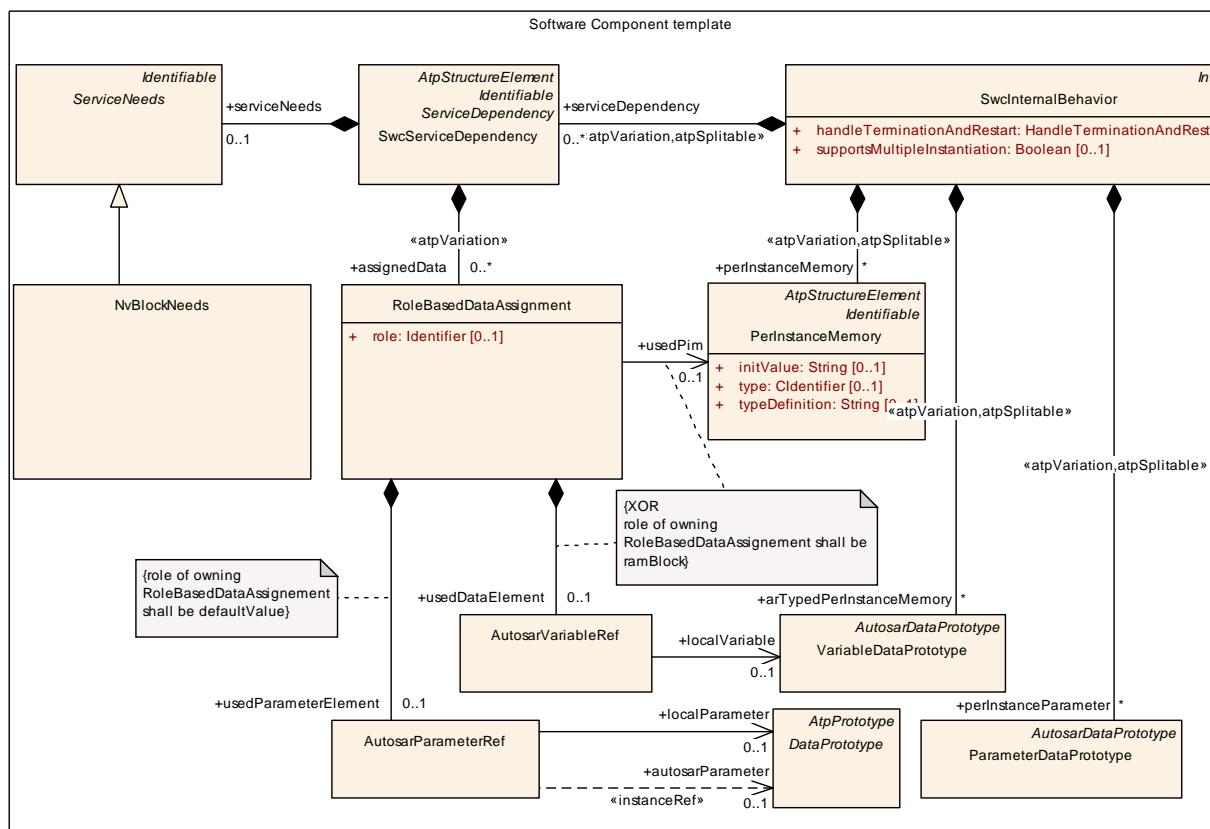


Figure 8.16: software-component information of NVRam Service needs

In figure 8.17 the ECU Configuration part of the NVRam allocation is shown. It relates the software-components' [SwcServiceDependency](#) and [NvBlockNeeds](#) information with the NVRam Managers [NvMBlockDescriptor](#) and the linker symbols of the RAM and ROM sections to be used.

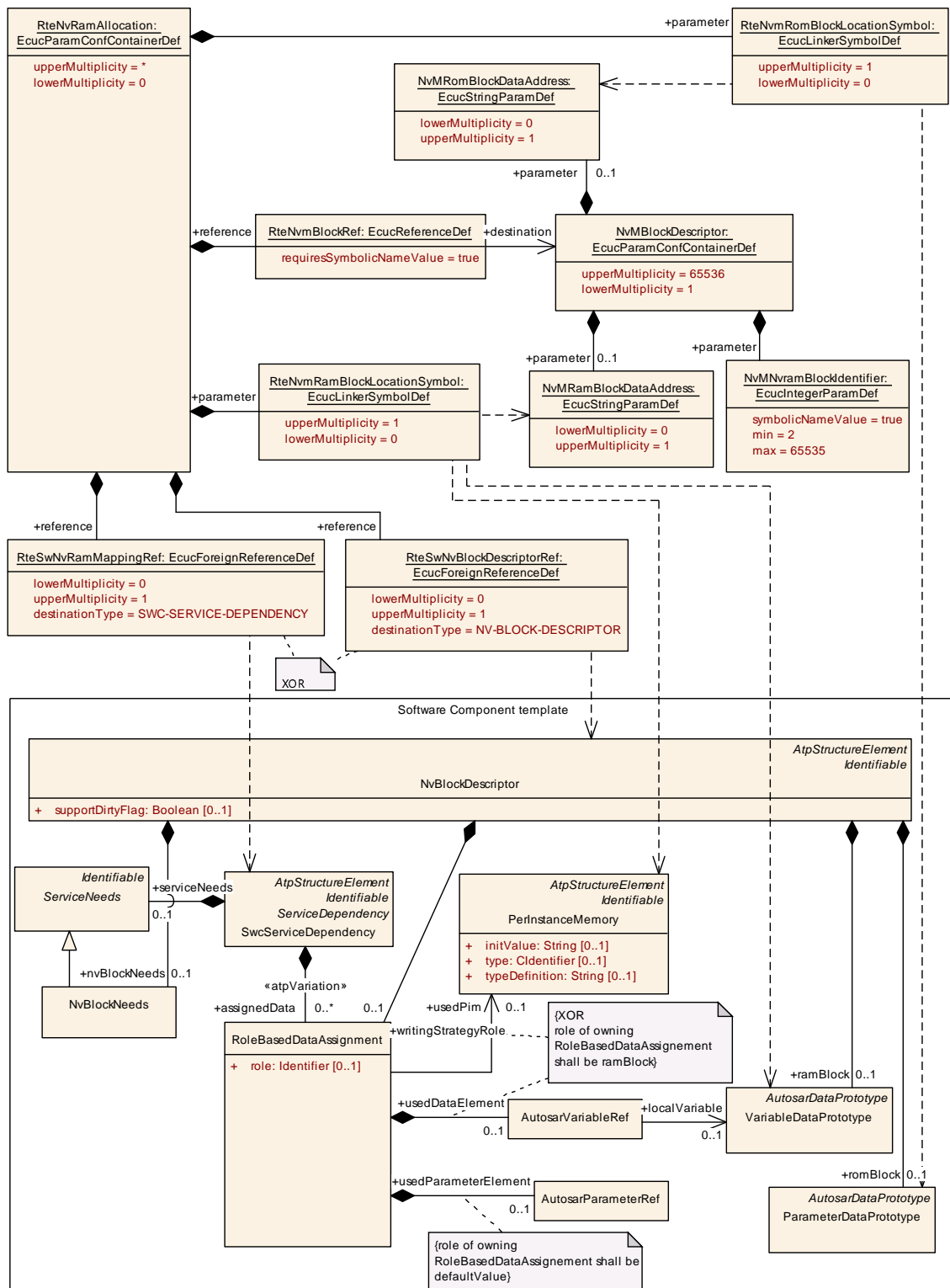


Figure 8.17: ECU Configuration of the NVRam Service

[SWS_Rte_CONSTR_09091] **RteSwNvRamMappingRef** and **RteSwNvBlockDescriptorRef** are excluding each other [If an **RteSwNvBlockDescriptorRef** is

defined there shall be no [RteSwNvRamMappingRef](#), [RteNvmRomBlockLocationSymbol](#) and [RteNvmRamBlockLocationSymbol](#) defined. If an [RteSwNvRamMappingRef](#) is defined there shall be no [RteSwNvBlockDescriptorRef](#) defined.]()

SWS Item	[ECUC_Rte_09040]
Container Name	RteNvRamAllocation
Parent Container	RteSwComponentInstance
Description	Specifies the relationship between the AtomicSwComponentType's NVRAMMapping / NVRAM needs and the NvM module configuration.
Configuration Parameters	

Name	RteNvmRamBlockLocationSymbol [ECUC_Rte_09042]		
Parent Container	RteNvRamAllocation		
Description	This is the name of the linker object name where the NVRam Block will be mirrored by the Nvm. This symbol will be resolved into the parameter "NvmRamBlockDataAddress" from the "NvmBlockDescriptor".		
Multiplicity	0..1		
Type	EcucLinkerSymbolDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteNvmRomBlockLocationSymbol [ECUC_Rte_09043]		
Parent Container	RteNvRamAllocation		
Description	This is the name of the linker object name where the NVRom Block will be accessed by the Nvm. This symbol will be resolved into the parameter "NvmRomBlockDataAddress" from the "NvmBlockDescriptor".		
Multiplicity	0..1		
Type	EcucLinkerSymbolDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteNvmBlockRef [ECUC_Rte_09041]		
Parent Container	RteNvRamAllocation		
Description	Reference to the used NvM block for storage of the NVRAMMapping information.		
Multiplicity	1		
Type	Symbolic name reference to NvMBlockDescriptor		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteSwNvBlockDescriptorRef [ECUC_Rte_09132]		
Parent Container	RteNvRamAllocation		
Description	Reference to the NvBlockDescriptor in case the RTE needs to call the NvM directly (e.g. for the supportDirtyFlag feature, storeCyclic feature, server invocation for NV data management or mode switch based invocation NvM services).		
Multiplicity	0..1		
Type	Foreign reference to NV-BLOCK-DESCRIPTOR		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteSwNvRamMappingRef [ECUC_Rte_09044]		
Parent Container	RteNvRamAllocation		
Description	Reference to the SwSeriveDependency which is used to specify the NvBlockNeeds. XOR		
Multiplicity	0..1		
Type	Foreign reference to SWC-SERVICE-DEPENDENCY		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.5.5 SWC Trigger queuing

This configuration determine the size of the queue queuing the issued triggers.

The [RteExternalTriggerConfig](#) container and [RteInternalTriggerConfig](#) container is defined in the context of the [RteSwComponentInstance](#) which already predefines the context of the [Trigger](#) / [InternalTriggeringPoint](#).

[SWS_Rte_CONSTR_09005] The references [RteSwcTriggerSourceRef](#) has to be consistent with the [RteSoftwareComponentInstanceRef](#) [The references [RteSwcTriggerSourceRef](#) has to be consistent with the [RteSoftwareComponentInstanceRef](#). This means the referenced [Trigger](#) / [InternalTriggeringPoint](#) has to belong to the [AtomicSwComponentType](#) which is referenced by the related [SwComponentPrototype](#).]()

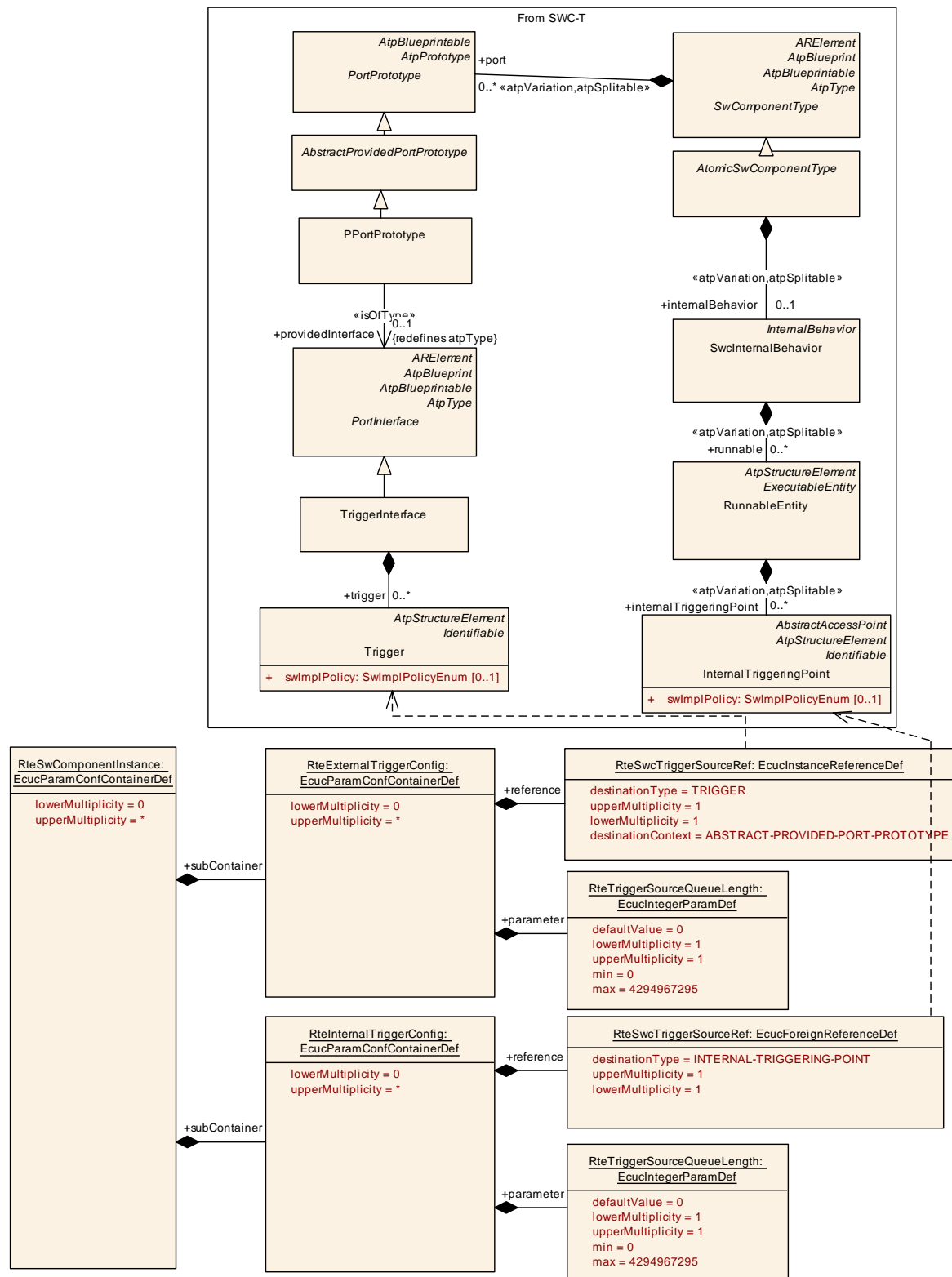


Figure 8.18: Configuration of SWC Trigger queuing

SWS Item	[ECUC_Rte_09105]
Container Name	RteExternalTriggerConfig
Parent Container	RteSwComponentInstance

Description	Defines the configuration of External Trigger Event Communication for Software Components
Configuration Parameters	

Name	RteTriggerSourceQueueLength [ECUC_Rte_09095]		
Parent Container	RteExternalTriggerConfig		
Description	<p>Length of trigger queue on the trigger source side.</p> <p>The queue is implemented by the RTE. A value greater or equal to 1 requests an queued behavior. Setting the value of RteTriggerSourceQueueLength to 0 requests an none queued implementation of the trigger communication.</p> <p>If there is no RteTriggerSourceQueueLength configured for a Trigger Emitter the default value of 0 applies as well.</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value	0		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteSwcTriggerSourceRef [ECUC_Rte_09106]		
Parent Container	RteExternalTriggerConfig		
Description	<p>Reference to a Trigger instance in the pPortPrototype of the related component instance.</p> <p>The referenced Trigger instance has to belong to the same software component instance as the RteSwcComponentInstance owning this parameter configures.</p>		
Multiplicity	1		
Type	Instance reference to TRIGGER context: ABSTRACT-PROVIDED-PORT-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

SWS Item	[ECUC_Rte_09096]
Container Name	RteInternalTriggerConfig
Parent Container	RteSwComponentInstance
Description	Defines the configuration of Inter Runnable Triggering for Software Components
Configuration Parameters	

Name	RteTriggerSourceQueueLength [ECUC_Rte_09098]		
Parent Container	RteInternalTriggerConfig		
Description	<p>Length of trigger queue on the trigger source side.</p> <p>The queue is implemented by the RTE. A value greater or equal to 1 requests an queued behavior. Setting the value of RteTriggerSourceQueueLength to 0 requests an none queued implementation of the trigger communication.</p> <p>If there is no RteTriggerSourceQueueLength configured for a Trigger Emitter the default value of 0 applies as well.</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value	0		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteSwcTriggerSourceRef [ECUC_Rte_09097]		
Parent Container	RteInternalTriggerConfig		
Description	<p>Reference to an InternalTriggeringPoint of the related component instance.</p> <p>The referenced InternalTriggeringPoint has to belong to the same software component instance as the RteSwComponentInstance owning this parameter configures.</p>		
Multiplicity	1		
Type	Foreign reference to INTERNAL-TRIGGERING-POINT		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.5.6 SWC Mode Machine Instance configuration

This configuration provides the settings for the implementation of a RTE assigned mode machine instance (see [SWS_Rte_07533]).

The `RteModeMachineInstanceConfig` container is defined in the context of the `RteSwComponentInstance` which already predefines the context of the `ModeDeclarationGroupPrototype` in the `RteSwcModeManagerRef`.

[SWS_Rte_CONSTR_09100] The reference `RteSwcModeManagerRef` has to be consistent with the `RteSoftwareComponentInstanceRef` [The reference `RteSwcModeManagerRef` has to be consistent with the `RteSoftwareComponentInstanceRef`. This means the referenced `ModeDeclarationGroupPrototype` shall be instantiated in the context of an `AbstractProvidedPortPrototype` owned by the `AtomicSwComponentType` which is referenced by the related `SwComponentPrototype`.]()

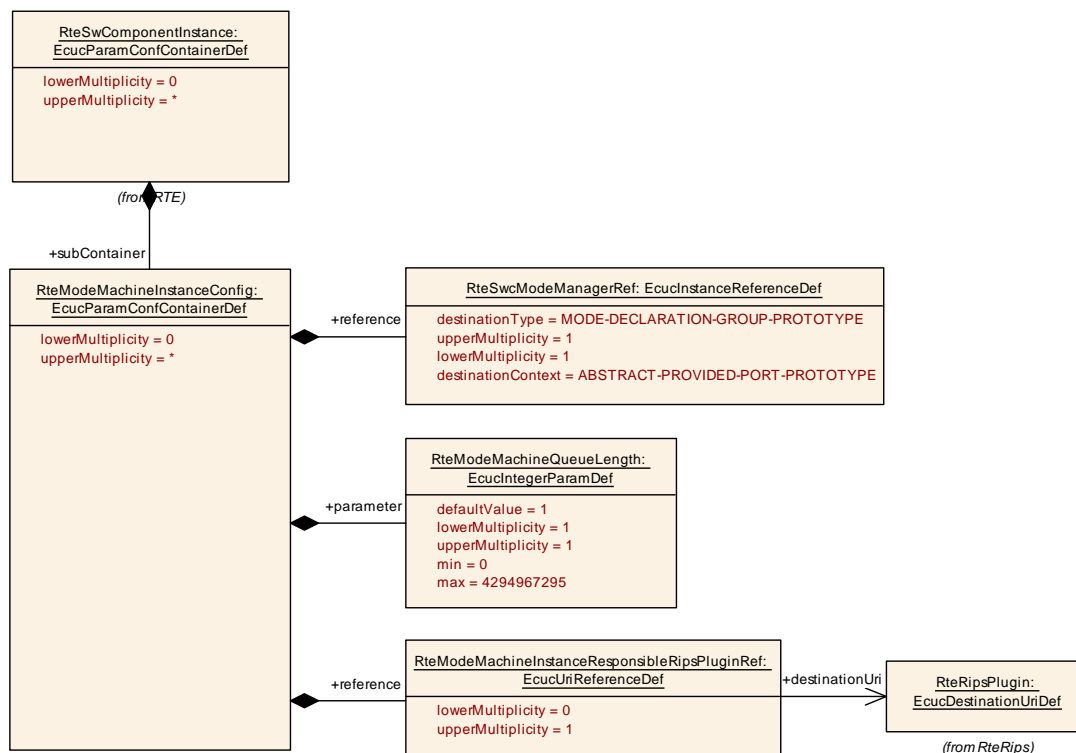


Figure 8.19: Configuration of a RTE assigned mode machine instance

SWS Item	[ECUC_Rte_09142]
Container Name	RteModeMachineInstanceConfig
Parent Container	RteSwComponentInstance
Description	Defines the configuration of RTE assigned (SWS_Rte_07533) mode machine instances.

Configuration Parameters

Name	RteModeMachineQueueLength [ECUC_Rte_09144]		
Parent Container	RteModeMachineInstanceConfig		
Description	Length of mode machine instance queue on the trigger source side. If there is no RteModeMachineQueueLength configured for a mode machine instance the value given in the ModeSwitchSenderComSpec.queueLength applies.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value	1		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteModeMachineInstanceResponsibleRipsPluginRef [ECUC_Rte_89013]		
Parent Container	RteModeMachineInstanceConfig		
Description	Optional reference to the configuration container of the RTE Implementation Plug-in implementing the protection of the mode machine instance.		
Multiplicity	0..1		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPlugin]		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	RteSwcModeManagerRef [ECUC_Rte_09143]		
Parent Container	RteModeMachineInstanceConfig		
Description	<p>Reference to a ModeDeclarationGroupPrototype instance in the provided PortPrototype (AbstractProvidedPortPrototype) of the related component instance.</p> <p>The referenced ModeDeclarationGroupPrototype instance has to belong to the same software component instance as the RteSwComponentInstance owning this parameter configures.</p>		
Multiplicity	1		
Type	Instance reference to MODE-DECLARATION-GROUP-PROTOTYPE context: ABSTRACT-PROVIDED-PORT-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.6 Handling of Software Component types

8.6.1 Selection of Software-Component Implementation

During the system development there is no need to select the actual implementation which will be later integrated on one ECU. Therefore the *ECU Extract of System Description* may not specify the `SwcImplementation` information yet.

For RTE Generation the information about the to be used `SwcImplementation` for each `SwComponentType` needs be provided to the RTE Generator (regardless whether the information is from the Ecu Extract or the Ecu Configuration).

The mapping of `SwcImplementation` to `SwComponentType` is done in the Ecu Configuration of the Rte using the two references `RteComponentTypeRef` and `RteImplementationRef` (see figure 8.20). For the mapping in the Ecu Extract please refer to the Specification of the System Template [8].

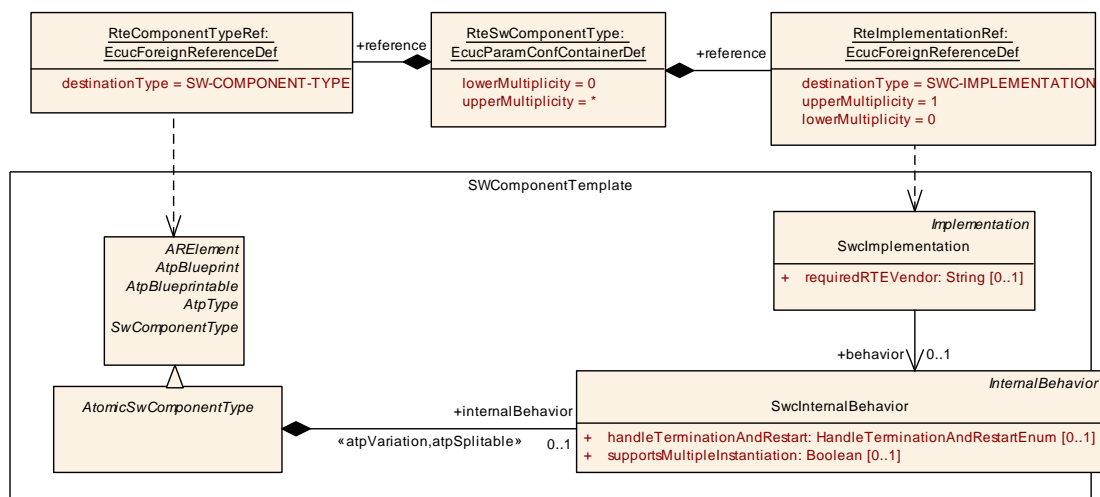


Figure 8.20: Selection of the Implementation for an AtomicSwComponentType

SWS Item	[ECUC_Rte_09006]
Container Name	RteSwComponentType
Parent Container	Rte
Description	Representation of one SwComponentType for the base of all configuration parameter which are affecting the whole type and not a specific instance.
Configuration Parameters	

Name	RteBypassSupportEnabled [ECUC_Rte_09114]
Parent Container	RteSwComponentType
Description	Individual switch to enable the bypass support for this software component type.
Multiplicity	0..1
Type	EcucBooleanParamDef
Default Value	false

Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteComponentTypeRef [ECUC_Rte_09003]		
Parent Container	RteSwComponentType		
Description	Reference to either AtomicSwComponentType or ParameterSwComponentType.		
Multiplicity	1		
Type	Foreign reference to SW-COMPONENT-TYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteImplementationRef [ECUC_Rte_09028]		
Parent Container	RteSwComponentType		
Description	The Implementation which shall be assigned to the SwComponentType.		
Multiplicity	0..1		
Type	Foreign reference to SWC-IMPLEMENTATION		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteComponentTypeCalibration	0..1	Specifies for each ParameterSwComponentType or AtomicSwComponentType whether calibration is enabled. If references to SwAddrMethodRef are provided in RteCalibrationSwAddrMethodRef only ParameterDataPrototypes with the referenced SwAddrMethod shall have software calibration support enabled.

8.6.2 Component Type Calibration

In the AUTOSAR Software Component Template two places may provide calibration data: the [ParameterSwComponentType](#) and the [AtomicSwComponentType](#) (or more precisely the subclasses of [AtomicSwComponentType](#)). Whether the calibration is enabled for a specific [SwComponentType](#) can be configured as shown in figure 8.21.

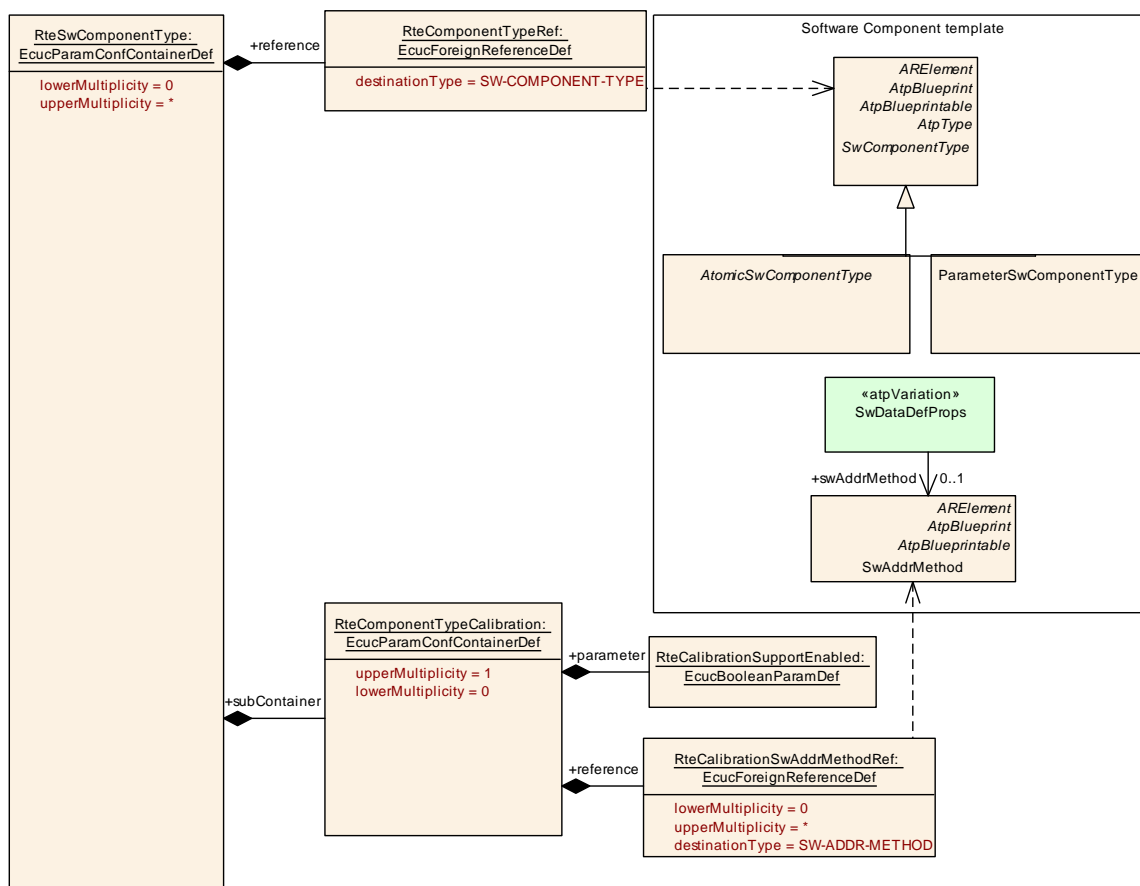


Figure 8.21: Configuration of the calibration for the [ParameterSwComponentType](#)

The foreign reference [RteComponentTypeRef](#) identifies the [SwComponentType](#) (which is limited to [ParameterSwComponentType](#) and [AtomicSwComponentType](#)).

The boolean parameter `RteCalibrationSupportEnabled` specifies whether calibration shall be enabled for the specified `SwComponentType`.

[SWS_Rte_05145] [For a `ParameterDataPrototype` of the referenced `SwComponentType` software calibration support shall be enabled if the parameter `RteCalibrationSupportEnabled` is set to `true` and in the corresponding container `RteComponentTypeCalibration`

- not a single `RteCalibrationSwAddrMethodRef` exists or
- a reference `RteCalibrationSwAddrMethodRef` to the `SwAddrMethod` of the `ParameterDataPrototype` exists.

]([SRS_Rte_00154](#), [SRS_Rte_00156](#), [SRS_Rte_00158](#))

SWS Item	[ECUC_Rte_09039]
Container Name	RteComponentTypeCalibration
Parent Container	RteSwComponentType
Description	Specifies for each <code>ParameterSwComponentType</code> or <code>AtomicSwComponentType</code> whether calibration is enabled. If references to <code>SwAddrMethod</code> are provided in <code>RteCalibrationSwAddrMethodRef</code> only <code>ParameterDataPrototypes</code> with the referenced <code>SwAddrMethod</code> shall have software calibration support enabled.
Configuration Parameters	

Name	RteCalibrationSupportEnabled [ECUC_Rte_09037]		
Parent Container	RteComponentTypeCalibration		
Description	Enables calibration support for the specified <code>ParameterSwComponentType</code> or <code>AtomicSwComponentType</code> .		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteCalibrationSwAddrMethodRef [ECUC_Rte_09038]		
Parent Container	RteComponentTypeCalibration		
Description	Reference to the <code>SwAddrMethod</code> for which software calibration support shall be enabled.		
Multiplicity	0..*		
Type	Foreign reference to SW-ADDR-METHOD		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.7 Implicit communication configuration

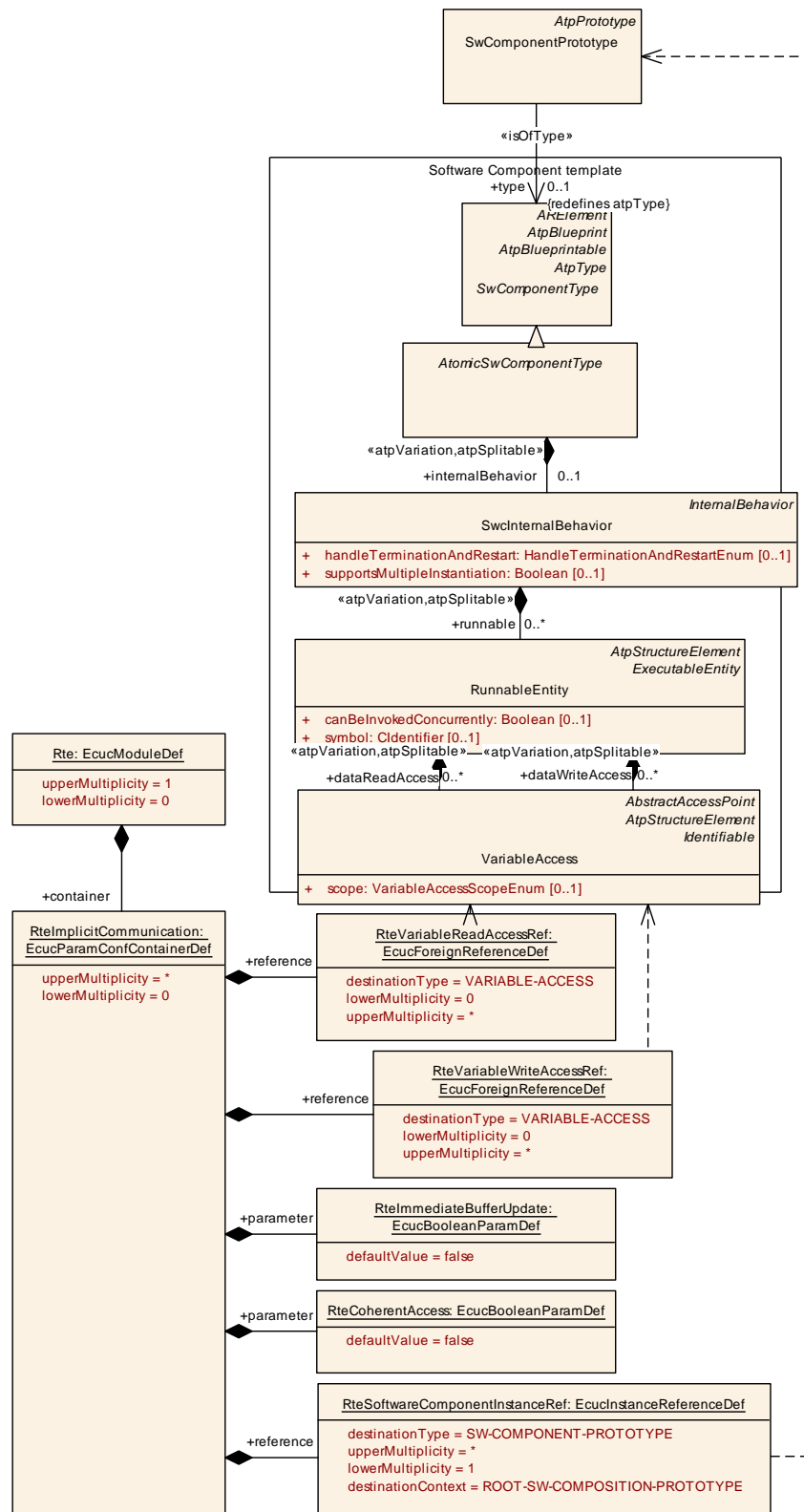


Figure 8.22: Configuration of the implicit communication

SWS Item	[ECUC_Rte_09034]
Container Name	RteImplicitCommunication
Parent Container	Rte
Description	Configuration of the Implicit Communication behavior to be generated.
Configuration Parameters	

Name	RteCoherentAccess [ECUC_Rte_09091]		
Parent Container	RteImplicitCommunication		
Description	<p>If set to true the referenced VariableAccess'es of this RteImplicitCommunication container are in one CoherencyGroup.</p> <p>Data values for Coherent Implicit Read Access'es are read before the first reading RunnableEntity starts and are stable during the execution of all the reading RunnableEntitys; except Coherent Implicit Write Access'es belongs to the same Coherency Group. Data values written by Coherent Implicit Write Access'es are available for readers not belonging to the Coherency Group after the last writing RunnableEntity has terminated.</p> <p>Please note that a Coherent Implicit Data Access can be defined for VariableAccess'es to same and different data element. Nevertheless all Coherent Implicit Data Access'es of one Coherency Group have to be executed in the same task.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteImmediateBufferUpdate [ECUC_Rte_09033]		
Parent Container	RteImplicitCommunication		
Description	<p>If set to true the RTE will perform preemption area specific buffer update immediately before (for VariableAccess in the role dataReadAccess) resp. after (for VariableAccess in the role dataWriteAccess) Runnable execution.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteSoftwareComponentInstanceRef [ECUC_Rte_09090]		
Parent Container	RteImplicitCommunication		
Description	Reference to a SwComponentPrototype. This denotes the instances of the VariableAccess belonging to the RteImplicitCommunication.		
Multiplicity	1..*		
Type	Instance reference to SW-COMPONENT-PROTOTYPE context: ROO T-SW-COMPOSITION-PROTOTYPE		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteVariableReadAccessRef [ECUC_Rte_09035]		
Parent Container	RteImplicitCommunication		
Description	Reference to the VariableAccess in the dataReadAccess role.		
Multiplicity	0..*		
Type	Foreign reference to VARIABLE-ACCESS		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteVariableWriteAccessRef [ECUC_Rte_09036]		
Parent Container	RteImplicitCommunication		
Description	Reference to the VariableAccess in the dataWriteAccess role.		
Multiplicity	0..*		
Type	Foreign reference to VARIABLE-ACCESS		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

Please note, that `RteImplicitCommunication` is defined as a container of `RteEcucModuleDef` to support the creation of the ECU Configuration Parameter Values related to `RteImplicitCommunication` independent from the other ECU Configuration Parameter Values. Typically the need for `coherent implicit data accesses` is known by the vendor of a set of software components. As long as `short-Names` of the `RootSwCompositionPrototype` and the referenced `CompositionSwComponentType` - describing the software of a flat ECU Extract - are known the ECU Configuration Parameter Values related to `RteImplicitCommunication` can be prescribed. In this case it is preferable to use relative references to the Vendor Specific Module Definition (VSMD), to `RootSwCompositionPrototype` and `CompositionSwComponentType` describing the software of a flat ECU Extract. With this relative references the ECU Configuration Parameter Values are independent from `ARPackage` structure only known by the ECU integrator. Nevertheless the `short-Name` and location of of the `EcucModuleConfigurationValues` must be defined upfront.

8.8 Exclusive access optimization

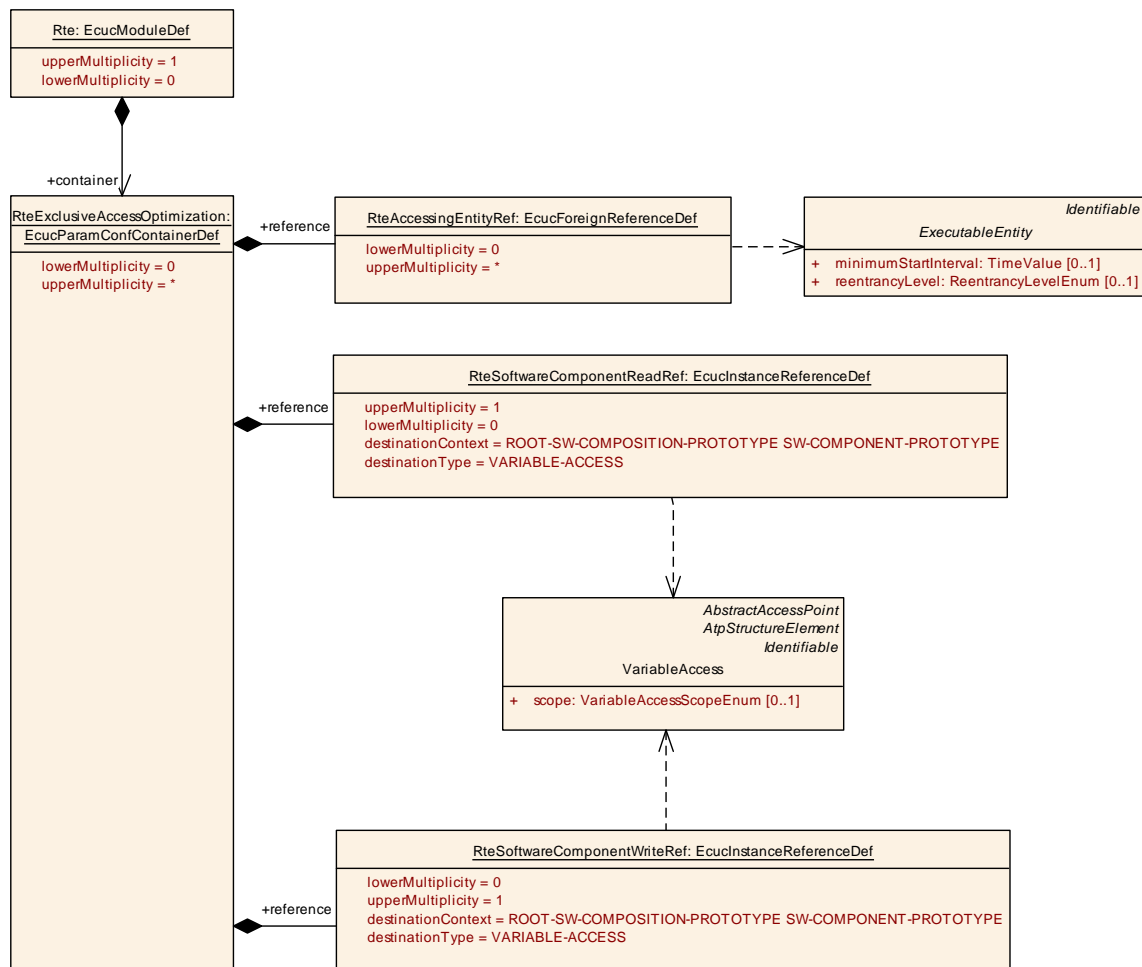


Figure 8.23: Configuration of exclusive access optimization

SWS Item	[ECUC_Rte_09165]
Container Name	RteExclusiveAccessOptimization
Parent Container	Rte
Description	Configuration of the optimized access behavior to be generated. In other words, access shall be mutually exclusive. How this is realized e.g. non preemptive task mapping, exclusive areas, mode management, exclusive access during ECU startup and shutdown or scheduling in exclusive time slots is up to the ECU integrator.
Configuration Parameters	

Name	RteAccessingEntityRef [ECUC_Rte_09166]
Parent Container	RteExclusiveAccessOptimization
Description	Reference to executable entities (e.g. NvM main function) that access the CommunicationGraph with non-modeled standardized interfaces.
Multiplicity	0..*
Type	Foreign reference to
Scope / Dependency	

Name	RteSoftwareComponentReadRef [ECUC_Rte_09167]
Parent Container	RteExclusiveAccessOptimization
Description	Reference to the read variableAccess role.
Multiplicity	0..1
Type	Instance reference to VARIABLE-ACCESS context: ROOT-SW-COMP OSITION-PROTOTYPE SW-COMPONENT-PROTOTYPE
Scope / Dependency	

Name	RteSoftwareComponentWriteRef [ECUC_Rte_09168]
Parent Container	RteExclusiveAccessOptimization
Description	Reference to the VariableAccess in the dataSendPoint role of the writing software-component.
Multiplicity	0..1
Type	Instance reference to VARIABLE-ACCESS context: ROOT-SW-COMP OSITION-PROTOTYPE SW-COMPONENT-PROTOTYPE
Scope / Dependency	

No Included Containers

8.9 Communication infrastructure

The configuration of the communication infrastructure (interaction of the RTE with the Com-Stack) is entirely predetermined by the ECU Extract provided as an input. The required input can be found in the AUTOSAR System Template [8] sections "Data Mapping" and "Communication".

In case the RTE does utilize the Com module for intra-ECU communication it is up to the vendor-specific configuration of the RTE to ensure configuration consistency.

8.10 Configuration of the BSW Scheduler

The configuration of the BSW Scheduler part of the RTE is shown in the overview in figure 8.24.

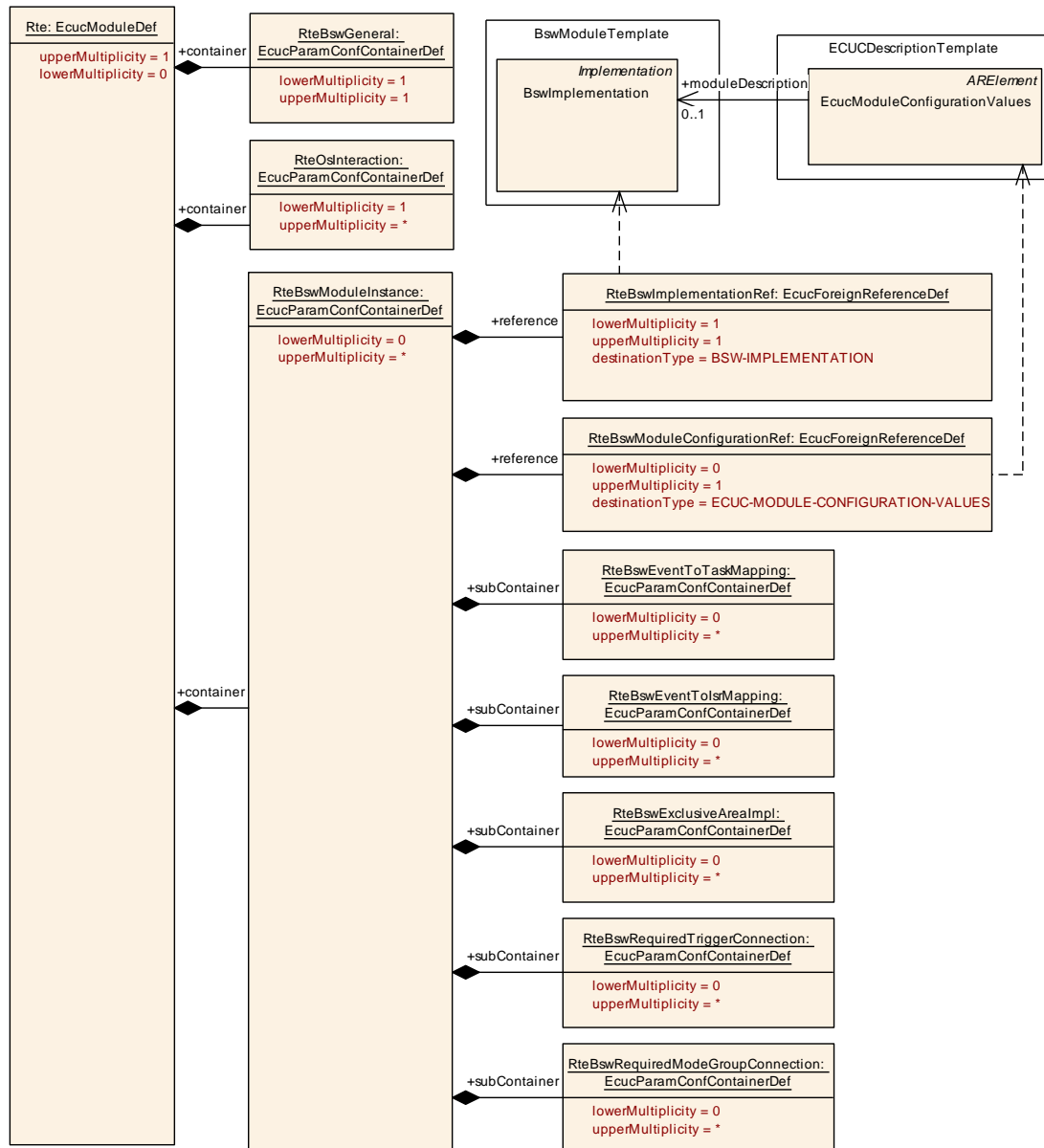


Figure 8.24: Configuration of BSW Scheduler overview

8.10.1 BSW Scheduler General configuration

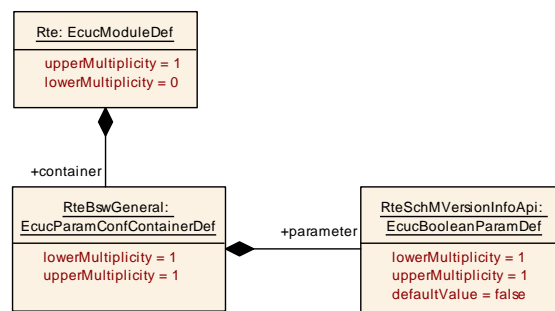


Figure 8.25: General configuration of BSW Scheduler

SWS Item	[ECUC_Rte_09061]
Container Name	RteBswGeneral
Parent Container	Rte
Description	General configuration parameters of the Bsw Scheduler section.
Configuration Parameters	

Name	RteSchMVersionInfoApi [ECUC_Rte_09062]		
Parent Container	RteBswGeneral		
Description	Enables the generation of the SchM_GetVersionInfo() API.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.10.2 BSW Module Instance configuration

SWS Item	[ECUC_Rte_09002]
Container Name	RteBswModuleInstance
Parent Container	Rte
Description	Represents one instance of a Bsw-Module configured on one ECU.
Configuration Parameters	

Name	RteBswImplementationRef [ECUC_Rte_09066]		
Parent Container	RteBswModuleInstance		
Description	Reference to the BswImplementation for which the Rte /SchM is configured.		
Multiplicity	1		
Type	Foreign reference to BSW-IMPLEMENTATION		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswModuleConfigurationRef [ECUC_Rte_09001]		
Parent Container	RteBswModuleInstance		
Description	Reference to the ECU Configuration Values provided for this BswImplementation.		
Multiplicity	0..1		
Type	Foreign reference to ECUC-MODULE-CONFIGURATION-VALUES		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteBswEventToIsr Mapping	0..*	Maps a BswModuleEntity onto an OsIsr based on the activating BswExternalTriggerOccurredEvent.
RteBswEventToTask Mapping	0..*	Maps a BswModuleEntity onto an OsTask based on the activating BswEvent. A BswModuleEntity can be activated by more than one BswEvent and thus be mapped to more than one OsTask. In the case of a BswSchedulableEntity executed via a direct or trusted function call this RteBswEventToTaskMapping is still specified but no RteBswMappedToTaskRef element is included. The RteBswPositionInTask parameter is necessary to provide an ordering of events invoked by the same RTE API.
RteBswExclusiveArea Impl	0..*	Represents one ExclusiveArea of one BswImplementation. Used to specify the implementation means of this ExclusiveArea.
RteBswExternalTrigger Config	0..*	Defines the configuration of Inter Basic Software Module Entity Triggering
RteBswInternalTrigger Config	0..*	Defines the configuration of internal Basic Software Module Entity Triggering
RteBswModeMachine InstanceConfig	0..*	Defines the configuration of Basic Software Scheduler assigned (SWS_Rte_07534) mode machine instances.
RteBswRequiredClient ServerConnection	0..*	Defines the connection between one requiredClientServerEntry and one providedClientServerEntry of a BswModuleDescription. This container shall be provided on the client side of the connection.
RteBswRequiredMode GroupConnection	0..*	Defines the connection between one requiredModeGroup of this BSW Module instance and one providedModeGroup instance.

RteBswRequiredSenderReceiverConnection	0..*	Defines the connection between one requiredData and one providedData of a BswModuleDescription. This container shall be provided on the receiver side of the connection.
RteBswRequiredTriggerConnection	0..*	Defines the connection between one requiredTrigger of this BSW Module instance and one releasedTrigger instance.

8.10.2.1 BSW ExclusiveArea configuration

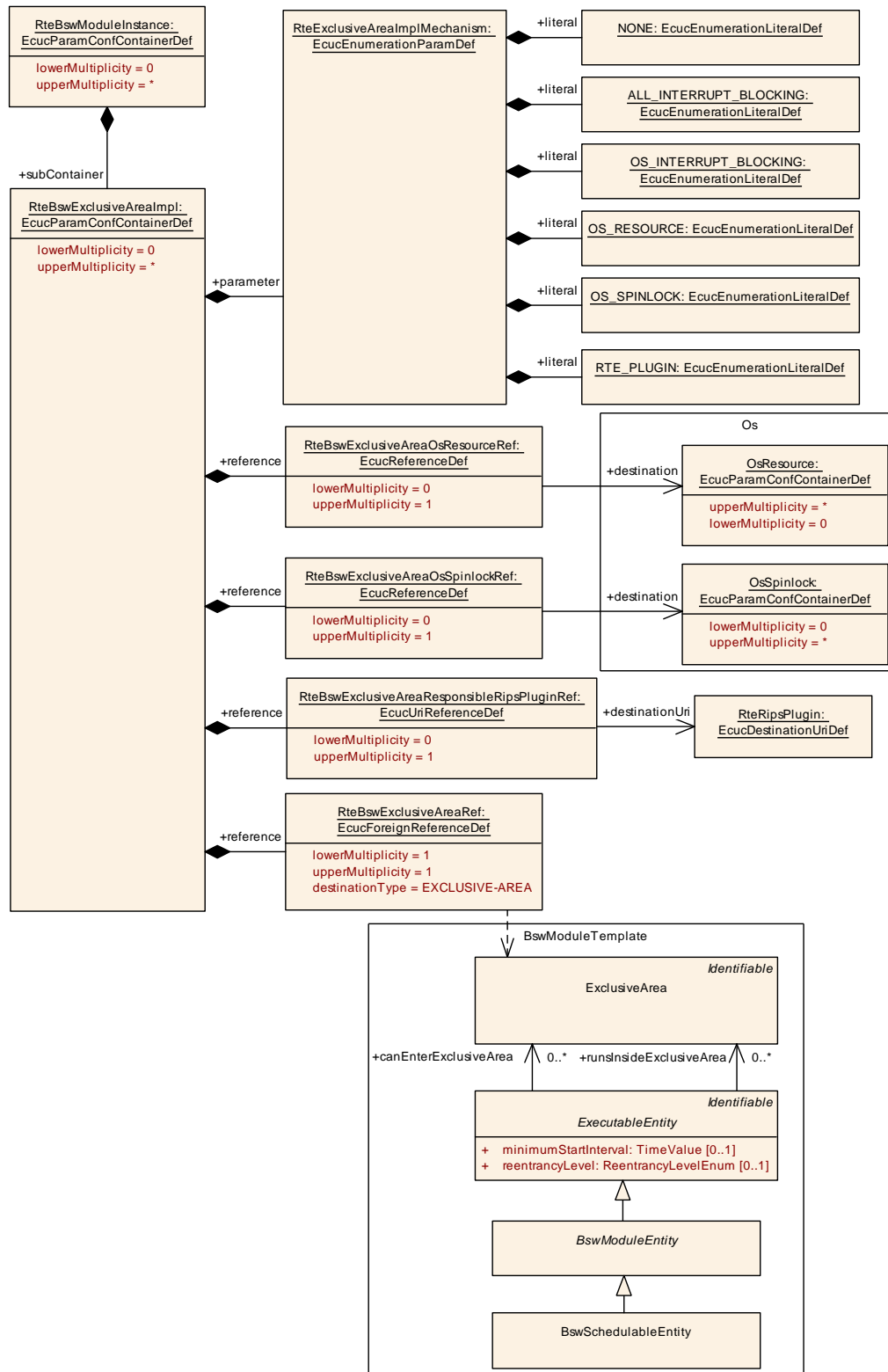


Figure 8.26: Configuration of BSW ExclusiveArea

Container Name	RteBswExclusiveAreaImpl
Parent Container	RteBswModuleInstance
Description	Represents one ExclusiveArea of one BswImplementation. Used to specify the implementation means of this ExclusiveArea.
Configuration Parameters	

Name	RteExclusiveAreaImplMechanism [ECUC_Rte_09029]		
Parent Container	RteBswExclusiveAreaImpl		
Description	To be used implementation mechanism for the specified ExclusiveArea.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	ALL_INTERRUPT_BLOCKING		
	NONE		
	OS_INTERRUPT_BLOCKING		
	OS_RESOURCE		
	OS_SPINLOCK		
	RTE_PLUGIN		RTE Implementation Plug-in
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswExclusiveAreaOsResourceRef [ECUC_Rte_09073]		
Parent Container	RteBswExclusiveAreaImpl		
Description	Optional reference to an OsResource in case RteExclusiveAreaImplMechanism is configured to OS_RESOURCE for this ExclusiveArea.		
Multiplicity	0..1		
Type	Reference to OsResource		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswExclusiveAreaOsSpinlockRef [ECUC_Rte_09112]		
Parent Container	RteBswExclusiveAreaImpl		
Description	Optional reference to an OsSpinlock in case RteExclusiveAreaImplMechanism is configured to OS_SPINLOCK for this ExclusiveArea.		
Multiplicity	0..1		
Type	Reference to OsSpinlock		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswExclusiveAreaRef [ECUC_Rte_09074]		
Parent Container	RteBswExclusiveAreaImpl		
Description	Reference to the ExclusiveArea for which the implementation mechanism shall be specified.		
Multiplicity	1		
Type	Foreign reference to EXCLUSIVE-AREA		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswExclusiveAreaResponsibleRipsPluginRef [ECUC_Rte_89011]		
Parent Container	RteBswExclusiveAreaImpl		
Description	Optional reference to the configuration container of the RTE Implementation Plug-in implementing the ExclusiveArea. It's required in case RteExclusiveAreaImplMechanism is configured to RTE_PLUGIN for this ExclusiveArea.		
Multiplicity	0..1		
Type	Reference to destinationUri [RteRipsUriDefSet / RteRipsPlugin]		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency			
No Included Containers			

8.10.2.2 BswEvent to task mapping

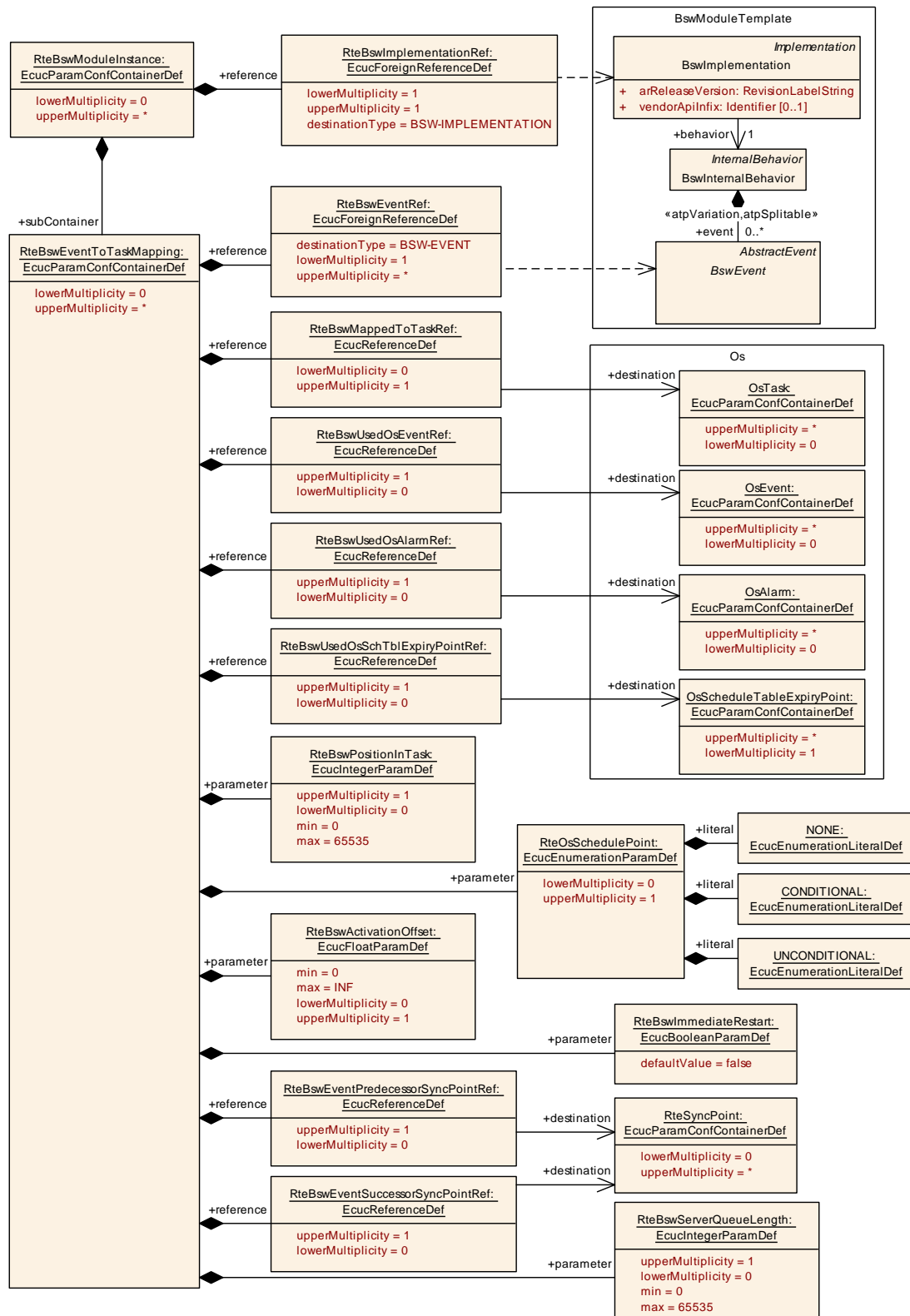


Figure 8.27: Configuration of BSW Event to Task Mapping

SWS Item	[ECUC_Rte_09065]
Container Name	RteBswEventToTaskMapping
Parent Container	RteBswModuleInstance
Description	Maps a BswModuleEntity onto an OsTask based on the activating BswEvent. A BswModuleEntity can be activated by more than one BswEvent and thus be mapped to more than one OsTask. In the case of a BswSchedulableEntity executed via a direct or trusted function call this RteBswEventToTaskMapping is still specified but no RteBswMappedToTaskRef element is included. The RteBswPositionInTask parameter is necessary to provide an ordering of events invoked by the same RTE API.
Configuration Parameters	

Name	RteBswActivationOffset [ECUC_Rte_09063]		
Parent Container	RteBswEventToTaskMapping		
Description	Activation offset in seconds.		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. INF]		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswImmediateRestart [ECUC_Rte_09093]		
Parent Container	RteBswEventToTaskMapping		
Description	<p>When RteBswImmediateRestart is set to true the BswSchedulableEntity shall be immediately re-started after termination if it was activated by this BswEvent while it was already started.</p> <p>This parameter shall not be set to true when the mapped BswEvent refers to a BswSchedulableEntity which minimumStartInterval attribute is > 0.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswPositionInTask [ECUC_Rte_09068]		
Parent Container	RteBswEventToTaskMapping		
Description	Each BswSchedulableEntity activation mapped to an OsTask has a specific position within the task execution. For periodic activation this is the order of execution. For event driver activation this is the order of evaluation which actual BswSchedulableEntity has to be executed. In case of direct or trusted function calls this parameter is necessary to provide an ordering of events when several ExecutableEntities are invoked by the same RTE API.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswServerQueueLength [ECUC_Rte_09134]		
Parent Container	RteBswEventToTaskMapping		
Description	Specifies the length of the queue for the server call serialization.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteOsSchedulePoint [ECUC_Rte_09022]		
Parent Container	RteBswEventToTaskMapping		
Description	<p>Introduce a schedule point by explicitly calling Os Schedule service after the execution of the ExecutableEntity. The Rte generator is allowed to optimize several consecutive calls to Os schedule into one single call if the ExecutableEntity executions in between have been skipped.</p> <p>The absence of this parameter is interpreted as "NONE".</p> <p>It shall be considered an invalid configuration if the task is preemptable and the value of this parameter is not set to "NONE" or the parameter is absent.</p>		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	CONDITIONAL	A Schedule Point shall be introduced at the end of the execution of this ExecutableEntity. The Schedule Point can be skipped if several Schedule Points would be called without any ExecutableEntity execution in between.	
	NONE	No Schedule Point shall be introduced at the end of the execution of this ExecutableEntity.	
	UNCONDITIONAL	A Schedule Point shall always be introduced at the end of the execution of this ExecutableEntity.	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	RteBswEventPredecessorSyncPointRef [ECUC_Rte_09130]		
Parent Container	RteBswEventToTaskMapping		
Description	<p>The RteBswEventPredecessorSyncPointRef is necessary to provide a cross core synchronization in case of BswEvents triggered by the same event source but mapped to tasks belonging to different partitions on different cores.</p> <p>The synchronization point must be reached by all referencing BswEvents before the execution in all related tasks is continued.</p> <p>In case of RteBswEventPredecessorSyncPointRef the BswModuleEntity activated by the mapped BswEvent is executed after the synchronization point is passed.</p>		
Multiplicity	0..1		
Type	Reference to RteSyncPoint		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswEventRef [ECUC_Rte_09064]		
Parent Container	RteBswEventToTaskMapping		
Description	Reference to the BswEvent.		
Multiplicity	1..*		
Type	Foreign reference to BSW-EVENT		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswEventSuccessorSyncPointRef [ECUC_Rte_09131]		
Parent Container	RteBswEventToTaskMapping		
Description	<p>The RteBswEventSuccessorSyncPointRef is necessary to provide a cross core synchronization in case of BswEvents triggered by the same event source but mapped to tasks belonging to different partitions on different cores.</p> <p>The synchronization point must be reached by all referencing BswEvents before the execution in all related tasks is continued.</p> <p>In case of RteBswEventSuccessorSyncPointRef the BswModuleEntity activated by the mapped BswEvent is executed before the synchronization point is entered.</p>		
Multiplicity	0..1		
Type	Reference to RteSyncPoint		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswMappedToTaskRef [ECUC_Rte_09067]		
Parent Container	RteBswEventToTaskMapping		
Description	Reference to the OsTask the BswSchedulableEntity activated by the RteBswEventRef is mapped to. If no reference to the OsTask is specified the BswSchedulableEntity activated by this BswEvent is executed in the context of the caller.		
Multiplicity	0..1		
Type	Reference to OsTask		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswUsedOsAlarmRef [ECUC_Rte_09069]		
Parent Container	RteBswEventToTaskMapping		
Description	If an OsAlarm is used to activate the OsTask this BswEvent is mapped to it shall be referenced here.		
Multiplicity	0..1		
Type	Reference to OsAlarm		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswUsedOsEventRef [ECUC_Rte_09070]		
Parent Container	RteBswEventToTaskMapping		
Description	If an OsEvent is used to activate the OsTask this BswEvent is mapped to it shall be referenced here.		
Multiplicity	0..1		
Type	Reference to OsEvent		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswUsedOsSchTblExpiryPointRef [ECUC_Rte_09071]		
Parent Container	RteBswEventToTaskMapping		
Description	If an OsScheduleTableExpiryPoint is used to activate the OsTask this BswEvent is mapped to it shall be referenced here.		
Multiplicity	0..1		
Type	Reference to OsScheduleTableExpiryPoint		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsFillRoutineRef [ECUC_Rte_89005]		
Parent Container	RteBswEventToTaskMapping		
Description	Reference to a Buffer-Fill Routine implemented by an RTE Implementation Plug-In. This routine gets invoked directly before the ExecutableEntity is started. Attributes: requiresIndex=true		
Multiplicity	0..*		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPluginFillFlush Routine]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsFlushRoutineRef [ECUC_Rte_89006]		
Parent Container	RteBswEventToTaskMapping		
Description	Reference to a Buffer-Flush Routine implemented by an RTE Implementation Plug-In. This routine gets invoked directly after the ExecutableEntity has terminated. Attributes: requiresIndex=true		
Multiplicity	0..*		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPluginFillFlush Routine]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.10.2.3 BSW Trigger configuration

8.10.2.3.1 BSW Trigger connection

The `RteBswRequiredTriggerConnection` container is defined in the context of the `RteBswModuleInstance` which is the required trigger context. So the reference to the `RteBswRequiredTriggerRef` is sufficient to define the required trigger. For the released trigger the tuple of `RteBswReleasedTriggerModInstRef` and `RteBswReleasedTriggerRef` is specified.

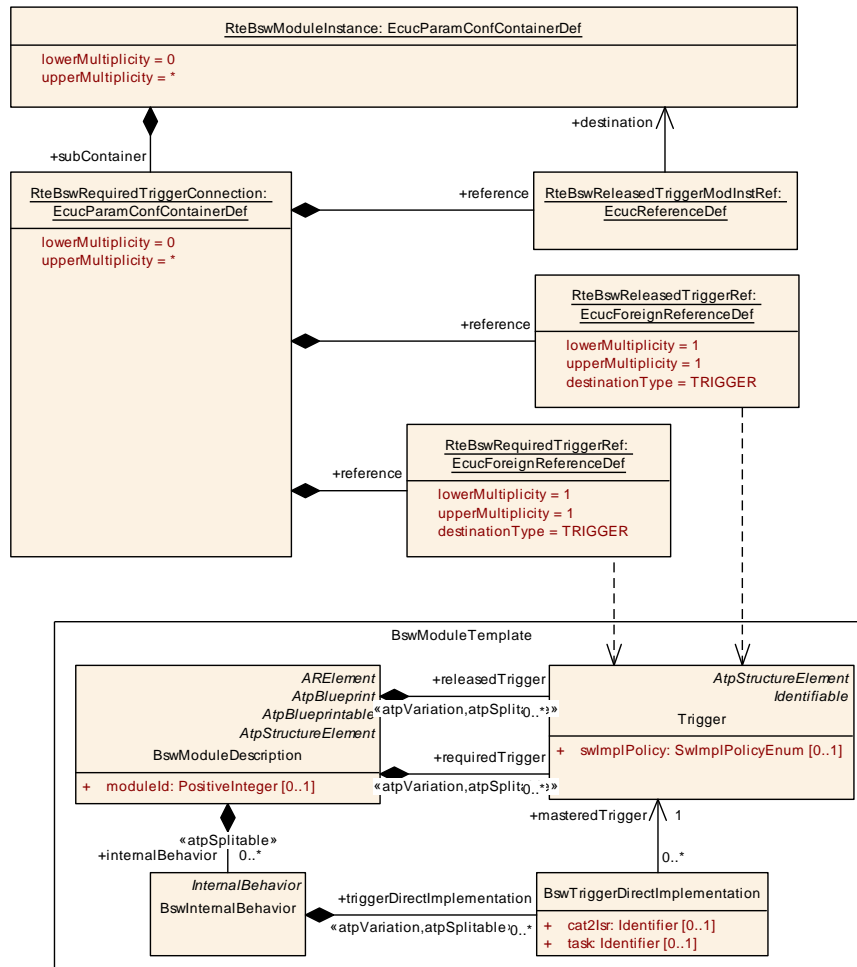


Figure 8.28: Configuration of BSW Trigger connection

SWS Item	[ECUC_Rte_09077]
Container Name	RteBswRequiredTriggerConnection
Parent Container	RteBswModuleInstance
Description	Defines the connection between one requiredTrigger of this BSW Module instance and one releasedTrigger instance.
Configuration Parameters	

Name	RteBswReleasedTriggerModInstRef [ECUC_Rte_09075]
Parent Container	RteBswRequiredTriggerConnection
Description	Reference to the RteBswModuleInstance configuration container which identifies the instance of the BSW Module. Used with the RteBswReleasedTriggerRef to unambiguously identify the Trigger instance.
Multiplicity	1
Type	Reference to RteBswModuleInstance
Post-Build Variant Value	false

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswReleasedTriggerRef [ECUC_Rte_09076]		
Parent Container	RteBswRequiredTriggerConnection		
Description	References the releasedTrigger to which this requiredTrigger shall be connected.		
Multiplicity	1		
Type	Foreign reference to TRIGGER		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswRequiredTriggerRef [ECUC_Rte_09078]		
Parent Container	RteBswRequiredTriggerConnection		
Description	References one requiredTrigger which shall be connected to the releasedTrigger.		
Multiplicity	1		
Type	Foreign reference to TRIGGER		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.10.2.3.2 BSW Trigger queuing

This configuration determine the size of the queue queuing the issued triggers.

The [RteBswExternalTriggerConfig](#) container and [RteBswInternalTriggerConfig](#) container is defined in the context of the [RteBswModuleInstance](#) which already predefines the context of the provided [Trigger](#) / [BswInternalTriggeringPoint](#).

[SWS_Rte CONSTR_09006] The references **RteBswTriggerSourceRef** has to be consistent with the **RteBswImplementationRef** [The references **RteBswTriggerSourceRef** has to be consistent with the **RteBswImplementationRef**. This means the referenced **Trigger** / **BswInternalTriggeringPoint** has to belong to the **BswModuleDescription** which is referenced by the related **BswImplementation**.]()

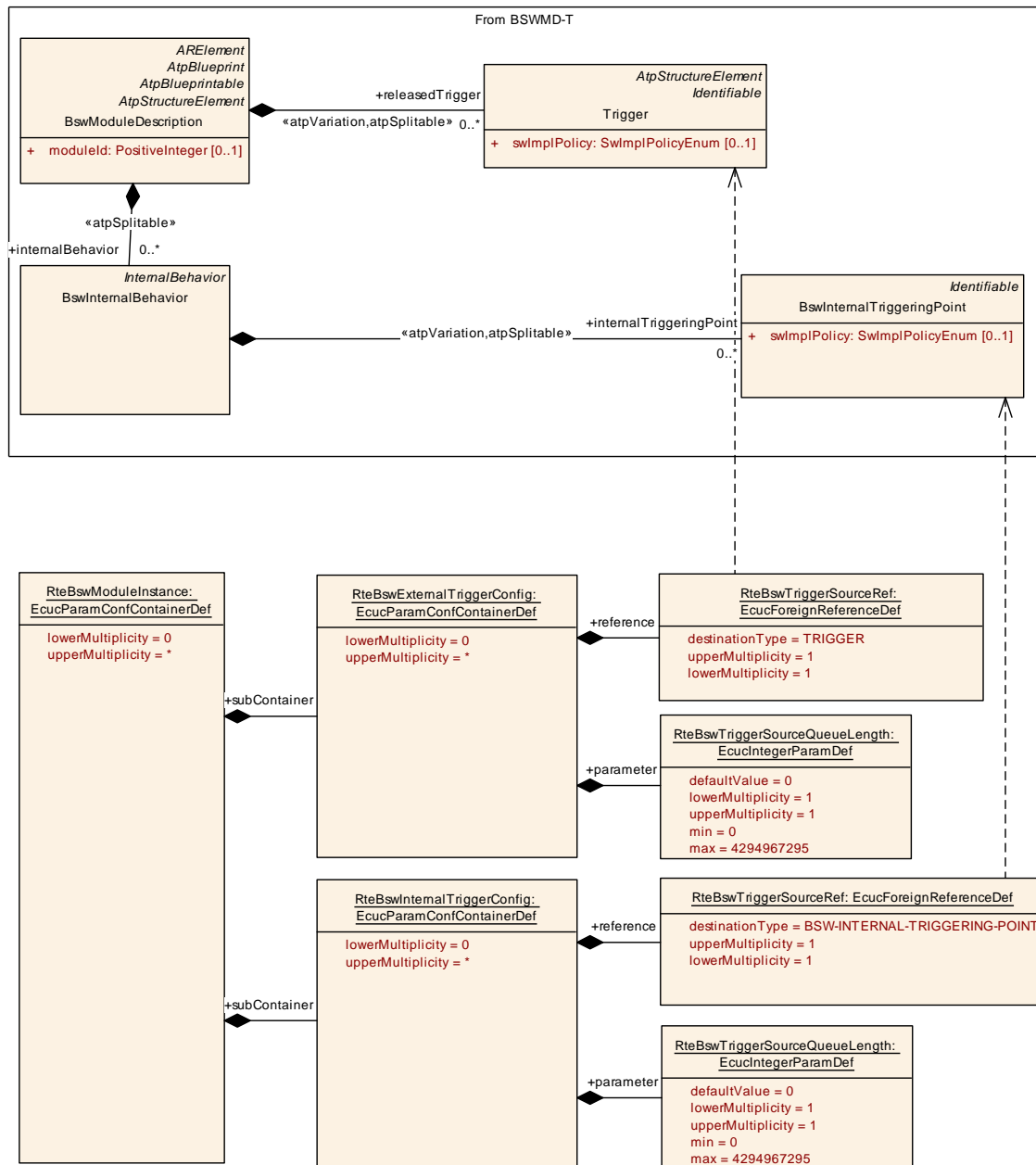


Figure 8.29: Configuration of BSW Trigger queuing

SWS Item	[ECUC_Rte_09099]
Container Name	RteBswExternalTriggerConfig
Parent Container	RteBswModuleInstance
Description	Defines the configuration of Inter Basic Software Module Entity Triggering

Configuration Parameters

Name	RteBswTriggerSourceQueueLength [ECUC_Rte_09101]		
Parent Container	RteBswExternalTriggerConfig		
Description	<p>Length of trigger queue on the trigger source side.</p> <p>The queue is implemented by the RTE. A value greater or equal to 1 requests an queued behavior. Setting the value of RteTriggerSourceQueueLength to 0 requests an none queued implementation of the trigger communication.</p> <p>If there is no RteBswTriggerSourceQueueLength configured for a Trigger Emitter the default value of 0 applies as well.</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value	0		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswTriggerSourceRef [ECUC_Rte_09100]		
Parent Container	RteBswExternalTriggerConfig		
Description	<p>Reference to a Trigger instance in the role releasedTrigger of the related BSW Module instance.</p> <p>The referenced Trigger has to belong to the same BSW Module instance as the RteBswModuleInstance owning this parameter configures.</p>		
Multiplicity	1		
Type	Foreign reference to TRIGGER		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

SWS Item	[ECUC_Rte_09102]
Container Name	RteBswInternalTriggerConfig
Parent Container	RteBswModuleInstance

Description	Defines the configuration of internal Basic Software Module Entity Triggering
Configuration Parameters	

Name	RteBswTriggerSourceQueueLength [ECUC_Rte_09104]		
Parent Container	RteBswInternalTriggerConfig		
Description	<p>Length of trigger queue on the trigger source side.</p> <p>The queue is implemented by the RTE. A value greater or equal to 1 requests an queued behavior. Setting the value of RteTriggerSourceQueueLength to 0 requests an none queued implementation of the trigger communication.</p> <p>If there is no RteBswTriggerSourceQueueLength configured for a Trigger Emitter the default value of 0 applies as well.</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value	0		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswTriggerSourceRef [ECUC_Rte_09103]		
Parent Container	RteBswInternalTriggerConfig		
Description	<p>Reference to a BswInternalTriggeringPoint of the related BSW Module instance.</p> <p>The referenced BswInternalTriggeringPoint has to belong to the same BSW Module instance as the RteBswModuleInstance owning this parameter configures.</p>		
Multiplicity	1		
Type	Foreign reference to BSW-INTERNAL-TRIGGERING-POINT		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.10.2.4 BSW ModeDeclarationGroup configuration

The `RteBswRequiredModeGroupConnection` container is defined in the context of the `RteBswModuleInstance` which is the required mode group context. So the reference to the `RteBswRequiredModeGroupRef` is sufficient to define the required mode group. For the provided mode group the tuple of `RteBswProvidedModeGrp-ModInstRef` and `RteBswProvidedModeGroupRef` is specified.

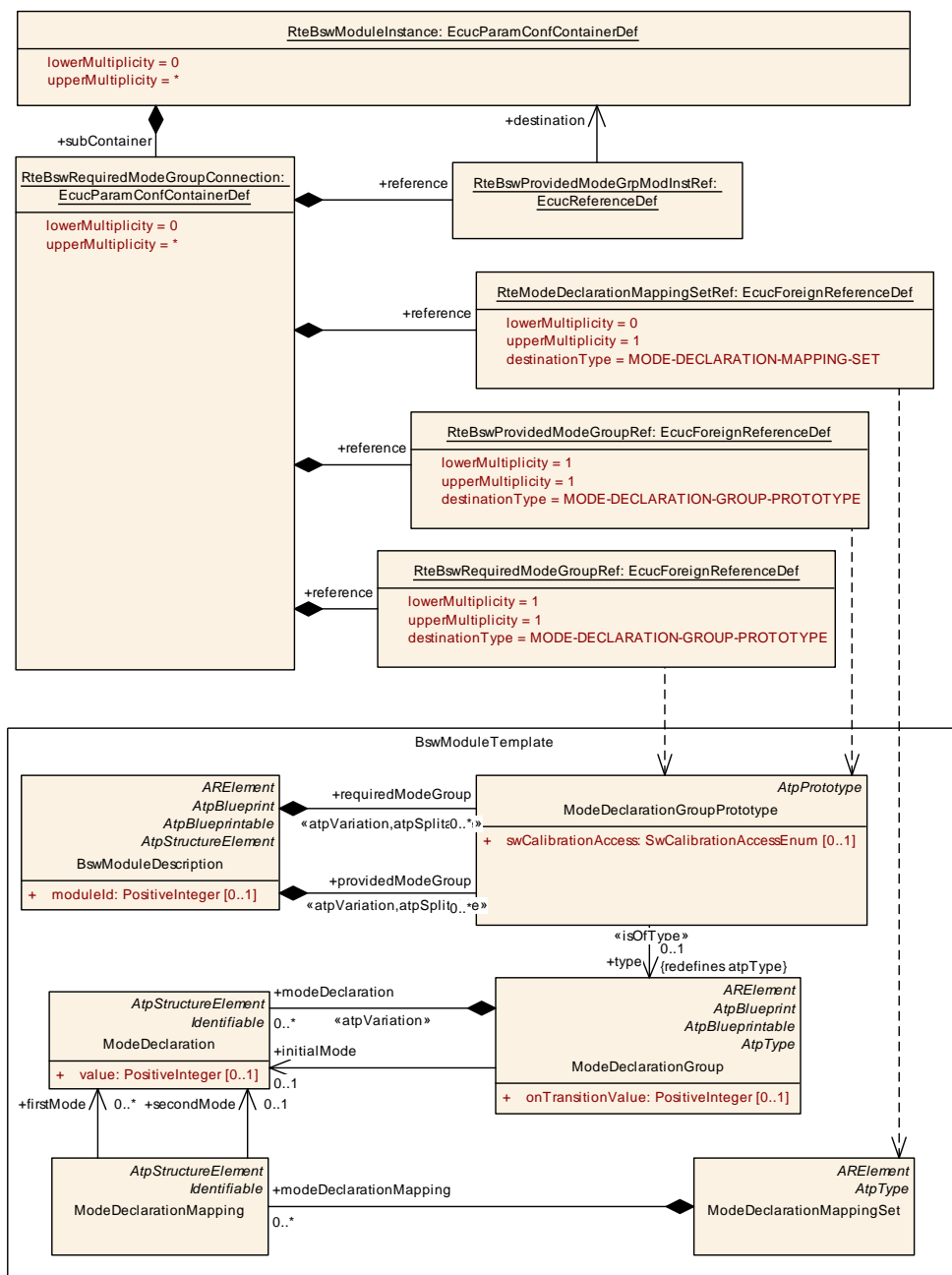


Figure 8.30: Configuration of BSW Scheduler overview

SWS Item	[ECUC_Rte_09081]
Container Name	RteBswRequiredModeGroupConnection
Parent Container	RteBswModuleInstance

Description	Defines the connection between one requiredModeGroup of this BSW Module instance and one providedModeGroup instance.
Configuration Parameters	

Name	RteBswProvidedModeGroupRef [ECUC_Rte_09079]		
Parent Container	RteBswRequiredModeGroupConnection		
Description	References the providedModeGroupPrototype to which this requiredModeGroup shall be connected.		
Multiplicity	1		
Type	Foreign reference to MODE-DECLARATION-GROUP-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswProvidedModeGrpModInstRef [ECUC_Rte_09080]		
Parent Container	RteBswRequiredModeGroupConnection		
Description	Reference to the RteBswModuleInstance configuration container which identifies the instance of the BSW Module. Used with the RteBswProvidedModeGroupRef to unambiguously identify the ModeDeclarationGroupPrototype instance.		
Multiplicity	1		
Type	Reference to RteBswModuleInstance		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswRequiredModeGroupRef [ECUC_Rte_09082]		
Parent Container	RteBswRequiredModeGroupConnection		
Description	References requiredModeGroupPrototype which shall be connected to the providedModeGroupPrototype.		
Multiplicity	1		
Type	Foreign reference to MODE-DECLARATION-GROUP-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Scope / Dependency	scope: local
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Name	RteModeDeclarationMappingSetRef [ECUC_Rte_09125]		
Parent Container	RteBswRequiredModeGroupConnection		
Description	This defines the effective ModeDeclarationMappingSet in the case that the provided ModeDeclarationGroupPrototype and the required ModeDeclarationGroupPrototype are not compatible.		
Multiplicity	0..1		
Type	Foreign reference to MODE-DECLARATION-MAPPING-SET		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.10.2.5 BSW Client Server configuration

The [RteBswRequiredClientServerConnection](#) container is defined in the context of the [RteBswModuleInstance](#). So the reference to the [RteBswRequiredClientServerEntryRef](#) is sufficient to define the required [BswModuleClientServerEntry](#). For the provided [BswModuleClientServerEntry](#) the [RteBswProvidedClientServerEntryRef](#) is specified.

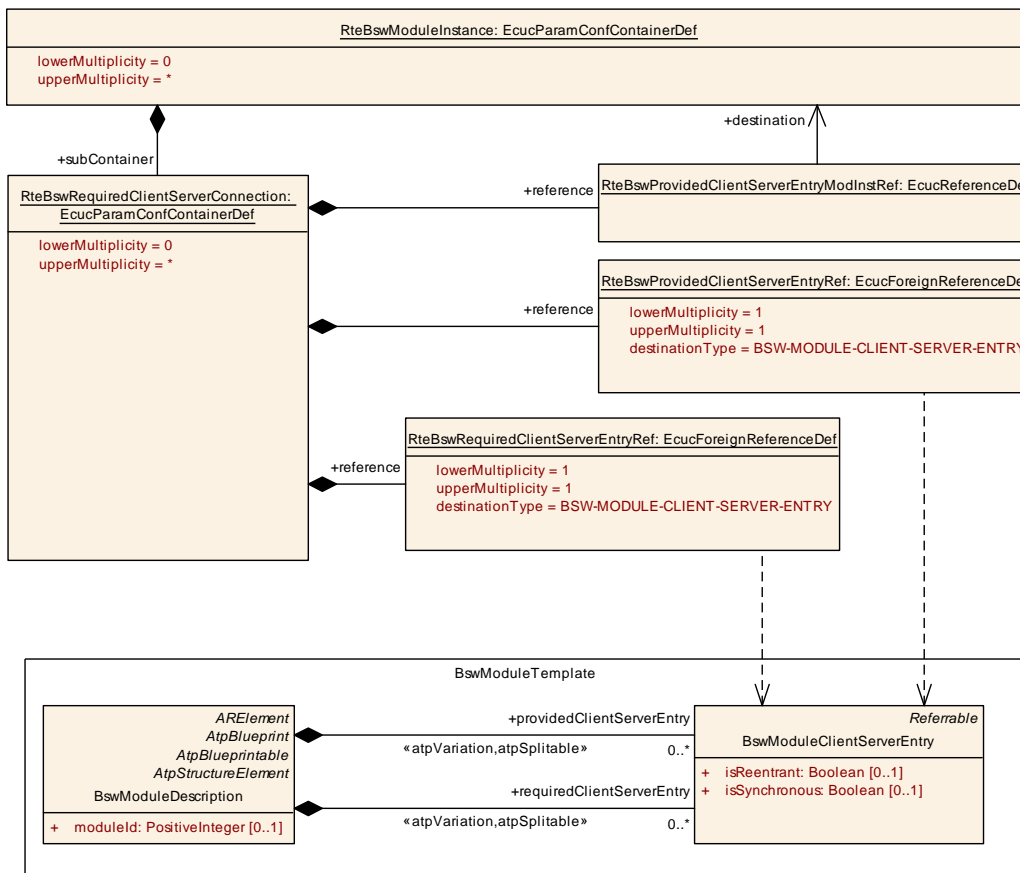


Figure 8.31: Configuration of BSW Client Server Communication

SWS Item	[ECUC_Rte_09117]
Container Name	RteBswRequiredClientServerConnection
Parent Container	RteBswModuleInstance
Description	Defines the connection between one requiredClientServerEntry and one providedClientServerEntry of a BswModuleDescription. This container shall be provided on the client side of the connection.
Configuration Parameters	

Name	RteBswProvidedClientServerEntryModInstRef [ECUC_Rte_09124]		
Parent Container	RteBswRequiredClientServerConnection		
Description	Reference to the RteBswModuleInstance configuration container which identifies the instance of the BSW Module. Used with the RteBswProvidedClientServerEntryRef to unambiguously identify the BswModuleClientServerEntry instance.		
Multiplicity	1		
Type	Reference to RteBswModuleInstance		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	

Scope / Dependency	scope: local
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Name	RteBswProvidedClientServerEntryRef [ECUC_Rte_09119]		
Parent Container	RteBswRequiredClientServerConnection		
Description	Reference the providedClientServerEntry for this connection.		
Multiplicity	1		
Type	Foreign reference to BSW-MODULE-CLIENT-SERVER-ENTRY		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswRequiredClientServerEntryRef [ECUC_Rte_09118]		
Parent Container	RteBswRequiredClientServerConnection		
Description	Reference the requiredClientServerEntry for this connection.		
Multiplicity	1		
Type	Foreign reference to BSW-MODULE-CLIENT-SERVER-ENTRY		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.10.2.6 BSW Sender Receiver configuration

The [RteBswRequiredSenderReceiverConnection](#) container is defined in the context of the [RteBswModuleInstance](#). So the reference to the [RteBswRequiredVariableDataPrototypeRef](#) is sufficient to define the required [VariableDataPrototype](#). For the provided [VariableDataPrototype](#) the [RteBswProvidedVariableDataPrototypeRef](#) is specified.

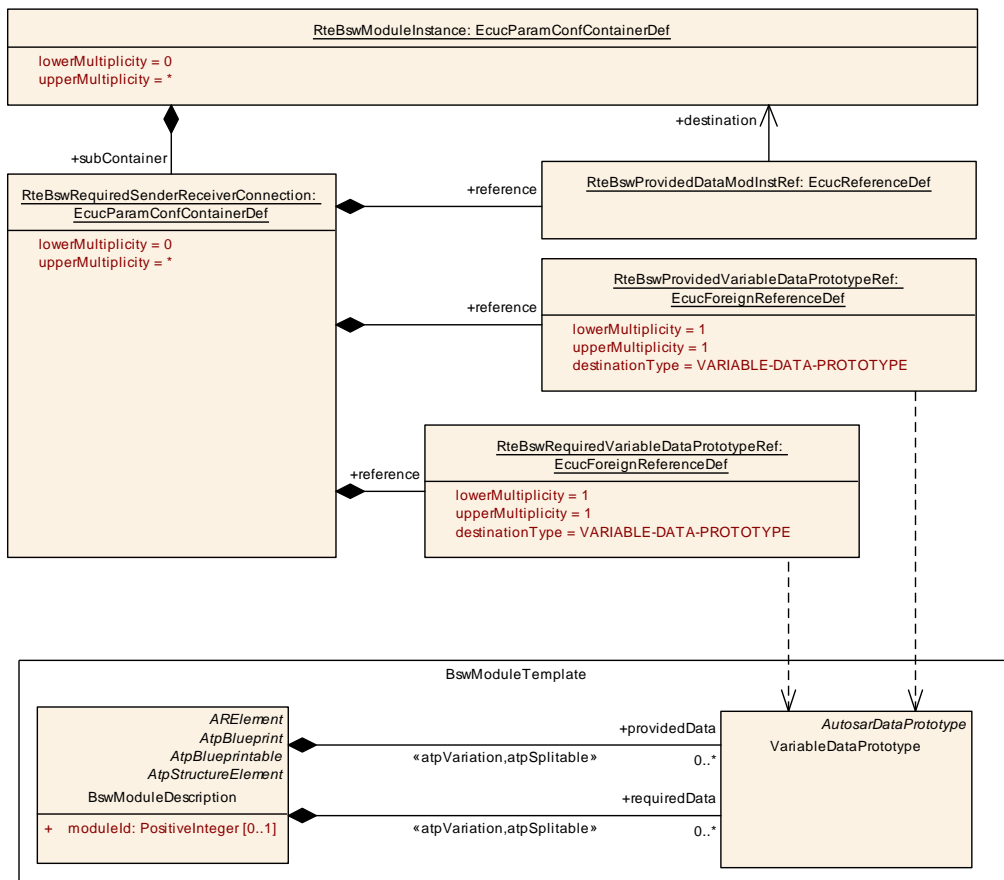


Figure 8.32: Configuration of BSW Sender Receiver Communication

SWS Item	[ECUC_Rte_09120]
Container Name	RteBswRequiredSenderReceiverConnection
Parent Container	RteBswModuleInstance
Description	Defines the connection between one requiredData and one providedData of a BswModuleDescription. This container shall be provided on the receiver side of the connection.
Configuration Parameters	

Name	RteBswProvidedDataModInstRef [ECUC_Rte_09123]		
Parent Container	RteBswRequiredSenderReceiverConnection		
Description	Reference to the RteBswModuleInstance configuration container which identifies the instance of the BSW Module. Used with the RteBswProvidedVariableDataPrototypeRef to unambiguously identify the VariableDataPrototype instance.		
Multiplicity	1		
Type	Reference to RteBswModuleInstance		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Scope / Dependency	scope: local
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Name	RteBswProvidedVariableDataPrototypeRef [ECUC_Rte_09122]		
Parent Container	RteBswRequiredSenderReceiverConnection		
Description	Reference the providedData for this connection.		
Multiplicity	1		
Type	Foreign reference to VARIABLE-DATA-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswRequiredVariableDataPrototypeRef [ECUC_Rte_09121]		
Parent Container	RteBswRequiredSenderReceiverConnection		
Description	Reference the requiredData for this connection.		
Multiplicity	1		
Type	Foreign reference to VARIABLE-DATA-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

8.10.2.7 BSW Mode Machine Instance configuration

This configuration provides the settings for the implementation of a *Basic Software Scheduler* assigned mode machine instance (see [[SWS_Rte_07534](#)]).

The [RteBswModeMachineInstanceConfig](#) container is defined in the context of the [RteBswModuleInstance](#) which already predefines the context of the [ModeDeclarationGroupPrototype](#) in the [RteBswModeManagerRef](#).

[SWS_Rte_CONSTR_09101] The reference [RteBswModeManagerRef](#) has to be consistent with the [RteBswImplementationRef](#) [The reference [RteBswModeManagerRef](#) has to be consistent with the [RteBswImplementationRef](#). This means

the referenced [ModeDeclarationGroupPrototype](#) has to be a [providedModeGroup](#) in the [BswModuleDescription](#) which is referenced by the related [BswImplementation](#).¹()

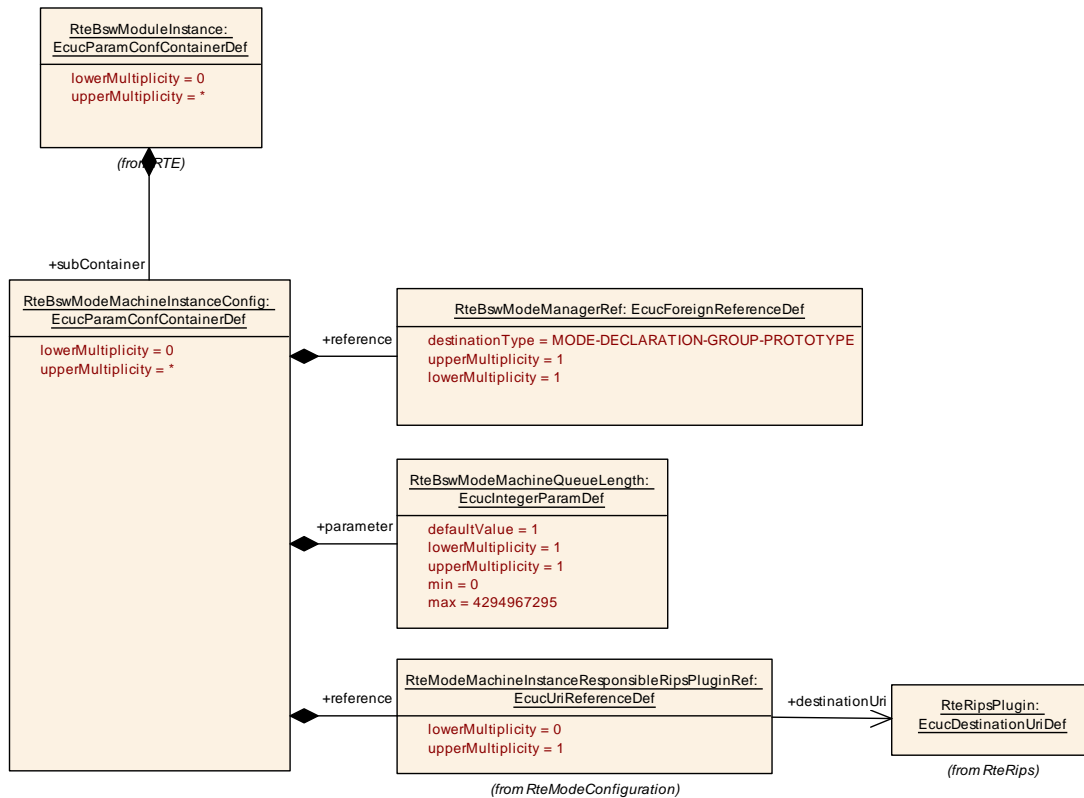


Figure 8.33: Configuration of a Basic Software Scheduler assigned mode machine instance

SWS Item	[ECUC_Rte_09148]
Container Name	RteBswModeMachineInstanceConfig
Parent Container	RteBswModuleInstance
Description	Defines the configuration of Basic Software Scheduler assigned (SWS_Rte_07534) mode machine instances.
Configuration Parameters	

Name	RteBswModeMachineQueueLength [ECUC_Rte_09150]	
Parent Container	RteBswModeMachineInstanceConfig	
Description	Length of mode machine instance queue on the trigger source side. If there is no RteBswModeMachineQueueLength configured for a mode machine instance the value given in the BswModeSenderPolicy.queueLength applies.	
Multiplicity	1	
Type	EcucIntegerParamDef	
Range	0 .. 4294967295	
Default Value	1	
Post-Build Variant Value	false	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteBswModeManagerRef [ECUC_Rte_09149]		
Parent Container	RteBswModeMachineInstanceConfig		
Description	<p>Reference to a ModeDeclarationGroupPrototype of the related BSW Module instance.</p> <p>The referenced ModeDeclarationGroupPrototype has to belong to the same BSW Module instance as the RteBswModuleInstance owning this parameter configures.</p>		
Multiplicity	1		
Type	Foreign reference to MODE-DECLARATION-GROUP-PROTOTYPE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteModeMachineInstanceResponsibleRipsPluginRef [ECUC_Rte_89013]		
Parent Container	RteBswModeMachineInstanceConfig		
Description	Optional reference to the configuration container of the RTE Implementation Plug-in implementing the protection of the mode machine instance.		
Multiplicity	0..1		
Type	Reference to destinationUri [RteRipsUriDefSet / RteRipsPlugin]		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

8.11 Configuration of Synchronization Points

With synchronization points it possible to ensure the correct execution order in case of [RTEEvents](#) activated by the identical event source (in particular the same `mode manager`) but mapped to [OsTasks](#) belonging to different partitions which in turn are belonging to different cores. With this configuration it is possible to ensure for instance the execution of all [on-exit ExecutableEntity](#)s before the [on-transition ExecutableEntity](#)s when required. Therefore the current applicability is constraint to [RTEEvents](#) triggered by mode communication.

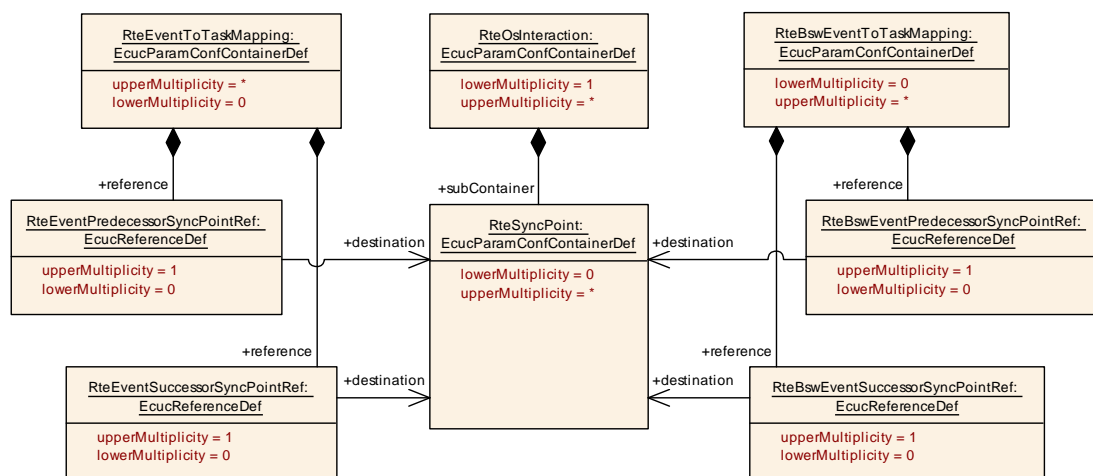


Figure 8.34: Configuration of Synchronization Points

SWS Item	[ECUC_Rte_09127]
Container Name	RteSyncPoint
Parent Container	RteOsInteraction
Description	<p>The RteSyncPoint is necessary to provide an cross core synchronization in case of RteEvents triggered by the same event source but mapped to tasks belonging to different partitions on different cores.</p> <p>The synchronization point must be reached by all referencing RteEvents before the execution in all related tasks is continued.</p> <p>In case of Rte(Bsw)EventSuccessorSyncPointRef the ExecutableEntity activated by the mapped event is executed before the synchronization point is entered.</p> <p>In case of Rte(Bsw)EventPredecessorSyncPointRef the ExecutableEntity activated by the mapped event is executed after the synchronization point is passed.</p>
Configuration Parameters	
No Included Containers	

[RteEventPredecessorSyncPointRef](#) and [RteEventSuccessorSyncPointRef](#) are only applicable for [RteEventToTaskMappings](#) where the mapped

`RTEEvent` is either a `SwcModeSwitchEvent` or a `ModeSwitchedAckEvent`. `RteBswEventPredecessorSyncPointRef` and `RteBswEventSuccessorSyncPointRef` are only applicable for `RteBswEventToTaskMappings` where the mapped `BswEvent` is either a `BswModeSwitchEvent` or a `BswModeSwitchedAckEvent`.

8.12 Configuration of Initialization

In order to support different interactions with the start up code of the ECU the RTE supports different initialization strategies for variables implementing `VariableDataPrototypes`. Basically the initialization can be done either by start-up code or by the `Rte_Start` function. Further on it is possible to avoid any initialization for data which has to be reset safe or is explicitly initialized by other SW, e.g. the RAM Blocks might be initialized by NVRAM Manager.

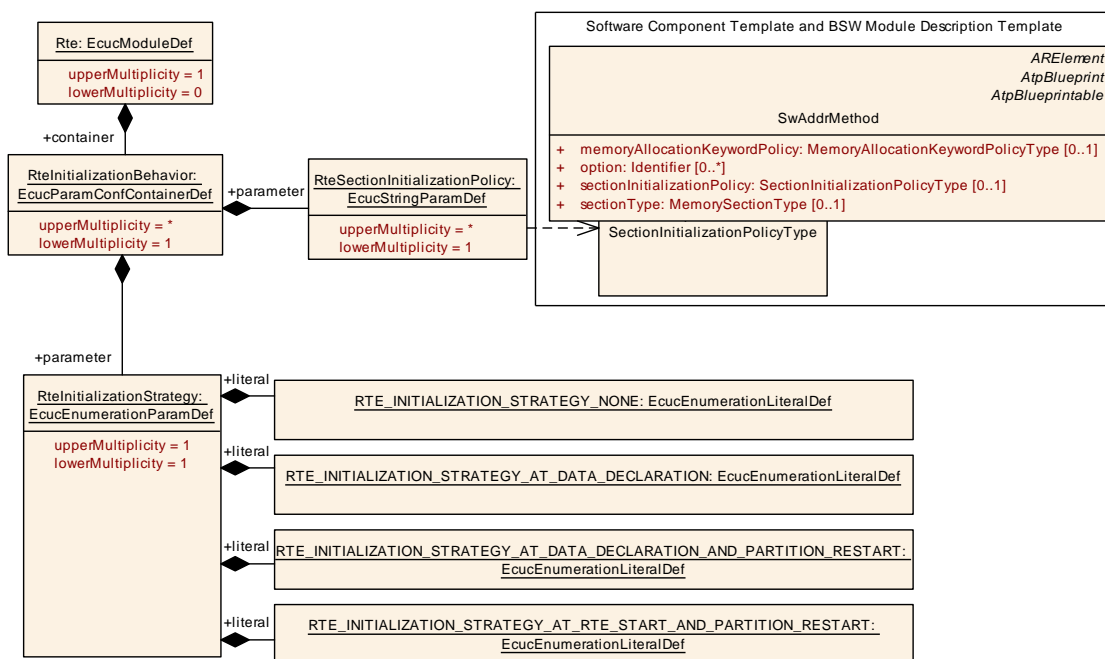


Figure 8.35: Configuration of initialization strategy

SWS Item	[ECUC_Rte_09087]
Container Name	RteInitializationBehavior
Parent Container	Rte
Description	<p>Specifies the initialization strategy for variables allocated by RTE with the purpose to implement <code>VariableDataPrototypes</code>.</p> <p>The container defines a set of <code>RteSectionInitializationPolicys</code> and one <code>RteInitializationStrategy</code> which is applicable for this set.</p>
Configuration Parameters	

Name	RteInitializationStrategy [ECUC_Rte_09089]		
Parent Container	RteInitializationBehavior		
Description	Definition of the initialization strategy applicable for the SectionInitializationPolicys selected by RteSectionInitializationPolicy.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	RTE_INITIALIZATION_STRATEGY_AT_DATA_DECLARATION	Variables shall be initialized at its declaration to the value defined by the related initValue attribute.	
	RTE_INITIALIZATION_STRATEGY_AT_DATA_DECLARATION_AND_PARTITION_RESTART	Variables shall be initialized at its declaration to the value defined by the related initValue attribute and during execution of Rte_RestartPartition to the value defined by the related initValue attribute.	
	RTE_INITIALIZATION_STRATEGY_AT_RTE_START_AND_PARTITION_RESTART	Variables shall be initialized during execution of Rte_Start and Rte_RestartPartition to the value defined by the related initValue attribute.	
	RTE_INITIALIZATION_STRATEGY_NONE	Variables shall not be initialized at all.	
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteSectionInitializationPolicy [ECUC_Rte_09088]		
Parent Container	RteInitializationBehavior		
Description	<p>This parameter describes the SectionInitializationPolicy for which a particular RTE initialization strategy applies.</p> <p>The SectionInitializationPolicy describes the intended initialization of MemorySections.</p> <p>The following values are standardized in AUTOSAR Methodology:</p> <ul style="list-style-type: none"> • NO-INIT: No initialization and no clearing is performed. Such data elements must not be read before one has written a value into it. • INIT: To be used for data that are initialized by every reset to the specified value (initValue). • POWER-ON-INIT: To be used for data that are initialized by "Power On" to the specified value (initValue). Note: there might be several resets between power on resets. • CLEARED: To be used for data that are initialized by every reset to zero. • POWER-ON-CLEARED: To be used for data that are initialized by "Power On" to zero. Note: there might be several resets between power on resets. 		
Multiplicity	1..*		
Type	EcucStringParamDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

[SWS_Rte_07075] [The RTE generator shall reject configurations where not all occurring [sectionInitializationPolicy](#) attribute values are configured to an [RteInitializationStrategy](#).] ([SRS_Rte_00018](#))

The call of [Rte_Start](#) may trigger [RunnableEntity](#)s for initialization purpose. Those [RunnableEntity](#)s are either triggered by [SwcModeSwitchEvents](#) or

InitEvents. To support the scheduling of such **RunnableEntity**s in the start up code of the ECU (e.g. by **BswM** or **EcucM**) its possible to map such **RTEEvents** to **RteInitializationRunnableBatch** containers which results in the existence of **Rte_Init** APIs.

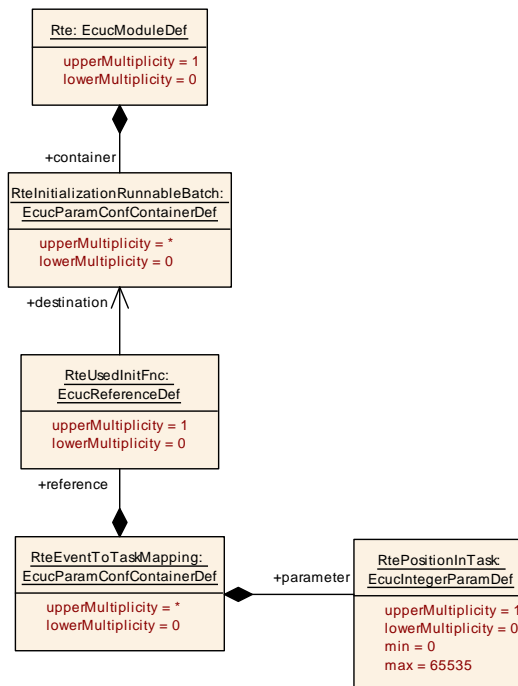


Figure 8.36: Configuration of **Rte_Init** functions

SWS Item	[ECUC_Rte_09115]
Container Name	RteInitializationRunnableBatch
Parent Container	Rte
Description	This container corresponds to an Rte_Init_<shortName of this container> function invoking the mapped RunnableEntity s.
Configuration Parameters	

No Included Containers

Rte_Init API may only schedule **RunnableEntity**s for initialization purpose ore which are on-entry **Runnable Entity**s.

[SWS_Rte_CONSTR_09063] Restricted kinds of **RTEEvents** which may mapped to **RteInitializationRunnableBatch** containers [Only **SwcModeSwitchEvents** with **activation = onEntry** and referring to the **initialMode** or **InitEvents** may be mapped to **RteInitializationRunnableBatch** containers with the means of a **RteUsedInitFnc** reference.]()

[SWS_Rte_06769] [The RTE Generator shall reject configurations violating **[SWS_Rte_CONSTR_09063]**.](**SRS_Rte_00143**, **SRS_Rte_00240**, **SRS_Rte_00018**)

[SWS_Rte_CONSTR_09064] A single **RteInitializationRunnableBatch** container may not handle **RTEEvents** of different partitions [All **RTEEvents** mapped to a **RteInitializationRunnableBatch** container may only trigger **RunnableEntities** belonging to partitions of the same core.]()

[SWS_Rte_06770] [The RTE Generator shall reject configurations violating [SWS_Rte_CONSTR_09064].] (SRS_Rte_00143, SRS_Rte_00240, SRS_Rte_00018)

8.13 Configuration of Task Chains

The configuration of **RteOsTaskChain** enables the definition of the task chain behavior. Please note [SWS_Rte_04558] and [SWS_Rte_04559].

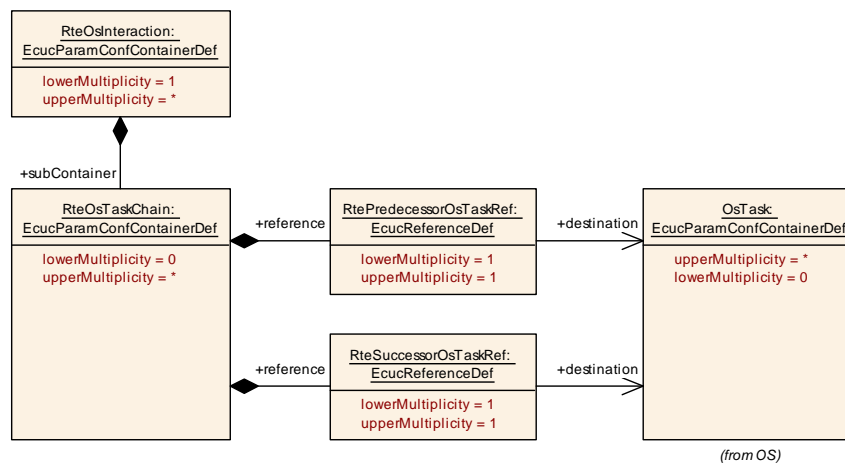


Figure 8.37: Configuration of task chains

SWS Item	[ECUC_Rte_09135]
Container Name	RteOsTaskChain
Parent Container	RteOsInteraction
Description	This container holds the configuration of one task chain configuration.
Configuration Parameters	

Name	RtePredecessorOsTaskRef [ECUC_Rte_09136]		
Parent Container	RteOsTaskChain		
Description	OsTask which shall chain another OsTask when it terminates.		
Multiplicity	1		
Type	Reference to OsTask		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	

Scope / Dependency	scope: ECU
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Name	RteSuccessorOsTaskRef [ECUC_Rte_09137]		
Parent Container	RteOsTaskChain		
Description	OsTask which shall be chained from the predecessor OsTask.		
Multiplicity	1		
Type	Reference to OsTask		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

No Included Containers

8.14 Configuration of distributed shared mode queues

The section lists the configuration for the general settings for [distributed shared mode queues](#).

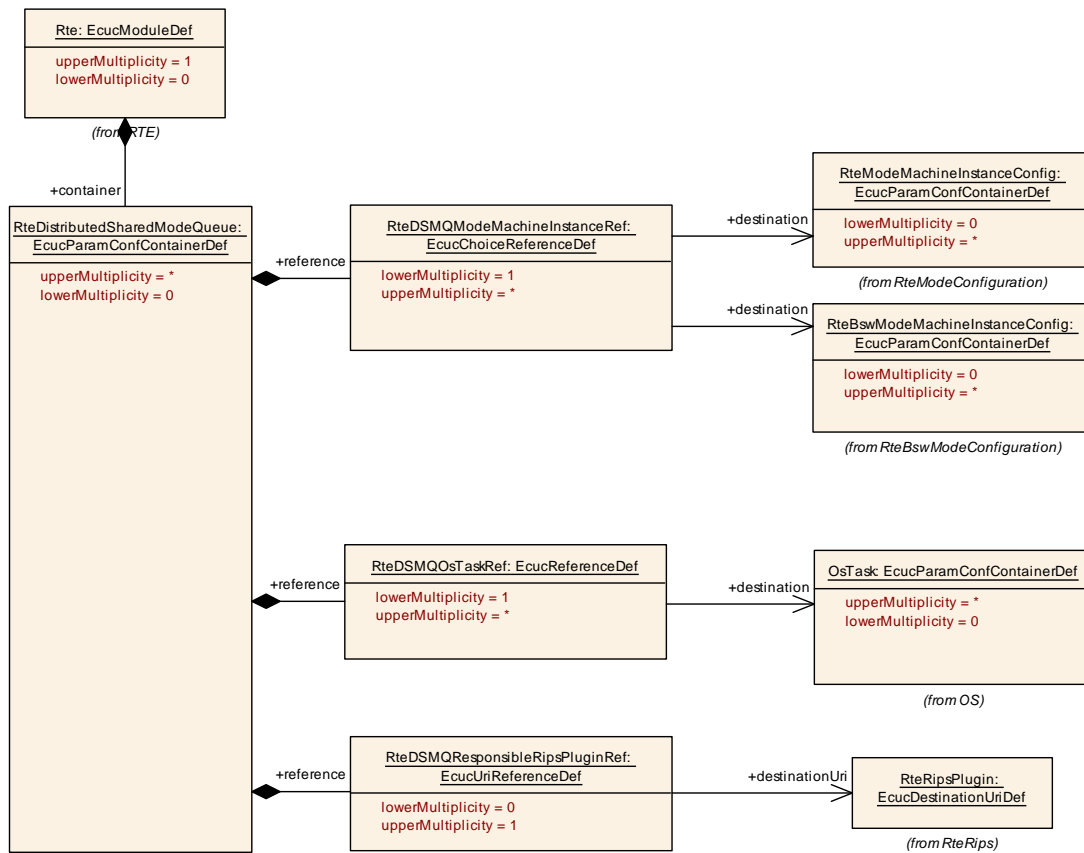


Figure 8.38: Configuration of RTE Implementation Plug-Ins

SWS Item	[ECUC_Rte_09145]
Container Name	RteDistributedSharedModeQueue
Parent Container	Rte
Description	This container holds the configuration of a distributed shared mode queue.
Configuration Parameters	

Name	RteDSMQModeMachineInstanceRef [ECUC_Rte_09146]		
Parent Container	RteDistributedSharedModeQueue		
Description	Reference to the mode machine instances which participate in this distributed shared mode queue.		
Multiplicity	1..*		
Type	Choice reference to [RteBswModeMachineInstanceConfig,RteModeMachineInstanceConfig]		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency			

Name	RteDSMQOsTaskRef [ECUC_Rte_09147]		
Parent Container	RteDistributedSharedModeQueue		
Description	Reference to the DSMQ transition OsTasks which are used to exclusively schedule on-entry ExecutableEntitys, on-transition ExecutableEntitys, on-exit ExecutableEntitys, and ModeSwitchAck ExecutableEntity activated by mode machine instances of this distributed shared mode queue.		
Multiplicity	1..*		
Type	Reference to OsTask		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	RteDSMQResponsibleRipsPluginRef [ECUC_Rte_89014]		
Parent Container	RteDistributedSharedModeQueue		
Description	Optional reference to the configuration container of the RTE Implementation Plug-in implementing the protection of all mode machine instances assigned to this distributed shared mode queue.		
Multiplicity	0..1		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPlugin]		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

8.15 Configuration of RTE Implementation Plug-Ins

8.15.1 General configuration definitions for Uri References

Please note, that for the structural decoupling of the RTE's configuration and the configuration of [RTE Implementation Plug-Ins Uri References](#) are used. See document [5], section *Uri Reference*. Thereby each [RTE Implementation Plug-In](#)

define its own [EcucModuleDef](#). AUTOSAR itself does not standardize those [EcucModuleDefs](#). Instead the required references in the ECU configuration of the RTE are defined as [EcucUriReferenceDefs](#) and for the reference destination containers the [EcucDestinationUriDefs](#) are standardized in the [RteRipsUriDefSet](#).

SWS Item	ECUC_Rte_89003
EcucDestinationUriDefSet Name	RteRipsUriDefSet
Description	Defines the set of DestinationUriDefs for the RTE Implementation Plug-in support.
Included EcucDestinationUriDefs	
Name	Description
RteRipsInvocationHandler	Defines the configuration container content of an invocation handler of an RTE Implementation Plug-In.
RteRipsPlugin	Defines the configuration container content of the RIPS Plug-in holding the Rte relevant settings.
RteRipsPluginFillFlush Routine	Defines the configuration container content of a Fill-Flush Routine implemented by a RTE Implementation Plug-In.

SWS Item	[ECUC_Rte_89009]
EcucDestinationUriDef Name	RteRipsInvocationHandler
Destination Uri Definition Set	RteRipsUriDefSet
Description	Defines the configuration container content of an invocation handler of an RTE Implementation Plug-In.
destinationUriNesting Contract	targetContainer
Configuration Parameters	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteRipsInvocationHandlerFnc	0..*	This container describes an invocation handler function implemented by an RTE Implementation Plug-In to handle the invocation of server runnables and triggered runnables via a transformer.

SWS Item	[ECUC_Rte_89004]
EcucDestinationUriDef Name	RteRipsPlugin
Destination Uri Definition Set	RteRipsUriDefSet
Description	Defines the configuration container content of the RIPS Plug-in holding the Rte relevant settings.
destinationUriNesting Contract	targetContainer
Configuration Parameters	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteRipsPluginProps	1	This container defines the identity of the Rte Implementation Plug-in and provides the RTE relevant parameters of the Rte Implementation Plug-in. The shortName of the container defines the name of the Rte Implementation Plug-in used for the API infixes.

SWS Item	[ECUC_Rte_89007]
EcucDestinationUriDef Name	RteRipsPluginFillFlushRoutine
Destination Uri Definition Set	RteRipsUriDefSet
Description	Defines the configuration container content of a Fill-Flush Routine implemented by a RTE Implementation Plug-In.
destinationUriNesting Contract	targetContainer
Configuration Parameters	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
RteRipsPluginFillFlushRoutineFnc	0..*	This container describes a Fill-Flush Routine function implemented by a RTE Implementation Plug-In to handle the buffering for implicit communication.

The general configuration of the RTE Generator concerning the used [RTE Implementation Plug-Ins](#) are defined in the container [RteRips](#).

8.15.2 General configuration of RTE Implementation Plug-Ins utilization

The section lists the configuration for the general settings to enable the [RTE Implementation Plug-In](#) support by RTE Generator.

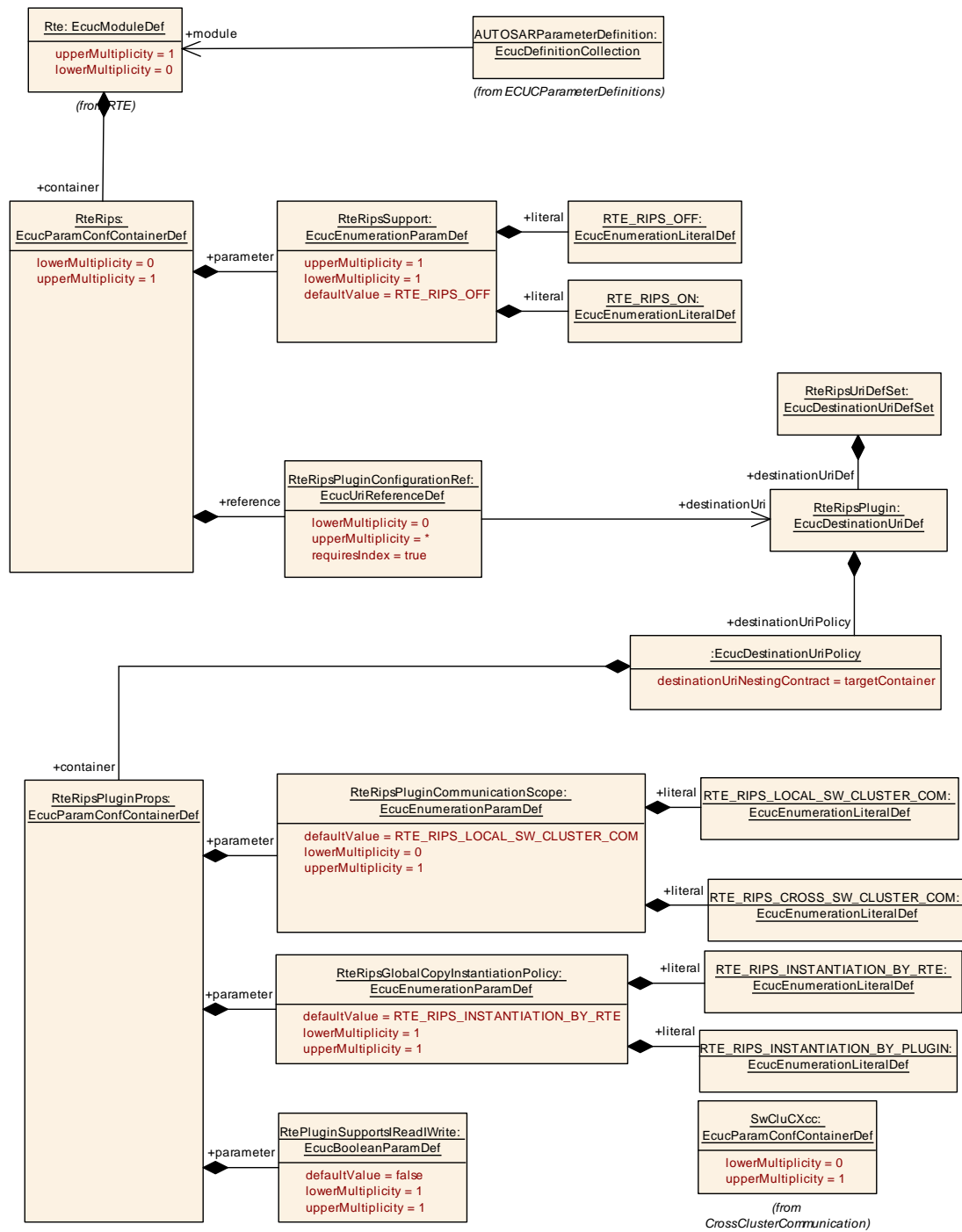


Figure 8.39: Configuration of RTE Implementation Plug-Ins

SWS Item	[ECUC_Rte_89000]
Container Name	RteRips
Parent Container	Rte
Description	This container provides the configuration of the Rte Implementation Plug-In support by RTE. If the container is NOT defined, the support for Rte Implementation Plug-Ins (RIPS) is globally disabled.

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteRipsSupport [ECUC_Rte_89001]		
Parent Container	RteRips		
Description	Globally enables or disables the support for Rte Implementation Plug-Ins (RIPS)		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	RTE_RIPS_OFF	Support for Rte Implementation Plug-Ins (RIPS) is globally disabled.	
	RTE_RIPS_ON	Support for Rte Implementation Plug-Ins (RIPS) is globally enabled.	
Default Value	RTE_RIPS_OFF		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	RteRipsPluginConfigurationRef [ECUC_Rte_89002]		
Parent Container	RteRips		
Description	Reference to the configuration container of the RTE Implementation Plug-in holding the RTE relevant settings. All referenced RTE Implementation Plug-ins are considered for the RTE generation. Attributes: requiresIndex=true		
Multiplicity	0..*		
Type	Reference to destinationUri [RteRipsUriDefSet/RteRipsPlugin]		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

The general implementation properties of the [RTE Implementation Plug-In](#) are defined in [RteRipsPluginProps](#).

SWS Item	[ECUC_Rte_09173]
Container Name	RteRipsPluginProps
Destination Uri Definition	RteRipsPlugin
Description	This container defines the identity of the Rte Implementation Plug-in and provides the RTE relevant parameters of the Rte Implementation Plug-in. The shortName of the container defines the name of the Rte Implementation Plug-in used for the API infixes.
Configuration Parameters	

Name	RtePluginSupportsIReadIWrite [ECUC_Rte_09169]		
Parent Container	RteRipsPluginProps		
Description	Denotes if or if not the plug-in supports the Rte_Rips_IRead/IWrite macros for primitive data.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsGlobalCopyInstantiationPolicy [ECUC_Rte_09170]		
Parent Container	RteRipsPluginProps		
Description	Globally enables or disables the support for Rte Implementation Plug-Ins (RIPS)		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	RTE_RIPS_INSTANTIATION_BY_PLUGIN	The Rte Implementation Plug-In shall provide the global copy(s) for each Communication Graph.	
	RTE_RIPS_INSTANTIATION_BY_RTE	The RTE shall provide an individual global copy for each Communication Graph.	
Default Value	RTE_RIPS_INSTANTIATION_BY_RTE		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	RteRipsPluginCommunicationScope [ECUC_Rte_09171]		
Parent Container	RteRipsPluginProps		
Description	Defines the communication scope for which the Rte Implementation Plug-Ins (RIPS) serves. If this parameter is not set, the default behavior RTE_RIPS_LOCAL_SW_CLUSTER_COM applies.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	RTE_RIPS_CROSS_SW_CLUSTER_COM	The Rte Implementation Plug-In handles the Cross Software Cluster Communication.	
	RTE_RIPS_LOCAL_SW_CLUSTER_COM	The Rte Implementation Plug-In handles the Local Software Cluster Communication.	
Default Value	RTE_RIPS_LOCAL_SW_CLUSTER_COM		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

The container [RteRipsPluginProps](#) is mandatory to describe the properties and the name infix used for the [RTE Implementation Plug-In Services](#) and header files.

[SWS_Rte_70092] [The [RTE Implementation Plug-In](#) shall describe its properties with an instance of an [RteRipsPluginProps](#).] ([SRS_Rte_00313](#))

8.15.3 Configuration of Fill-Flush-Routines of RTE Implementation Plug-Ins

The section lists the configuration for the Fill-Flush-Routines needed in case a [RTE Implementation Plug-In](#) implements implicit communication. The details are described in section [7.3.4.7.1](#).

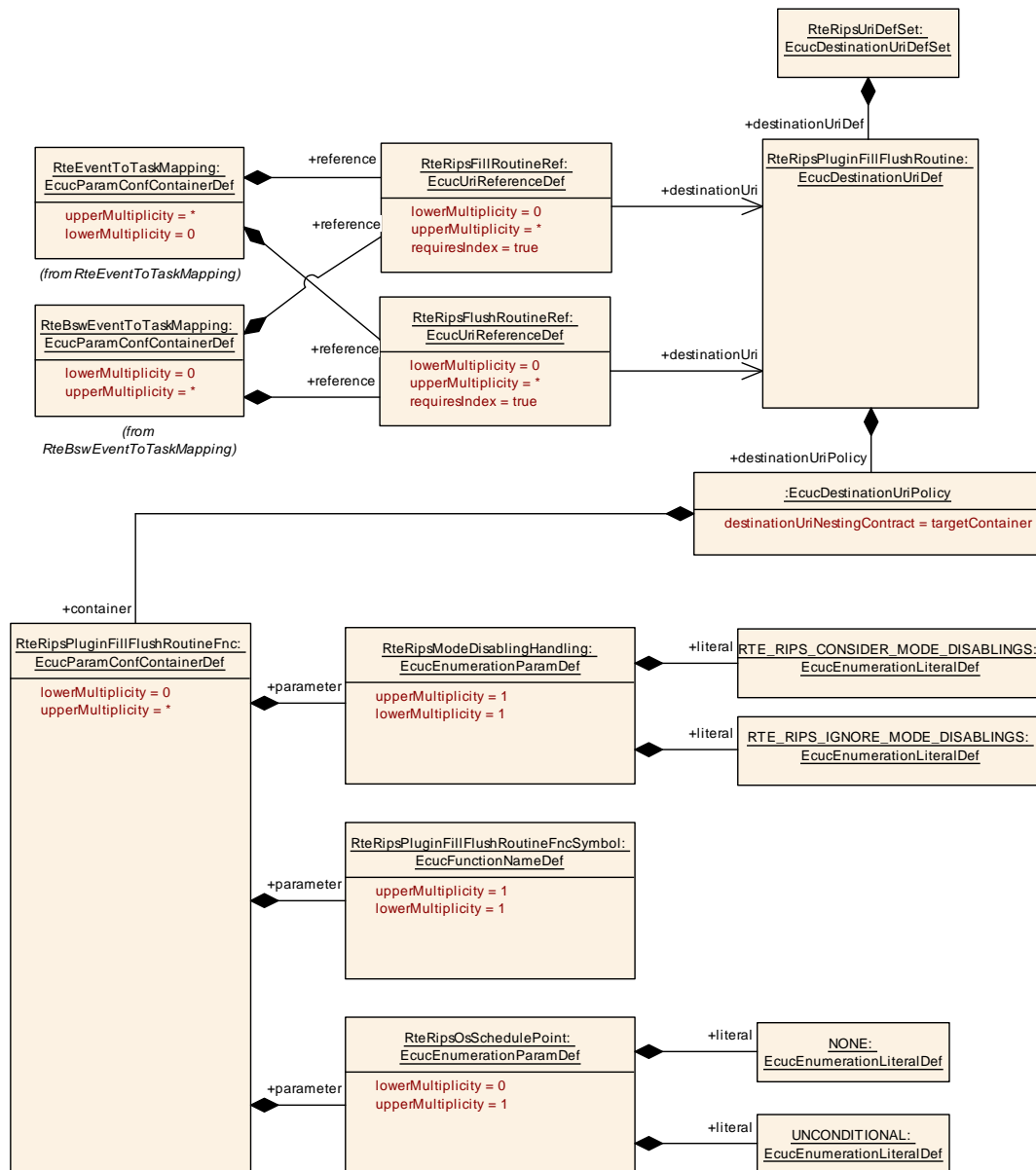


Figure 8.40: Configuration of Fill-Flush-Routines of RTE Implementation Plug-Ins

SWS Item	[ECUC_Rte_79003]		
Container Name	RteRipsPluginFillFlushRoutineFnc		
Destination Uri Definition	RteRipsPluginFillFlushRoutine		
Description	This container describes a Fill-Flush Routine function implemented by a RTE Implementation Plug-In to handle the buffering for implicit communication.		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Configuration Parameters			

Name	RteRipsModeDisablingHandling [ECUC_Rte_79004]		
Parent Container	RteRipsPluginFillFlushRoutineFnc		
Description	This parameter configures whether mode disabling dependencies are considered for the invocation of Rte_Rips_FillFlushRoutines.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	RTE_RIPS_CONSIDER_MODE_DISABLINGS	Support for Rte Implementation Plug-Ins (RIPS) is globally disabled.	
	RTE_RIPS_IGNORE_MODE_DISABLINGS	Support for Rte Implementation Plug-Ins (RIPS) is globally enabled.	
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	RteRipsOsSchedulePoint [ECUC_Rte_79006]		
Parent Container	RteRipsPluginFillFlushRoutineFnc		
Description	Introduce a schedule point by explicitly calling Os Schedule service after the execution of the Rte_Rips_FillFlushRoutine.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	NONE	No Schedule Point shall be introduced at the end of the execution of this Rte_Rips_FillFlushRoutine.	
	UNCONDITIONAL	A Schedule Point shall always be introduced at the end of the execution of this Rte_Rips_FillFlushRoutine.	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	RteRipsPluginFillFlushRoutineFncSymbol [ECUC_Rte_79005]		
Parent Container	RteRipsPluginFillFlushRoutineFnc		
Description	C-Symbol of the Rte_Rips_FillFlushRoutine function.		
Multiplicity	1		
Type	EcucFunctionNameDef		
Default Value			

Regular Expression			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

No Included Containers

8.15.4 Configuration of invocation handlers of RTE Implementation Plug-Ins

The section lists the configuration for the invocation handles needed in case a [RTE Implementation Plug-In](#) needs to invoke [server runnables](#) respectively the [triggered runnables](#). The details are described in section [7.3.11.2](#).

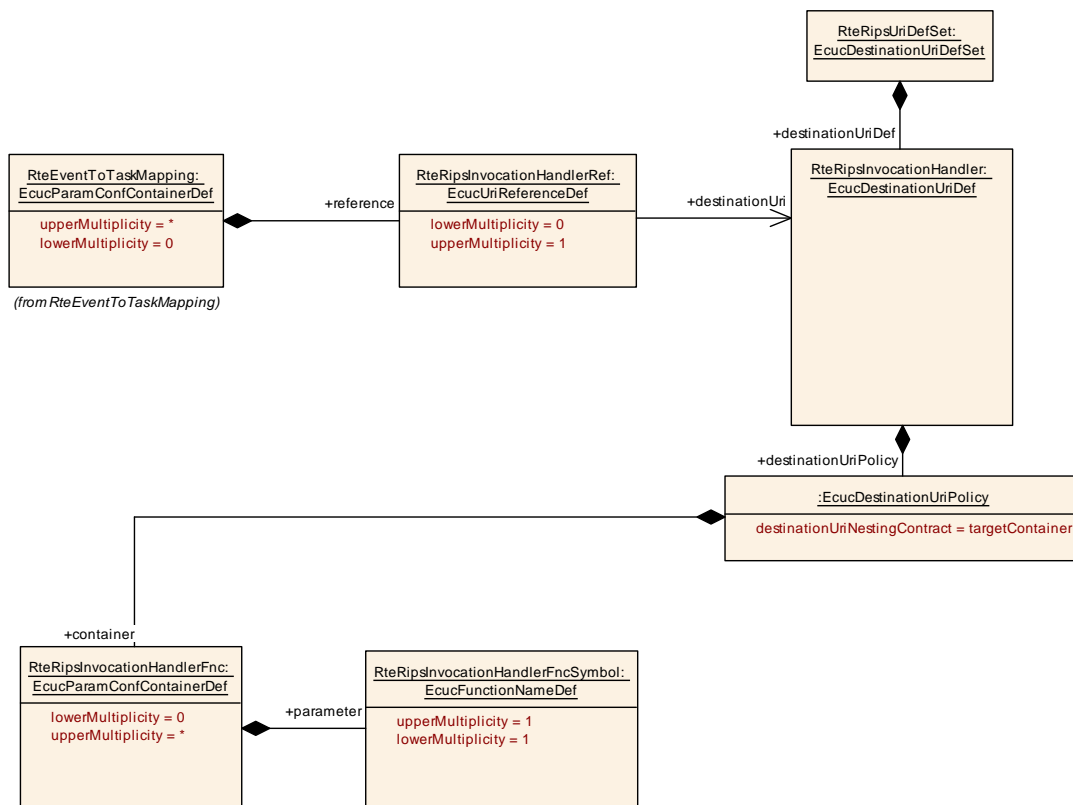


Figure 8.41: Configuration of invocation handler of RTE Implementation Plug-Ins

SWS Item	[ECUC_Rte_79007]
Container Name	RteRipsInvocationHandlerFnc
Destination Uri Definition	RteRipsInvocationHandler

Description	This container describes an invocation handler function implemented by an RTE Implementation Plug-In to handle the invocation of server runnables and triggered runnables via a transformer.		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	RteRipsInvocationHandlerFncSymbol [ECUC_Rte_79008]		
Parent Container	RteRipsInvocationHandlerFnc		
Description	C-Symbol of the Rte_Rips_FillFlushRoutine function.		
Multiplicity	1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

A Metamodel Restrictions

This chapter lists all the restrictions to the AUTOSAR meta-model this version of the AUTOSAR RTE specification document relies on. The RTE generator shall reject configuration where any of the specified restrictions are violated.

A.1 Restrictions concerning `WaitPoint`

1. **[SWS_Rte_01358]** [The RTE shall raise an error if [constr_1091] is violated, so if `RunnableEntity` has `WaitPoint` connected to any of the following `RTE-Events`:

- `OperationInvokedEvent`
- `SwcModeSwitchEvent`
- `TimingEvent`
- `BackgroundEvent`
- `DataReceiveErrorEvent`
- `ExternalTriggerOccurredEvent`
- `InternalTriggerOccurredEvent`
- `DataWriteCompletedEvent`

These events can only start a runnable.]([SRS_Rte_00092](#), [SRS_Rte_00018](#))

Note: The only events that can unblock a `WaitPoint` are those listed in [constr_1091].

Rationale: For `OperationInvokedEvents`, `SwcModeSwitchEvents`, `TimingEvents`, `BackgroundEvents`, `DataReceiveErrorEvent`, `ExternalTriggerOccurredEvent`, `InternalTriggerOccurredEvent`, and `DataWriteCompletedEvent` it suffices to allow the activation of a `RunnableEntity`.

2. **[SWS_Rte_07402]** [The RTE generator shall reject a model where two (or more) different `RunnableEntities` in the same internal behavior each have a `WaitPoint` referencing the same `DataReceivedEvent`, and the runnables are mapped to different tasks.]([SRS_Rte_00092](#), [SRS_Rte_00018](#))

Rationale: In the same software components, the two runnables will attempt to read from the same queue, and only the one that accesses the queue first will actually receive the data.

3. **[SWS_Rte_CONSTR_80031]{DRAFT}** **Software Components integrated in an `Applicative Software Cluster` shall not define any `WaitPoint`**

[The ECU Extract of an `Applicative Software Cluster` shall not instantiate any `AtomicSwComponentType` defining a `WaitPoint`.]()

4. **[SWS_Rte_CONSTR_80206]**{DRAFT} [The RTE generator shall reject a model violating **[SWS_Rte_CONSTR_80031]** in the Cluster Generation phase.](*SRS_Rte_00092, SRS_Rte_00018*)

Rationale: No blocking APIs are expected in `Applicative Software Clusters`. Several `Software Clusters` share the same Basic Software including the operating system. This requires a 'gentle' behavior of the `Software Clusters` in order to avoid blocking of the common schedule.

A.2 Restrictions concerning RTEEvent

1. **[SWS_Rte_03526]** [The RTE generator shall reject configurations in which a `RunnableEntity` is triggered by multiple `OperationInvokedEvents` but violating the constraint [constr_2000] *Compatibility of ClientServerOperations triggering the same RunnableEntity* as defined in document [2]](*SRS_Rte_00072, SRS_Rte_00018*)

Rationale: The signature of the `RunnableEntity` is dependent on its connected `RTEEvent`. Multiple `OperationInvokedEvents` are only supported if all referred `ClientServerOperations` would result in the same `RunnableEntity` prototype for the server runnable (see 5.7.5.6).

2. **[SWS_Rte_03010]** [One runnable entity shall only be resumed by one single `RTEEvent` on its `WaitPoint`. The RTE doesn't support the `WaitPoint` of one runnable entity connected to several `RTEEvents`.](*SRS_Rte_00092, SRS_Rte_00018*)

Rationale: The `WaitPoint` of the runnable entity is caused by calling of the RTE API. One runnable entity can only call one RTE API at a time, and so it can only wait for one `RTEEvent`.

3. **[SWS_Rte_07007]** [The RTE generator shall reject configurations where different execution instances of a runnable entity, which use implicit data access, are mapped to different preemption areas.](*SRS_Rte_00018, SRS_Rte_00128, SRS_Rte_00129, SRS_Rte_00133, SRS_Rte_00142*)

Rationale: Buffers used for implicit communication shall be consistent during the whole task/ISR2 execution. If it is guaranteed that one task/ISR2 does not preempt the other, direct accesses to the same copy buffer from different tasks/ISR2s are possible.

4. **[SWS_Rte_07403]** [The RTE generator shall reject a model where in the same `SwcInternalBehavior` two (or more) different `DataReceivedEvents`, that

reference the same `VariableDataPrototype` with `event semantics`, trigger different runnable entities mapped to different tasks.]([SRS_Rte_00072](#), [SRS_Rte_00018](#))

Rationale: In the same software components, the two runnables will attempt to read from the same queue, and only the one that accesses the queue first will actually receive the data.

A.3 Restrictions concerning queued implementation policy

1. **[SWS_Rte_03018]** [RTE does not support receiving with `WaitPoint` for `VariableDataPrototypes` with their `swImplPolicy` attribute is not set to `queued`.]([SRS_Rte_00109](#), [SRS_Rte_00092](#), [SRS_Rte_00018](#))

Requirement [\[SWS_Rte_03018\]](#) rejects configurations where a `DataReceivedEvent` is referenced by a `WaitPoint` and references a `VariableDataPrototype` referenced by a `NvDataInterface`.

Rationale: unqueued implementation policy indicates that the receiver shall not wait for the `VariableDataPrototype`.

2. All the `VariableAccesses` in the `dataSendPoint` role referring to one `VariableDataPrototype` through one `PPortPrototype` are considered to have the same behavior by sending and acknowledgment reception. All `DataSendCompletedEvents` that reference `VariableAccesses` in the `dataSendPoint` role referring to the same `VariableDataPrototype` are considered equivalent.

Rationale: The API `Rte_Send/Rte_Write` is dependent on the port name and the `VariableDataPrototype` name, not on the `VariableAccesses`. For each combination of one `VariableDataPrototype` and one port only one API will be generated and implemented for sending or acknowledgement reception.

A.4 Restrictions concerning ServerCallPoint

1. **[SWS_Rte_03014]** [All the `ServerCallPoints` referring to one `ClientServerOperation` through one `RPortPrototype` are considered to have the same behavior by calling service. The RTE generator shall reject configuration where this is violated.]([SRS_Rte_00051](#), [SRS_Rte_00018](#))

Rationale: The API `Rte_Call` is dependent on the port name and the operation name, not on the `ServerCallPoints`. For each combination of one operation and one port only one API will be generated and implemented for calling a service. It is e.g. not possible to have different timeout values specified for different

`ServerCallPoints` of the same `ClientServerOperation`. It is also not allowed to specify both, a synchronous and an asynchronous server call point for the same `ClientServerOperation` instance.

2. **[SWS_Rte_03605]** [If several require ports of a software component are categorized by the same client/server interface, all invocations of the same operation of this client/server interface have to be either synchronous, or all invocations of the same operation have to be asynchronous. This restriction applies under the following conditions:
 - the usage of the indirect API is specified for at least one of the respective port prototypes **and/or**
 - the software component supports multiple instantiation, **and** the RTE generation shall be performed in compatibility mode.

]([SRS_Rte_00051](#), [SRS_Rte_00018](#))

Rationale: The signature of `Rte_Call` and the existence of `Rte_Result` depend on the kind of invocation.

3. **[SWS_Rte_07170]** [The RTE generator shall reject the configuration where [constr_2006] is violated.]([SRS_Rte_00051](#), [SRS_Rte_00018](#))

Rationale: The support of several `AsynchronousServerCallResultPoints` per `AsynchronousServerCallPoint` would potentially support multiple `AsynchronousServerCallReturnsEvents` as well as multiple `WaitPoints` for the same `AsynchronousServerCallPoint`.

A.5 Restriction concerning multiple instantiation of software components

1. **[SWS_Rte_07101]** [The RTE generator shall reject configurations where [constr_2024] is violated, so in which a `PortAPIOption` with `enableTakeAddress = TRUE` is defined by a software-component supporting multiple instantiation.]([SRS_Rte_00018](#))

Rationale: The main focus of the feature is support for configuration of AUTOSAR Services which are limited to single instances.

A.6 Restrictions concerning runnable entity

1. **[SWS_Rte_03527]** [The RTE does NOT support multiple Runnable Entities that share the same entry point.]([SRS_Rte_00072](#), [SRS_Rte_00018](#))

Rationale: The name of the runnable entity entry point is formed by a combination of SWC symbol prefix and `symbol` attribute of `RunnableEntity`. This means that two runnables in different SWCs can have the same `symbol` attribute as long as different SWC prefixes are used.

2. **[SWS_Rte_02733]** [The RTE Generator shall reject a configuration where a runnable has the attribute `canBeInvokedConcurrently` set to true and the attribute `minimumStartInterval` set to greater zero.]([SRS_Rte_00018](#))

Rationale: If a runnable should run concurrently (i.e., have several `ExecutableEntity execution-instances`), this implies that the minimum interval between the start of the runnables is zero. The configuration to be rejected is inconsistent.

3. **[SWS_Rte_08909]** [The RTE Generator shall reject a configuration where a `RunnableEntity` defines a `dataWriteAccess` and a `dataSendPoint` to the same data element, except when those data accesses are subject to variability with `bindingTime` later than `codeGenerationTime`.]([SRS_Rte_00018](#))

Note: Please note that if the accesses are subject to variability, this misconfiguration can only be detected if the latest `bindingTime` is `codeGenerationTime`. In other cases it is in the responsibility of the user to ensure that at run-time only one variant is active, i.e. either `dataWriteAccess` (implicit sending) or `dataSendPoint` (explicit sending), but not both.

A.7 Restrictions concerning runnables with dependencies on modes

1. Operations may not be disabled by a mode disabling dependency.

[SWS_Rte_02706] [RTE shall reject the configurations violating [constr_1523].]([SRS_Rte_00143](#), [SRS_Rte_00018](#))

[SWS_Rte_03869] [RTE shall reject the configurations violating [constr_4098].]([SRS_Rte_00143](#), [SRS_Rte_00018](#))

Rationale: It is a preferable implementation, if the server responds with an explicit application error, when the server operation is not supported in a mode. To implement the disabling of operations would require a high amount of book keeping even for internal client server communication to prevent that the unique request response mapping gets lost.

2. Only a category 1 runnable may be triggered by
 - a `SwcModeSwitchEvent`
 - an `RTEEvent` with a mode disabling dependency

[SWS_Rte_02500] [The RTE generator shall reject configurations with category 2 runnables connected to `SwcModeSwitchEvents` and `RTEEvents` / `BswEvents` with `mode disabling dependencies` if the mode machine instance is synchronous. The rejection may be reduced to a warning when the RTE generator is explicitly set to a non strict mode.]([SRS_Rte_00143](#), [SRS_Rte_00213](#), [SRS_Rte_00018](#))

Rationale: The above runnables are executed or terminated on the transitions between different modes. To execute the mode switch withing finite time, also these runnables have to be executed within finite execution time.

3. All `on-entry ExecutableEntities`, `on-transition ExecutableEntities`, and `on-exit ExecutableEntities` of the same `core local mode user group` should be mapped to the same task in case of synchronous mode switching procedure.

[SWS_Rte_02662] [The RTE generator shall reject configurations with on-entry, on-transition, or on-exit `ExecutableEntity`'s of the same `core local mode user group` that are mapped to different tasks in case of synchronous mode switching procedure.]([SRS_Rte_00143](#), [SRS_Rte_00213](#), [SRS_Rte_00018](#))

In case of asynchronous mode switching procedure, a mapping of all affected runnables to no task is also possible.

Rationale: This restriction simplifies the implementation of the semantics of a synchronous mode switch.

4. To guarantee that all `mode disabling dependent ExecutableEntities` of a `core local mode user group` have terminated before the start of the `on-exit ExecutableEntities` of the transition, the `mode disabling dependent ExecutableEntities` should run with higher or equal priority.

[SWS_Rte_02663] [The RTE generator shall reject configurations with `mode disabling dependent ExecutableEntities` that are mapped to a task with lower priority than the task that contains the `on-entry ExecutableEntities` and `on-exit ExecutableEntities` of that `core local mode user group` supporting a synchronous mode switching procedure.]([SRS_Rte_00143](#), [SRS_Rte_00213](#), [SRS_Rte_00018](#))

5. **[SWS_Rte_02664]** [The RTE generator shall reject configurations of a task with
 - `on-exit ExecutableEntities` mapped after `on-entry ExecutableEntities` or
 - `on-transition ExecutableEntities` mapped after `on-entry ExecutableEntities` or
 - `on-exit ExecutableEntities` mapped after `on-transition ExecutableEntities`

of the same `mode machine instance` supporting a synchronous mode switching procedure.]([SRS_Rte_00143](#), [SRS_Rte_00213](#), [SRS_Rte_00018](#))

Rationale: This restriction simplifies the implementation of the semantics of a synchronous mode switch.

6. **[SWS_Rte_06839]** [The RTE generator shall reject configurations of a DSMQ transition `OsTask` with

- `on-exit ExecutableEntitys` mapped after `on-entry ExecutableEntitys` or
- `on-exit ExecutableEntitys` mapped after `on-transition ExecutableEntitys` or
- `on-exit ExecutableEntitys` mapped after `ModeSwitchAck ExecutableEntitys` or
- `on-transition ExecutableEntitys` mapped after `on-entry ExecutableEntitys` or
- `on-transition ExecutableEntitys` mapped after `ModeSwitchAck ExecutableEntitys` or
- `on-entry ExecutableEntitys` mapped after `ModeSwitchAck ExecutableEntitys`

of `mode machine` instances belonging to a distributed shared mode group.] (*SRS_Rte_00310*, *SRS_Rte_00143*, *SRS_Rte_00213*, *SRS_Rte_00018*)

Rationale: This restriction simplifies the implementation of the semantics of a synchronous mode switch in combination with a distributed shared mode group.

7. **[SWS_Rte_07157]** [The RTE generator shall reject configurations with

- `on-exit ExecutableEntitys` mapped after `on-entry ExecutableEntitys` or
- `on-transition ExecutableEntitys` mapped after `on-entry ExecutableEntitys` or
- `on-exit ExecutableEntitys` mapped after `on-transition ExecutableEntitys`

of the same software component or Basic Software Module for a `mode machine instance` supporting an asynchronous mode switching procedure.] (*SRS_Rte_00143*, *SRS_Rte_00213*, *SRS_Rte_00018*)

Rationale: This restriction simplifies the implementation of the semantics of an asynchronous mode switch.

8. If a mode is used to trigger a runnable for entering or leaving the mode, but this runnable has a `mode disabling dependency` on the same mode, the `mode`

`disabling dependency` inhibits the activation of the runnable on the transition (see section 4.4.4).

To prevent such a misleading configuration, it is strongly recommended not to configure a `mode disabling dependency` for an `on-entry ExecutableEntity` or `on-exit ExecutableEntity`, using the same mode.

9. In case that the mode machine instance is initialized by `Rte_Init` API the related `on-entry Runnable Entities` for the `initialMode` have to be executed in the context of the `Rte_Init` API. In order to enable the complete transition to the `initialMode` it is required that all `on-entry Runnable Entities` are mapped to `RteInitializationRunnableBatch` containers otherwise a part of the `on-entry Runnable Entities` wouldn't be scheduled during the transition to the `initialMode`.

[SWS_Rte_CONSTR_09062] Entire mapping of on-entry Runnable Entities for `initialMode` to `RteInitializationRunnableBatch` containers [Either all or none of the `on-entry Runnable Entities` of a particular `mode machine instance` for the `initialMode` shall be mapped to `RteInitializationRunnableBatch` containers.]()

[SWS_Rte_06768] [The RTE Generator shall reject configurations violating **[SWS_Rte_CONSTR_09062]**.] (*SRS_Rte_00143, SRS_Rte_00240, SRS_Rte_00018*)

Please note as well **[SWS_Rte_CONSTR_09063]** which limits the applicability of the mapping to `RteInitializationRunnableBatch` containers.

A.8 Restriction concerning SwcInternalBehavior

1. **[SWS_Rte_07686]** [The RTE Generator shall reject configurations where an `ApplicationSwComponentType`, `ServiceSwComponentType`, `ComplexDeviceDriverSwComponentType`, `EcuAbstractionSwComponentType`, `SensorActuatorSwComponentType` or `ServiceProxySwComponentType` does not contain a `SwcInternalBehavior`.] (*SRS_Rte_00018*)

A.9 Restrictions concerning Initial Value

1. **[SWS_Rte_07642]** [When the *external configuration switch* `strictInitialValuesCheck` is enabled, the RTE Generator shall reject configurations where a `SwAddrMethod` has a `sectionInitializationPolicy` set to `init` but no `initValues` are specified on the sender or receiver side.] (*SRS_Rte_00068, SRS_Rte_00108, SRS_Rte_00018*)

Rationale: The `initValue` is used to guarantee that the RTE won't deliver undefined values.

2. **[SWS_Rte_08311]** [When the *external configuration switch* `strictInitialValuesCheck` is enabled, the RTE Generator shall reject configurations where a `SwAddrMethod` has a `sectionInitializationPolicy` set to `init` but no `initValue` is specified on the inter runnable variable.] ([SRS_Rte_00068](#), [SRS_Rte_00108](#), [SRS_Rte_00018](#))

Rationale: The `initValue` is used to guarantee that the RTE won't deliver undefined values.

3. **[SWS_Rte_07681]** [If strict checking of initial values is enabled (see [\[SWS_Rte_07680\]](#)), the RTE Generator shall reject configurations where a `ParameterDataPrototype` has no `initValues`.] ([SRS_Rte_00108](#), [SRS_Rte_00018](#))

Rationale: This allows to provide the values with a calibration without any involvements from the RTE Generator, and still permits to enable a stricter check on projects where it is required.

A.10 Restriction concerning `PerInstanceMemory`

1. **[SWS_Rte_07045]** [The RTE generator shall reject configurations where the `type` attribute of a '`C`' typed `PerInstanceMemory` is equal to the name of a `ImplementationDataType` contained in the input configuration.] ([SRS_Rte_00013](#), [SRS_Rte_00077](#))

Rationale: This would lead to equally named C type definitions.

A.11 Restrictions concerning unconnected r-port

1. **[SWS_Rte_03019]** [If strict checking has been enabled (see [\[SWS_Rte_05099\]](#)) in the RTE Generation phase there shall not be unconnected r-port. The RTE generator shall in this case reject the configuration with unconnected r-port.] ([SRS_Rte_00139](#), [SRS_Rte_00018](#))

Rationale: Unconnected r-port is considered as wrong configuration of the system.

2. **[SWS_Rte_02750]** [The RTE Generator phase shall reject configurations where an r-port typed with a `ParameterInterface` is not connected and an `initValue` of a `ParameterRequireComSpec` is not provided for each `ParameterDataPrototypes` of this `ParameterInterface`.] ([SRS_Rte_00139](#), [SRS_Rte_00159](#), [SRS_Rte_00018](#))

3. **[SWS_Rte_82004]{DRAFT}** [If strict checking has been enabled (see [\[SWS_Rte_05099\]](#)) in the *Cluster Generation phase* there shall not be unconnected r-port where for the related Data Communication Graph no RTE Implementation Plug-In support is enabled. The RTE generator shall in this case reject the configuration with unconnected r-port.]([SRS_Rte_00139](#), [SRS_Rte_00018](#))

A.12 Restrictions concerning unconnected requiredData, requiredModeGroup, requiredTrigger and required-ClientServerEntry

1. **[SWS_Rte_02316]** [If strict checking has been enabled (see [\[SWS_Rte_05099\]](#)) there shall not be unconnected [requiredData](#), [requiredModeGroup](#), [requiredTrigger](#) or [requiredClientServerEntry](#). The RTE generator shall in this case reject the configuration with unconnected [requiredData](#), [requiredModeGroup](#), [requiredTrigger](#), or [requiredClientServerEntry](#).]([SRS_Rte_00139](#), [SRS_Rte_00018](#))

A.13 Restrictions regarding communication of mode switch notifications

1. **[SWS_Rte_02670]** [RTE shall not support connections with multiple senders (n:1 communication) of [mode switch notifications](#) connected to the same receiver. The RTE generator shall reject configurations with multiple senders of [mode switch notifications](#) connected to the same receiver.]([SRS_Rte_00131](#), [SRS_Rte_00018](#))

Rationale: No use case is known to justify the required complexity.

2. **[SWS_Rte_08788]** [RTE shall reject configurations
 - where one [ModeDeclarationGroupPrototype](#) of a provide port is connected to [ModeDeclarationGroupPrototypes](#) of require ports from more than one partition
 and
 - where at least one of the mode user partitions can be restarted
 and
 - where the [modeUserErrorBehavior](#) of [ModeDeclarationGroup](#) is not set to [lastMode](#)
]([SRS_Rte_00131](#), [SRS_Rte_00018](#))

3. For each [ModeDeclarationGroup](#), used in the SW-C's ports, RTE needs a unique mapping to an [ImplementationDataType](#).

[SWS_Rte_02738] [RTE shall reject a configuration, in which there is not exactly one [ModeRequestTypeMap](#) referencing the [ModeDeclarationGroup](#) used in a [ModeDeclarationGroupPrototype](#) of the SW-C's ports.]([SRS_Rte_00144](#), [SRS_Rte_00018](#))

4. **[SWS_Rte_08908]** [The Rte Generator shall reject configurations violating [constr_1098].]([SRS_Rte_00018](#), [SRS_Rte_00143](#), [SRS_Rte_00144](#))

A.14 Restrictions regarding Measurement and Calibration

1. **[SWS_Rte_03951]** [RTE does not support measurement of queued communication.]([SRS_Rte_00153](#), [SRS_Rte_00018](#))

Rationale: Measurement of queued communication is not supported yet. Reasons are:

- A queue can be empty. What's to measure then? Data interpretation is ambiguous.
- Which of the queue entries the measurement data has to be taken from (first pending entry, last entry, an intermediate one, mean value, min. or max. value)? Needs might differ out of user view? Data interpretation is ambiguous.
- Compared e.g. to sender-receiver last-is-best approach only inefficient solutions are possible because implementation of queues entails storage of information dynamically at different memory locations. So always additional copies are required.

2. **[SWS_Rte_03970]** [The RTE generator shall reject configurations violating [constr_1092] so containing require ports attached to [ParameterSwComponentTypes](#).]([SRS_Rte_00154](#), [SRS_Rte_00156](#), [SRS_Rte_00018](#))

Rationale: Require ports on [ParameterSwComponentTypes](#) don't make sense. [ParameterSwComponentTypes](#) only have to provide calibration parameters to other [SwComponentTypes](#).

A.15 Restriction concerning ExclusiveAreaImplMechanism

1. **Usage of [WaitPoints](#) is restricted depending on *ExclusiveAreaImplMechanism***

If an exclusive area's configuration value for *ExclusiveAreaImplMechanism* is *InterruptBlocking* or *OsResource*, no runnable entity shall contain any [WaitPoint](#) inside this exclusive area.

Please note that a wait point can either be a modelling `WaitPoint` e. g. a `WaitPoint` in the SW-C description caused by the usage of a blocking API (e. g. `Rte_Receive`) or an implementation wait point caused by a special implementation to fulfill the requirements of the ECU configuration, e. g. the runnable-to-task mapping.

Rationale: The operating system has the limitation that a `WaitEvent` call is not allowed with disabled interrupts. Therefore the implementation mechanism *InterruptBlocking* cannot be used if the exclusive area contains a `WaitPoint`.

Further the operating system has the limitation that an OS `WaitPoint` cannot be entered with occupied OS Resources. This implies that the implementation mechanism *OsResource* cannot be used if the exclusive area contains a `WaitPoint`.

A.16 Restrictions concerning `AtomicSwComponentTypes`

1. **[SWS_Rte_07190]** [The RTE generator shall reject configurations where multiple `SwComponentTypes` have the same `component type symbol` regardless of the `ARPackage` hierarchy.](*SRS_Rte_00018*)

Rational: This is required to generated unique names for the *Application Header Files* and component data structures.

2. **[SWS_Rte_07191]** [The RTE generator shall reject configurations where a `SwComponentType` has `PortPrototypes` typed by different `PortInterfaces` with equal short name but conflicting `ApplicationErrors`. `ApplicationErrors` are conflicting if `ApplicationErrors` with same name do have different `errorCodes`.](*SRS_Rte_00018*)

Rational: This is required to generated unique symbolic names for `ApplicationErrors`. (see also [SWS_Rte_02576])

A.17 Restriction concerning the `enableUpdate` attribute of `Non-queuedReceiverComSpecs`

1. **[SWS_Rte_07654]** [The RTE Generator shall reject configurations violating [constr_1103] so where a `VariableDataPrototype` is referenced by a `Non-queuedReceiverComSpec` with the `enableUpdate` attribute enabled, when this `VariableDataPrototype` is referenced by a `VariableAccess` in the `dataReadAccess` role.](*SRS_Rte_00179*, *SRS_Rte_00018*)

Rational: the update flag is restricted to explicit communication currently.

A.18 Restrictions concerning the large and dynamic data type

1. **[SWS_Rte_07810]** [The RTE shall reject the configuration if a `dataElement` that contain an `ImplementationDataType` with `subElements` with `arraySizeSemantics` equal to `variableSize` resolves to another type than `uint8[n]`.] ([SRS_Rte_00018](#))

Rationale: COM limits the dynamic signals to the `ComSignalType` `UINT_8DYN` (see the requirement COM569). COM doesn't support dynamic signals included into signal groups. See more explanations in chapter 4.3.1.14.

2. **[SWS_Rte_08423]** [The RTE shall reject the configuration if an `ImplementationDataType` does not have a `dynamicArraySizeProfile` defined and contains a `subElement` with the category `ARRAY` that in turn contains a `subElement` with `arraySizeSemantics` set to `variableSize`.] ([SRS_Rte_00018](#))
3. **[SWS_Rte_07811]** [The RTE shall reject configurations where a `dataElement` mapped to a Com I-PDU with `ComIPduType` equal to `TP` and `swImplPolicy` is different from `queued` and `supportedFeatures` of the `PortAPIOption` is not set to `supportsBufferLocking`.] ([SRS_Rte_00018](#))

Rationale: Otherwise COM might return `COM_BUSY`. See more explanations in chapter 4.3.1.15.

4. **[SWS_Rte_08603]** [The RTE shall reject configurations where a `dataElement` mapped to a LdCom I-PDU with `LdComApiType` equals to `LdCom_TP` and `swImplPolicy` is different from `queued` and `supportedFeatures` of the `PortAPIOption` is not set to `supportsBufferLocking`.] ([SRS_Rte_00018](#))
5. **[SWS_Rte_08604]** [The RTE shall reject configurations where a `ClientServerOperation` mapped to a Com I-PDU with `ComIPduType` equal to `TP` and `supportedFeatures` of the `PortAPIOption` is not set to `supportsBufferLocking`.] ([SRS_Rte_00018](#))
6. **[SWS_Rte_08605]** [The RTE shall reject configurations where a `ClientServerOperation` mapped to a LdCom I-PDU with `LdComApiType` equals to `LdCom_TP` and `supportedFeatures` of the `PortAPIOption` is not set to `supportsBufferLocking`.] ([SRS_Rte_00018](#))
7. **[SWS_Rte_07812]** [The RTE shall reject the configuration if a `dataElement` with an `ImplementationDataType` with `subElements` with `arraySizeSemantics` equal to `variableSize` has a `swImplPolicy` different from `queued`.] ([SRS_Rte_00018](#))

Rationale: Otherwise COM might return `COM_BUSY`. See more explanations in chapter 4.3.1.15.

A.19 Restriction concerning REFERENCE types

1. **[SWS_Rte_07670]** [The RTE shall reject a configuration violating [constr_1295].] ([SRS_Rte_00018](#))

Rationale: This prevents the misuse of references for communication via the referenced memory (intra-partition scope) between `ApplicationSwComponentTypes` and/or `SensorActuatorSwComponentTypes`. For example, such a misuse could occur with application software components communicating together and being mapped to different partitions or ECUs.

A.20 Restriction concerning ModeDeclarationGroup categories and value attributes

1. **[SWS_Rte_06801]** [The RTE generator shall reject a configuration if constraint [constr_1298] is violated.] ([SRS_Rte_00018](#))

[SWS_Rte_06802] [The RTE generator shall reject a configuration if constraint [constr_1299] is violated.] ([SRS_Rte_00018](#))

[SWS_Rte_06803] [The RTE generator shall reject a configuration if constraint [constr_1181] is violated.] ([SRS_Rte_00018](#))

Rationale: In case of category `EXPLICIT_ORDER` the `onTransitionValue` and `value` attributes are required to generate the according definitions (see [5.5.3](#) and [6.4.2](#)). Thereby unique numbers are required. In case of `ALPHABETIC_ORDER` the definition of those values are meaningless and causing the risk of inconsistency to the numbering according the alphabetical sorting.

A.21 Restrictions concerning C/S Interfaces

1. **[SWS_Rte_07845]** [The Rte Generator shall reject configurations where a `ClientServerOperation` in a `PPortPrototype` is defined but no `RunnableEntity` is triggered by an `OperationInvokedEvent` that references the `ClientServerOperation`.] ([SRS_Rte_00029](#), [SRS_Rte_00018](#))

Rationale: Otherwise the implementation by a server runnable of the operation in the C/S interface does not exist.

2. **[SWS_Rte_72023]{DRAFT}** [In the Cluster Generation Mode the RTE generator shall reject configurations where a `SynchronousServerCallPoint` requires a blocking serialization of the server call.] ([SRS_Rte_00029](#), [SRS_Rte_00018](#))

Please note that **[SWS_Rte_72023]** does not prevent from usage of `direct function call` or `trusted function call` configuration.

Rationale: No blocking APIs are expected in [Applicative Software Clusters](#) to avoid blocking of the common schedule. See as well [\[SWS_Rte_CONSTR_80031\]](#).

A.22 Restrictions concerning S/R Features

1. **[SWS_Rte_CONSTR_80200]{DRAFT}** [If at any [RPortPrototype](#) belonging to a [Data Communication Graph](#) an [NonqueuedReceiverComSpec](#) is defined with either
 - the attribute [aliveTimeout](#) set to a value greater than zero **and/or**
 - the attribute [handleNeverReceived](#) set to TRUE **and/or**
 - the attribute [handleOutOfRange](#) not set to none **and/or**
 - the attribute [handleDataStatus](#) set to TRUE **and/or**
 - the attribute the [enableUpdate](#) set to TRUE
 exists the [CpSoftwareClusterCommunicationResource.comProps.sendIndication](#) shall be set to [anySendOperation.](#)]([SRS_Rte_00300](#), [SRS_Rte_00301](#), [SRS_Rte_00018](#))
2. **[SWS_Rte_82012]{DRAFT}** [The RTE generator shall reject a configuration if constraint [\[SWS_Rte_CONSTR_80200\]](#) is violated.]([SRS_Rte_00300](#), [SRS_Rte_00301](#), [SRS_Rte_00018](#))

B External Requirements

A summary on model constraints is provided in document [\[34\]](#).

C MISRA C Compliance

In general, all RTE code, whether generated or not, shall conform to the MISRA C standard [SWS_Rte_01168] [27]. This chapter lists all the MISRA C rules that may be violated by the generated RTE.

The MISRA C standard was defined with having mainly hand-written code in mind. Part of the MISRA C rules only apply to hand-written code, they do not make much sense in the context of automatic code generation. Additionally, there are some rules that are violated because of technical reasons, mainly to reduce RTE overhead.

The rules listed in this chapter are expected to be violated by RTE code. Violations to the rules listed here do not need to be documented as non-compliant to MISRA C in the generated code itself.

MISRA rule	2.3
Description	A project should not contain unused type declarations.
Violations	This is in support of [SWS_Rte_02648].

Table C.1: MISRA rule 2.3

MISRA rules	5.1 to 5.5, Dir1.1
Description	Identifiers (internal and external) shall not rely on significance of more than 31 characters. Furthermore the compiler/linker shall be checked to ensure that 31 character significance and case sensitivity are supported for external identifiers.
Violations	The defined RTE naming convention may result in identifiers with more than 31 characters. The compliance to this rule is under user's control.

Table C.2: MISRA rules 5.1 to 5.5, Dir1.1

MISRA rule	8.5
Description	An external object or function shall be declared once and in one and only one file.
Violations	This is in support of application header file generation.

Table C.3: MISRA rule 8.5

MISRA rule	8.8
Description	The static storage class specifier shall be used in all declarations of objects and functions that have internal linkage.
Violations	E.g. for the purpose of monitoring during calibration or debugging it may be necessary to use non-static declarations at file scope.

Table C.4: MISRA rule 8.8

MISRA rule	12.3
Description	The comma operator should not be used.
Violations	Function-like macros may have to use the comma operator. Function-like macros are required for efficiency reasons [SRS_BSW_00330].

Table C.5: MISRA rule 12.3

MISRA rule	11.2
Description	Conversions shall not be performed between a pointer to an incomplete type and any other type.
Violations	Casting to/from pointer type may be needed for the interface with COM. Casting from a pointer to a <code>data element with status</code> to a pointer to a <code>data element without status</code> .

Table C.6: MISRA rule 11.2

MISRA rule	11.3
Description	A cast shall not be performed between a pointer to object type and a pointer to a different object type.
Violations	Casting to/from pointer type may be needed for the interface with COM. Casting from a pointer to a <code>data element with status</code> to a pointer to a <code>data element without status</code> .

Table C.7: MISRA rule 11.3

MISRA rule	8.7
Description	Functions and objects should not be defined with external linkage if they are referenced in only one translation unit.
Violations	Support the use cases where SW-Cs are delivered as OBJ code and the ports might not be connected during generation time.

Table C.8: MISRA rule 8.7

MISRA rule	11.5
Description	A conversion should not be performed from pointer to void into pointer to object.
Violations	Casting to/from pointer type may be needed for the interface with COM. Casting from a pointer to a data element with status to a pointer to a data element without status.

Table C.9: MISRA rule 11.5

D Referenced Meta Classes

Class	ARPackage			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ARPackage			
Note	<p>AUTOSAR package, allowing to create top level packages to structure the contained ARElements.</p> <p>ARPackages are open sets. This means that in a file based description system multiple files can be used to partially describe the contents of a package.</p> <p>This is an extended version of MSR's SW-SYSTEM.</p>			
Base	ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
arPackage	ARPackage	*	aggr	<p>This represents a sub package within an ARPackage, thus allowing for an unlimited package hierarchy.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=arPackage.shortName, arPackage.variation Point.shortLabel vh.latestBindingTime=blueprintDerivationTime xml.sequenceOffset=30</p>
element	PackageableElement	*	aggr	<p>Elements that are part of this package</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=element.shortName, element.variation Point.shortLabel vh.latestBindingTime=systemDesignTime xml.sequenceOffset=20</p>
referenceBase	ReferenceBase	*	aggr	<p>This denotes the reference bases for the package. This is the basis for all relative references within the package. The base needs to be selected according to the base attribute within the references.</p> <p>Stereotypes: atpSplitable</p> <p>Tags: atp.Splitkey=referenceBase.shortLabel xml.sequenceOffset=10</p>

Table D.1: ARPackage

Class	AbstractAccessPoint (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::AccessCount			
Note	Abstract class indicating an access point from an ExecutableEntity.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Subclasses	AsynchronousServerCallResultPoint, ExternalTriggeringPointIdent, InternalTriggeringPoint , ModeAccessPointIdent, ModeSwitchPoint , ParameterAccess , ServerCallPoint , VariableAccess			
Attribute	Type	Mult.	Kind	Note
returnValue Provision	RteApiReturnValue ProvisionEnum	0..1	attr	This attribute controls the provision of return values for RTE APIs that correspond to the enclosing access point.

Table D.2: AbstractAccessPoint

Class	AbstractProvidedPortPrototype (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	This abstract class provides the ability to become a provided PortPrototype.			





Class	AbstractProvidedPortPrototype (abstract)			
Base	ARObject, AtpBlueprintable, AtpFeature, AtpPrototype, Identifiable , MultilanguageReferrable, PortPrototype , Referrable			
Subclasses	PPortPrototype, PRPortPrototype			
Attribute	Type	Mult.	Kind	Note
providedComSpec	PPortComSpec	*	aggr	Provided communication attributes per interface element (data element or operation).

Table D.3: AbstractProvidedPortPrototype

Class	AbstractRequiredPortPrototype (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	This abstract class provides the ability to become a required PortPrototype.			
Base	ARObject, AtpBlueprintable, AtpFeature, AtpPrototype, Identifiable , MultilanguageReferrable, PortPrototype , Referrable			
Subclasses	PRPortPrototype, RPortPrototype			
Attribute	Type	Mult.	Kind	Note
requiredComSpec	RPortComSpec	*	aggr	Required communication attributes, one for each interface element.

Table D.4: AbstractRequiredPortPrototype

Class	AnyInstanceRef			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::AnyInstanceRef			
Note	Describes a reference to any instance in an AUTOSAR model. This is the most generic form of an instance ref. Refer to the superclass notes for more details.			
Base	ARObject, AtpInstanceRef			
Attribute	Type	Mult.	Kind	Note
base	AtpClassifier	1	ref	This is the base from which navigation path begins. Stereotypes: atpDerived
contextElement	AtpFeature	*	ref	This is one step in the navigation path specified by the instance ref.
target	AtpFeature	1	ref	This is the target of the instance ref.

Table D.5: AnyInstanceRef

Enumeration	ApiPrincipleEnum			
Package	M2::AUTOSARTemplates::CommonStructure::InternalBehavior			
Note	This enumeration represents the ability to control the granularity of API generation.			
Literal	Description			
common	The Rte or SchM API is provided for the whole software component / BSW Module Tags: atp.EnumerationLiteralIndex=0			
perExecutable	The Rte or SchM API is provided for a specific ExecutableEntity of a software component / BSW Module Tags: atp.EnumerationLiteralIndex=1			

Table D.6: ApiPrincipleEnum

Class	ApplicationArrayDataType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::Datatypes			
Note	An application data type which is an array, each element is of the same application data type. Tags: atp.recommendedPackage=ApplicationDataTypes			
Base	ARElement, ARObject, ApplicationCompositeDataType , ApplicationDataType , AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, AutosarDataType , CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
dynamicArraySizeProfile	String	0..1	attr	Specifies the profile which the array will follow if it is a variable size array.
element	ApplicationArrayElement	0..1	aggr	This association implements the concept of an array element. That is, in some cases it is necessary to be able to identify single array elements, e.g. as input values for an interpolation routine.

Table D.7: ApplicationArrayDataType

Class	ApplicationArrayElement			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::DataPrototypes			
Note	Describes the properties of the elements of an application array data type.			
Base	ARObject, ApplicationCompositeElementDataPrototype , AtpFeature, AtpPrototype, DataPrototype , Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
arraySizeHandling	ArraySizeHandlingEnum	0..1	attr	The way how the size of the array is handled.
arraySizeSemantics	ArraySizeSemanticsEnum	0..1	attr	This attribute controls how the information about the array size shall be interpreted.
indexDataType	ApplicationPrimitiveDataType	0..1	ref	This reference can be taken to assign a CompuMethod of category TEXTTABLE to the array. The texttable entries associate a textual value to an index number such that the element with that index number is represented by a symbolic name.
maxNumberOfElements	PositiveInteger	0..1	attr	The maximum number of elements that the array can contain. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime

Table D.8: ApplicationArrayElement

Class	ApplicationCompositeDataType (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::Datatypes			
Note	Abstract base class for all application data types composed of other data types.			
Base	ARElement, ARObject, ApplicationDataType , AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, AutosarDataType , CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Subclasses	ApplicationArrayDataType , ApplicationRecordDataType			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.9: ApplicationCompositeDataType

Class	ApplicationCompositeElementDataPrototype (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::DataPrototypes			
Note	This class represents a data prototype which is aggregated within a composite application data type (record or array). It is introduced to provide a better distinction between target and context in instance Refs.			
Base	ARObject, AtpFeature, AtpPrototype, DataPrototype , Identifiable , MultilanguageReferrable , Referrable			
Subclasses	ApplicationArrayElement , ApplicationRecordElement			
Attribute	Type	Mult.	Kind	Note
type	ApplicationDataType	0..1	tref	This represents the corresponding data type. Stereotypes: isOfType

Table D.10: ApplicationCompositeElementDataPrototype

Class	ApplicationDataType (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::Datatypes			
Note	ApplicationDataType defines a data type from the application point of view. Especially it should be used whenever something "physical" is at stake. An ApplicationDataType represents a set of values as seen in the application model, such as measurement units. It does not consider implementation details such as bit-size, endianness, etc. It should be possible to model the application level aspects of a VFB system by using ApplicationData Types only.			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, AutosarDataType , CollectableElement , Identifiable , MultilanguageReferrable , PackageableElement , Referrable			
Subclasses	ApplicationCompositeDataType , ApplicationPrimitiveDataType			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.11: ApplicationDataType

Class	ApplicationError			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	This is a user-defined error that is associated with an element of an AUTOSAR interface. It is specific for the particular functionality or service provided by the AUTOSAR software component.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
errorCode	Integer	0..1	attr	The RTE generator is forced to assign this value to the corresponding error symbol. Note that for error codes certain ranges are predefined (see RTE specification).

Table D.12: ApplicationError

Class	ApplicationPrimitiveDataType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::Datatypes			
Note	A primitive data type defines a set of allowed values. Tags: atp.recommendedPackage=ApplicationDataTypes			
Base	ARElement, ARObject, ApplicationDataType , AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, AutosarDataType , CollectableElement , Identifiable , MultilanguageReferrable , PackageableElement , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.13: ApplicationPrimitiveDataType

Class	ApplicationRecordDataType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::Datatypes			
Note	An application data type which can be decomposed into prototypes of other application data types. Tags: atp.recommendedPackage=ApplicationDataTypes			
Base	ARElement, ARObject, ApplicationCompositeDataType , ApplicationDataType , AtpBlueprint , AtpBlueprintable , AtpClassifier , AtpType , AutosarDataType , CollectableElement , Identifiable , MultilanguageReferrable , PackageableElement , Referrable			
Attribute	Type	Mult.	Kind	Note
element (ordered)	ApplicationRecordElement	*	aggr	Specifies an element of a record. The aggregation of ApplicationRecordElement is subject to variability with the purpose to support the conditional existence of elements inside a ApplicationrecordData Type. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime

Table D.14: ApplicationRecordDataType

Class	ApplicationRecordElement			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::DataPrototypes			
Note	Describes the properties of one particular element of an application record data type.			
Base	ARObject, ApplicationCompositeElementDataPrototype , AtpFeature , AtpPrototype , DataPrototype , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
isOptional	Boolean	0..1	attr	This attribute represents the ability to declare the enclosing ApplicationRecordElement as optional. This means the that, at runtime, the ApplicationRecord Element may or may not have a valid value and shall therefore be ignored. The underlying runtime software provides means to set the ApplicationRecordElement as not valid at the sending end of a communication and determine its validity at the receiving end.

Table D.15: ApplicationRecordElement

Class	ApplicationRuleBasedValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	This meta-class represents rule based values for DataPrototypes typed by ApplicationDataTypes (ApplicationArrayDataType or a compound ApplicationPrimitiveDataType which also boils down to an array-nature).			
Base	ARObject, AbstractRuleBasedValueSpecification , ValueSpecification			
Attribute	Type	Mult.	Kind	Note
category	Identifier	0..1	attr	This represents the category of the RuleBasedValue Specification Tags: xml.sequenceOffset=-20
swAxisCont (ordered)	RuleBasedAxisCont	*	aggr	This represents the axis values of a Compound Primitive Data Type (curve or map). The first swAxisCont describes the x-axis, the second swAxisCont describes the y-axis, the third swAxisCont describes the z-axis. In addition to this, the axis can be denoted in swAxisIndex.





Class	ApplicationRuleBasedValueSpecification			
swValueCont	RuleBasedValueCont	0..1	aggr	This represents the values of an array or Compound Primitive Data Type.

Table D.16: ApplicationRuleBasedValueSpecification

Class	ApplicationSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	The ApplicationSwComponentType is used to represent the application software. Tags: atp.recommendedPackage=SwComponentTypes			
Base	ARElement, ARObject, AtomicSwComponentType , AtpBlueprint , AtpBlueprintable , AtpClassifier , AtpType , CollectableElement , Identifiable , MultilanguageReferrable , PackageableElement , Referrable , SwComponentType			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.17: ApplicationSwComponentType

Class	ApplicationValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	This meta-class represents values for DataPrototypes typed by ApplicationDataTypes (this includes in particular compound primitives). For further details refer to ASAM CDF 2.0. This meta-class corresponds to some extent with SW-INSTANCE in ASAM CDF 2.0.			
Base	ARObject, ValueSpecification			
Attribute	Type	Mult.	Kind	Note
category	Identifier	0..1	attr	Specifies to which category of ApplicationDataType this ApplicationValueSpecification can be applied (e.g. as an initial value), thus imposing constraints on the structure and semantics of the contained values, see [constr_1006] and [constr_2051].
swAxisCont (ordered)	SwAxisCont	*	aggr	This represents the axis values of a Compound Primitive Data Type (curve or map). The first swAxisCont describes the x-axis, the second swAxisCont describes the y-axis, the third swAxisCont describes the z-axis. In addition to this, the axis can be denoted in swAxisIndex.
swValueCont	SwValueCont	0..1	aggr	This represents the values of a Compound Primitive Data Type.

Table D.18: ApplicationValueSpecification

Class	ArgumentDataPrototype			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	An argument of an operation, much like a data element, but also carries direction information and is owned by a particular ClientServerOperation.			
Base	ARObject, AtpFeature, AtpPrototype, AutosarDataPrototype , DataPrototype , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
direction	ArgumentDirectionEnum	0..1	attr	This attribute specifies the direction of the argument prototype.





Class	ArgumentDataPrototype			
serverArgumentImplPolicy	ServerArgumentImplPolicyEnum	0..1	attr	This defines how the argument type of the servers RunnableEntity is implemented. If the attribute is not defined this has the same semantics as if the attribute is set to the value useArgumentType for primitive arguments and structures.

Table D.19: ArgumentDataPrototype

Enumeration	ArgumentDirectionEnum
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes
Note	Use cases: <ul style="list-style-type: none"> Arguments in ClientServerOperation can have different directions that need to be formally indicated because they have an impact on how the function signature looks like eventually. Arguments in BswModuleEntry already determine a function signature, but the direction is used to specify the semantics, especially of pointer arguments.
Literal	Description
in	The argument value is passed to the callee. Tags: atp.EnumerationLiteralIndex=0
inout	The argument value is passed to the callee but also passed back from the callee to the caller. Tags: atp.EnumerationLiteralIndex=1
out	The argument value is passed from the callee to the caller. Tags: atp.EnumerationLiteralIndex=2

Table D.20: ArgumentDirectionEnum

Enumeration	ArrayImplPolicyEnum
Package	M2::AUTOSARTemplates::CommonStructure::ImplementationDataTypes
Note	This meta-class provides values to configure the implementation of the payload part of an array.
Literal	Description
payloadAsArray	This configuration demands the implementation of the payload as an array. Tags: atp.EnumerationLiteralIndex=0
payloadAsPointerTo Array	This configuration demands the implementation of the payload as a pointer to an array. Tags: atp.EnumerationLiteralIndex=1

Table D.21: ArrayImplPolicyEnum

Enumeration	ArraySizeSemanticsEnum
Package	M2::AUTOSARTemplates::CommonStructure::ImplementationDataTypes
Note	This type controls how the information about the number of elements in an ApplicationArrayDataType is to be interpreted.
Literal	Description
fixedSize	This means that the ApplicationArrayDataType will always have a fixed number of elements. Tags: atp.EnumerationLiteralIndex=0
variableSize	This implies that the actual number of elements in the ApplicationArrayDataType might vary at run-time. The value of arraySize represents the maximum number of elements in the array. Tags: atp.EnumerationLiteralIndex=1

Table D.22: ArraySizeSemanticsEnum

Class	ArrayValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	Specifies the values for an array.			
Base	ARObject, CompositeValueSpecification , ValueSpecification			
Attribute	Type	Mult.	Kind	Note
element (ordered)	ValueSpecification	*	aggr	The value for a single array element. All Value Specifications aggregated by ArrayValueSpecification shall have the same structure. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
intendedPartial Initialization Count	PositiveInteger	0..1	attr	This attribute shall only have a meaning for dynamic arrays and shall be taken as a sanity check: the number filled in the attribute shall be identical to the number of ArrayValueSpecification.element. If the attribute does not exist it means that no partial initialization is intended.

Table D.23: ArrayValueSpecification

Class	AssemblySwConnector			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	AssemblySwConnectors are exclusively used to connect SwComponentPrototypes in the context of a CompositionSwComponentType.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable , Referrable , SwConnector			
Attribute	Type	Mult.	Kind	Note
provider	AbstractProvidedPort Prototype	0..1	iref	Instance of providing port. InstanceRef implemented by: PPortInComposition InstanceRef
requester	AbstractRequiredPort Prototype	0..1	iref	Instance of requiring port. InstanceRef implemented by: RPortInComposition InstanceRef

Table D.24: AssemblySwConnector

Class	AsynchronousServerCallPoint			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ServerCall			
Note	An AsynchronousServerCallPoint is used for asynchronous invocation of a ClientServerOperation. IMPORTANT: a ServerCallPoint cannot be used concurrently. Once the client RunnableEntity has made the invocation, the ServerCallPoint cannot be used until the call returns (or an error occurs!) at which point the ServerCallPoint becomes available again.			
Base	ARObject, AbstractAccessPoint , AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable , Referrable , ServerCallPoint			
Attribute	Type	Mult.	Kind	Note
—	—	—	—	—

Table D.25: AsynchronousServerCallPoint

Class	AsynchronousServerCallResultPoint			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ServerCall			
Note	If a RunnableEntity owns a AsynchronousServerCallResultPoint it is entitled to get the result of the referenced AsynchronousServerCallPoint. If it is associated with AsynchronousServerCallReturnsEvent, this RTEEvent notifies the completion of the required ClientServerOperation or a timeout. The occurrence of this event can either unblock a WaitPoint or can lead to the invocation of a RunnableEntity.			
Base	ARObject, AbstractAccessPoint , AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
asynchronous ServerCallPoint	AsynchronousServerCallPoint	0..1	ref	The referenced Asynchronous Server Call Point defines the asynchronous server call from which the results are returned.

Table D.26: AsynchronousServerCallResultPoint

Class	AsynchronousServerCallReturnsEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This event is raised when an asynchronous server call is finished.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
eventSource	AsynchronousServerCallResultPoint	0..1	ref	The referenced AsynchronousServerCallResultPoint which is raises the RTEEvent in case of returning asynchronous server call.

Table D.27: AsynchronousServerCallReturnsEvent

Class	AtomicSwComponentType (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	An atomic software component is atomic in the sense that it cannot be further decomposed and distributed across multiple ECUs.			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable , SwComponentType			
Subclasses	ApplicationSwComponentType , ComplexDeviceDriverSwComponentType , EcuAbstractionSwComponentType , NvBlockSwComponentType , SensorActuatorSwComponentType , ServiceProxySwComponentType , ServiceSwComponentType			
Attribute	Type	Mult.	Kind	Note
internalBehavior	SwcInternalBehavior	0..1	aggr	The SwcInternalBehaviors owned by an AtomicSw ComponentType can be located in a different physical file. Therefore the aggregation is <<atpSplitable>>. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=internalBehavior.shortName, internalBehavior.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
symbolProps	SymbolProps	0..1	aggr	This represents the SymbolProps for the AtomicSw ComponentType. Stereotypes: atpSplitable Tags: atp.Splitkey=symbolProps.shortName

Table D.28: AtomicSwComponentType

Class	<<atpMixedString>> AttributeValueVariationPoint (abstract)			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents the ability to derive the value of the Attribute from a system constant (by Sw SystemconstDependentFormula). It also provides a bindingTime.			
Base	ARObject, FormulaExpression, SwSystemconstDependentFormula			
Subclasses	AbstractEnumerationValueVariationPoint, AbstractNumericalVariationPoint, BooleanValueVariationPoint, FloatValueVariationPoint, IntegerValueVariationPoint, PositiveIntegerValueVariationPoint, TimeValueVariationPoint, UnlimitedIntegerValueVariationPoint			
Attribute	Type	Mult.	Kind	Note
bindingTime	BindingTimeEnum	0..1	attr	<p>This is the binding time in which the attribute value needs to be bound.</p> <p>If this attribute is missing, the attribute is not a variation point. In particular this means that It needs to be a single value according to the type specified in the pure model. It is an error if it is still a formula.</p> <p>Tags:xml.attribute=true</p>
blueprintValue	String	0..1	attr	<p>This represents a description that documents how the value shall be defined when deriving objects from the blueprint.</p> <p>Tags:xml.attribute=true</p>
sd	String	0..1	attr	<p>This special data is provided to allow synchronization of Attribute value variation points with variant management systems. The usage is subject of agreement between the involved parties.</p> <p>Tags:xml.attribute=true</p>
shortLabel	PrimitivIdentifier	0..1	attr	<p>This allows to identify the variation point. It is also intended to allow RTE support for CompileTime Variation points.</p> <p>Tags:xml.attribute=true</p>

Table D.29: AttributeValueVariationPoint

Class	AutosarDataPrototype (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::DataPrototypes			
Note	Base class for prototypical roles of an AutosarDataType.			
Base	ARObject, AtpFeature, AtpPrototype, DataPrototype, Identifiable, MultilanguageReferrable, Referrable			
Subclasses	ArgumentDataPrototype, ParameterDataPrototype, VariableDataPrototype			
Attribute	Type	Mult.	Kind	Note
type	AutosarDataType	0..1	tref	<p>This represents the corresponding data type.</p> <p>Stereotypes: isOfType</p>

Table D.30: AutosarDataPrototype

Class	AutosarDataType (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::Datatypes			
Note	Abstract base class for user defined AUTOSAR data types for software.			
Base	ARElement, ARObject, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Subclasses	AbstractImplementationDataType, ApplicationDataType			
Attribute	Type	Mult.	Kind	Note





Class	AutosarDataType (abstract)			
swDataDef Props	SwDataDefProps	0..1	aggr	The properties of this AutosarDataType.

Table D.31: AutosarDataType

Class	BackgroundEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This event is used to trigger RunnableEntities that are supposed to be executed in the background.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.32: BackgroundEvent

Class	BaseType (abstract)			
Package	M2::MSR::AsamHdo::BaseTypes			
Note	This abstract meta-class represents the ability to specify a platform dependant base type.			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, Packageable Element, Referrable			
Subclasses	SwBaseType			
Attribute	Type	Mult.	Kind	Note
baseType Definition	BaseTypeDefinition	1	aggr	This is the actual definition of the base type. Tags: xml.roleElement=false xml.roleWrapperElement=false xml.sequenceOffset=20 xml.typeElement=false xml.typeWrapperElement=false

Table D.33: BaseType

Class	BaseTypeDirectDefinition			
Package	M2::MSR::AsamHdo::BaseTypes			
Note	This BaseType is defined directly (as opposite to a derived BaseType)			
Base	ARObject, BaseTypeDefinition			
Attribute	Type	Mult.	Kind	Note
baseType Encoding	BaseTypeEncoding String	0..1	attr	This specifies, how an object of the current BaseType is encoded, e.g. in an ECU within a message sequence. Tags: xml.sequenceOffset=90
baseTypeSize	PositiveInteger	0..1	attr	Describes the length of the data type specified in the container in bits. Tags: xml.sequenceOffset=70
byteOrder	ByteOrderEnum	0..1	attr	This attribute specifies the byte order of the base type. Tags: xml.sequenceOffset=110





Class	BaseTypeDirectDefinition			
memAlignment	PositiveInteger	0..1	attr	<p>This attribute describes the alignment of the memory object in bits. E.g. "8" specifies, that the object in question is aligned to a byte while "32" specifies that it is aligned four byte. If the value is set to "0" the meaning shall be interpreted as "unspecified".</p> <p>Tags:xml.sequenceOffset=100</p>
native Declaration	NativeDeclarationString	0..1	attr	<p>This attribute describes the declaration of such a base type in the native programming language, primarily in the Programming language C. This can then be used by a code generator to include the necessary declarations into a header file. For example</p> <p>BaseType with shortName: "MyUnsignedInt" native Declaration: "unsigned short"</p> <p>Results in</p> <p>typedef unsigned short MyUnsignedInt;</p> <p>If the attribute is not defined the referring Implementation DataTypes will not be generated as a typedef by RTE.</p> <p>If a nativeDeclaration type is given it shall fulfill the characteristic given by BaseTypeEncoding and BaseType Size.</p> <p>This is required to ensure the consistent handling and interpretation by software components, RTE, COM and MCM systems.</p> <p>Tags:xml.sequenceOffset=120</p>

Table D.34: BaseTypeDirectDefinition

Enumeration	BindingTimeEnum
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling
Note	This enumerator specifies the applicable binding times for the pre build variation points.
Literal	Description
codeGeneration Time	<ul style="list-style-type: none"> • Coding by hand, based on requirements document. • Tool based code generation, e.g. from a model. • The model may contain variants. • Only code for the selected variant(s) is actually generated. <p>Tags:atp.EnumerationLiteralIndex=0</p>
linkTime	<p>Configure what is included in object code, and what is omitted Based on which variant(s) are selected</p> <p>E.g. for modules that are delivered as object code (as opposed to those that are delivered as source code)</p> <p>Tags:atp.EnumerationLiteralIndex=1</p>
preCompileTime	<p>This is typically the C-Preprocessor. Exclude parts of the code from the compilation process, e.g., because they are not required for the selected variant, because they are incompatible with the selected variant, because they require resources that are not present in the selected variant. Object code is only generated for the selected variant(s). The code that is excluded at this stage code will not be available at later stages.</p> <p>Tags:atp.EnumerationLiteralIndex=2</p>





Enumeration	BindingTimeEnum
systemDesignTime	<ul style="list-style-type: none"> Designing the VFB. Software Component types (PortInterfaces). SWC Prototypes and the Connections between SWCprototypes. Designing the Topology ECUs and interconnecting Networks Designing the Communication Matrix and Data Mapping Tags: atp.EnumerationLiteralIndex=3

Table D.35: BindingTimeEnum

Class	<<atpMixedString>> BooleanValueVariationPoint			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents an attribute value variation point for Boolean attributes. Note that this class might be used in the extended meta-model on			
Base	ARObject, AttributeValueVariationPoint , FormulaExpression , SwSystemconstDependentFormula			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.36: BooleanValueVariationPoint

Class	BswApiOptions (abstract)			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	This meta-class represents the ability to define options for the definition of the signature of function prototypes.			
Base	ARObject			
Subclasses	BswClientPolicy, BswDataReceptionPolicy , BswDataSendPolicy, BswExclusiveAreaPolicy , BswInternalTriggeringPointPolicy, BswParameterPolicy, BswPerInstanceMemoryPolicy, BswReleasedTriggerPolicy			
Attribute	Type	Mult.	Kind	Note
enableTakeAddress	Boolean	0..1	attr	If set to true, the BSW Module is able to use the API reference for deriving a pointer to an object

Table D.37: BswApiOptions

Class	BswAsynchronousServerCallPoint			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Represents an asynchronous procedure call point via the BSW Scheduler.			
Base	ARObject, BswModuleCallPoint , Referrable			
Attribute	Type	Mult.	Kind	Note
calledEntry	BswModuleClientServerEntry	1	ref	The entry to be called.

Table D.38: BswAsynchronousServerCallPoint

Class	BswAsynchronousServerCallResultPoint			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	The callback point for an BswAsynchronousServerCallPoint i.e. the point at which the result can be retrieved from the BSW Scheduler.			





Class	BswAsynchronousServerCallResultPoint			
Base	ARObject, BswModuleCallPoint , Referrable			
Attribute	Type	Mult.	Kind	Note
asynchronous ServerCallPoint	BswAsynchronous ServerCallPoint	1	ref	The call point invoking the call to which the result belongs.

Table D.39: BswAsynchronousServerCallResultPoint

Class	BswBackgroundEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	A recurring BswEvent which is used to perform background activities. It is similar to a BswTimingEvent but has no fixed time period and is activated only with low priority.			
Base	ARObject, AbstractEvent, BswEvent , BswScheduleEvent , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.40: BswBackgroundEvent

Class	BswCalledEntity			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	BSW module entity which is designed to be called from another BSW module or cluster.			
Base	ARObject, BswModuleEntity , ExecutableEntity , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.41: BswCalledEntity

Class	BswDataReceivedEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	This event is thrown on reception of the referenced data via Sender-Receiver-Communication over the BSW Scheduler.			
Base	ARObject, AbstractEvent, BswEvent , BswScheduleEvent , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
data	VariableDataPrototype	1	ref	The received data.

Table D.42: BswDataReceivedEvent

Class	BswDataReceptionPolicy (abstract)			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Specifies the reception policy for the referred data in sender-receiver communication over the BSW Scheduler. To be used for inter-partition and/or inter-core communication.			
Base	ARObject, BswApiOptions			
Subclasses	BswQueuedDataReceptionPolicy			
Attribute	Type	Mult.	Kind	Note
receivedData	VariableDataPrototype	1	ref	The data received over the BSW Scheduler using this policy.

Table D.43: BswDataReceptionPolicy

Class	BswEvent (abstract)			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Base class of various kinds of events which are used to trigger a BswModuleEntity of this BSW module or cluster. The event is local to the BSW module or cluster. The short name of the meta-class instance is intended as an input to configure the required API of the BSW Scheduler.			
Base	ARObject, AbstractEvent, Identifiable , MultilanguageReferrable , Referrable			
Subclasses	BswOperationInvokedEvent , BswScheduleEvent			
Attribute	Type	Mult.	Kind	Note
context Limitation	BswDistinguished Partition	*	ref	The existence of this reference indicates that the usage of the event is limited to the context of the referred Bsw DistinguishedPartitions.
disabledInMode	ModeDeclaration	*	iref	The modes, in which this event is disabled. Stereotypes: atpSplitable Tags: atp.Splitkey=disabledInMode.contextMode DeclarationGroup, disabledInMode.targetMode InstanceRef implemented by: ModeInBswModule DescriptionInstanceRef
startsOnEvent	BswModuleEntity	1	ref	The entity which is started by the event.

Table D.44: BswEvent

Class	BswExclusiveAreaPolicy			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	The ExclusiveArea for which the BSW Scheduler using this policy.			
Base	ARObject, BswApiOptions			
Attribute	Type	Mult.	Kind	Note
apiPrinciple	ApiPrincipleEnum	0..1	attr	Specifies for this ExclusiveArea if either one common set of Enter and Exit APIs for the whole BSW module is requested from the SchM or if the set of Enter and Exit APIs is expected per BswModuleEntity. The default value is "common".
exclusiveArea	ExclusiveArea	1	ref	The ExclusiveArea for which the BSW Scheduler using this policy.

Table D.45: BswExclusiveAreaPolicy

Enumeration	BswExecutionContext			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswInterfaces			
Note	Specifies the execution context required or guaranteed for the call associated with this service.			
Literal	Description			
hook	Context of an OS "hook" routine always Tags: atp.EnumerationLiteralIndex=0			
interruptCat1	CAT1 interrupt context always Tags: atp.EnumerationLiteralIndex=1			
interruptCat2	CAT2 interrupt context always Tags: atp.EnumerationLiteralIndex=2			
task	Task context always Tags: atp.EnumerationLiteralIndex=3			
unspecified	The execution context is not specified by the API Tags: atp.EnumerationLiteralIndex=4			

Table D.46: BswExecutionContext

Class	BswExternalTriggerOccurredEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	A BswEvent resulting from a trigger released by another module or cluster.			
Base	ARObject, AbstractEvent, BswEvent , BswScheduleEvent , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
trigger	Trigger	1	ref	The trigger associated with this event. The trigger is external to this module.

Table D.47: BswExternalTriggerOccurredEvent

Class	BswImplementation			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswImplementation			
Note	Contains the implementation specific information in addition to the generic specification (BswModule Description and BswBehavior). It is possible to have several different BswImplementations referring to the same BswBehavior. Tags: atp.recommendedPackage=BswImplementations			
Base	ARElement, ARObject, CollectableElement, Identifiable , Implementation , MultilanguageReferrable , PackageableElement , Referrable			
Attribute	Type	Mult.	Kind	Note
arRelease Version	RevisionLabelString	1	attr	Version of the AUTOSAR Release on which this implementation is based. The numbering contains three levels (major, minor, revision) which are defined by AUTOSAR.
behavior	BswInternalBehavior	1	ref	The behavior of this implementation. This relation is made as an association because <ul style="list-style-type: none"> it follows the pattern of the SWCT since ARElement cannot be splitted, but we want supply the implementation later, the Bsw Implementation is not aggregated in BswBehavior
preconfigured Configuration	EcucModule ConfigurationValues	*	ref	Reference to the set of preconfigured (i.e. fixed) configuration values for this BswImplementation. If the BswImplementation represents a cluster of several modules, more than one EcucModuleConfigurationValues element can be referred (at most one per module), otherwise at most one such element can be referred. Tags: xml.roleWrapperElement=true
recommended Configuration	EcucModule ConfigurationValues	*	ref	Reference to one or more sets of recommended configuration values for this module or module cluster.
vendorApiInfix	Identifier	0..1	attr	In driver modules which can be instantiated several times on a single ECU, SRS_BSW_00347 requires that the names of files, APIs, published parameters and memory allocation keywords are extended by the vendorId and a vendor specific name. This parameter is used to specify the vendor specific name. In total, the implementation specific API name is generated as follows: <Module Name>_<vendorId>_<vendorApiInfix>_<API name from SWS>. E.g. assuming that the vendorId of the implementer is 123 and the implementer chose a vendorApiInfix of "v11r456" an API name Can_Write defined in the SWS will translate to Can_123_v11r456_Write.





Class	BswImplementation			
				<p>△</p> <p>This attribute is mandatory for all modules with upper multiplicity > 1. It shall not be used for modules with upper multiplicity =1.</p> <p>See also SWS_BSW_00102.</p>
vendorSpecificModuleDef	EcucModuleDef	*	ref	<p>Reference to</p> <ul style="list-style-type: none"> the vendor specific EcucModuleDef used in this BswImplementation if it represents a single module several EcucModuleDefs used in this BswImplementation if it represents a cluster of modules one or no EcucModuleDefs used in this BswImplementation if it represents a library <p>Tags:xml.roleWrapperElement=true</p>

Table D.48: BswImplementation

Class	BswInternalBehavior			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Specifies the behavior of a BSW module or a BSW cluster w.r.t. the code entities visible by the BSW Scheduler. It is possible to have several different BswInternalBehaviors referring to the same BswModuleDescription.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , InternalBehavior , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
arTypedPerInstanceMemory	VariableDataPrototype	*	aggr	<p>Defines an AUTOSAR typed memory-block that needs to be available for each instance of the Basic Software Module. The aggregation of arTypedPerInstanceMemory is subject to variability with the purpose to support variability in the Basic Software Module's implementations. Typically different algorithms in the implementation are requiring different number of memory objects.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=arTypedPerInstanceMemory.shortName, arTypedPerInstanceMemory.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
bswPerInstanceMemoryPolicy	BswPerInstanceMemoryPolicy	*	aggr	<p>Policy for a arTypedPerInstanceMemory The policy selects the options of the Schedule Manager API generation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=bswPerInstanceMemoryPolicy, bswPerInstanceMemoryPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
clientPolicy	BswClientPolicy	*	aggr	<p>Policy for a requiredClientServerEntry. The policy selects the options of the Schedule Manager API generation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=clientPolicy, clientPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>





Class	BswInternalBehavior			
distinguished Partition	BswDistinguished Partition	*	aggr	<p>Indicates an abstract partition context in which the enclosing BswModuleEntity can be executed.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=distinguishedPartition.shortName, distinguishedPartition.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=60</p>
entity	BswModuleEntity	*	aggr	<p>A code entity for which the behavior is described</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=entity.shortName, entity.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=5</p>
event	BswEvent	*	aggr	<p>An event required by this module behavior.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=event.shortName, event.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=10</p>
exclusiveArea Policy	BswExclusiveArea Policy	*	aggr	<p>Policy for an ExclusiveArea in this BswInternalBehavior. The policy selects the options of the Schedule Manager API generation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=exclusiveAreaPolicy, exclusiveAreaPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
includedData TypeSet	IncludedDataTypeSet	*	aggr	<p>The includedDataTypeSet is used by a basic software module for its implementation.</p> <p>Stereotypes: atpSplitable</p> <p>Tags:atp.Splitkey=includedDataTypeSet</p>
internal TriggeringPoint	BswInternalTriggering Point	*	aggr	<p>An internal triggering point.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=internalTriggeringPoint.shortName, internalTriggeringPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=2</p>
internal TriggeringPoint Policy	BswInternalTriggering PointPolicy	*	aggr	<p>Policy for an internalTriggeringPoint in this BswInternal Behavior.. The policy selects the options of the Schedule Manager API generation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=internalTriggeringPointPolicy, internalTriggeringPointPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>





Class	BswInternalBehavior			
modeReceiverPolicy	BswModeReceiverPolicy	*	aggr	<p>Implementation policy for the reception of mode switches.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=modeReceiverPolicy, modeReceiverPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=25</p>
modeSenderPolicy	BswModeSenderPolicy	*	aggr	<p>Implementation policy for providing a mode group.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=modeSenderPolicy, modeSenderPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=20</p>
parameterPolicy	BswParameterPolicy	*	aggr	<p>Policy for a perInstanceParameter in this BswInternalBehavior. The policy selects the options of the Schedule Manager API generation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=parameterPolicy, parameterPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
perInstanceParameter	ParameterDataPrototype	*	aggr	<p>Describes a read only memory object containing characteristic value(s) needed by this BswInternalBehavior. The role name perInstanceParameter is chosen in analogy to the similar role in the context of SwcInternalBehavior.</p> <p>In contrast to constantMemory, this object is not allocated locally by the module's code, but by the BSW Scheduler and it is accessed from the BSW module via the BSW Scheduler API. The main use case is the support of software emulation of calibration data.</p> <p>The aggregation is subject to variability with the purpose to support implementation variants.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=perInstanceParameter.shortName, perInstanceParameter.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=45</p>
receptionPolicy	BswDataReceptionPolicy	*	aggr	<p>Data reception policy for inter-partition and/or inter-core communication.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=receptionPolicy, receptionPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=55</p>
releasedTriggerPolicy	BswReleasedTriggerPolicy	*	aggr	<p>Policy for a releasedTrigger. The policy selects the options of the Schedule Manager API generation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=releasedTriggerPolicy, releasedTriggerPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>





Class	BswInternalBehavior			
schedulerName Prefix	BswSchedulerName Prefix	*	aggr	Optional definition of one or more prefixes to be used for the BswScheduler. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=schedulerNamePrefix.shortName, schedulerNamePrefix.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=50
sendPolicy	BswDataSendPolicy	*	aggr	Policy for a providedData. The policy selects the options of the Schedule Manager API generation. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=sendPolicy, sendPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
service Dependency	BswService Dependency	*	aggr	Defines the requirements on AUTOSAR Services for a particular item. The aggregation is subject to variability with the purpose to support the conditional existence of ServiceNeeds. The aggregation is splitable in order to support that ServiceNeeds might be provided in later development steps. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=serviceDependency.ident.shortName, serviceDependency.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=40
triggerDirect Implementation	BswTriggerDirect Implementation	*	aggr	Specifies a trigger to be directly implemented via OS calls. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=triggerDirectImplementation, triggerDirectImplementation.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=15
variationPoint Proxy	VariationPointProxy	*	aggr	Proxy of a variation points in the C/C++ implementation. Stereotypes: atpSplitable Tags: atp.Splitkey=variationPointProxy.shortName

Table D.49: BswInternalBehavior

Class	BswInternalTriggerOccurredEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	A BswEvent, which can happen sporadically. The event is activated by explicit calls from the module to the BSW Scheduler. The main purpose for such an event is to cause a context switch, e.g. from an ISR context into a task context. Activation and switching are handled within the same module or cluster only.			
Base	ARObject, AbstractEvent, BswEvent, BswScheduleEvent, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
eventSource	BswInternalTriggering Point	1	ref	The activation point is the source of this event.

Table D.50: BswInternalTriggerOccurredEvent

Class	BswInternalTriggeringPoint			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Represents the activation point for one or more BswInternalTriggerOccurredEvents.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
swImplPolicy	SwImplPolicyEnum	0..1	attr	This attribute, when set to value queued, specifies a queued processing of the internal trigger event.

Table D.51: BswInternalTriggeringPoint

Class	BswInterruptEntity			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	BSW module entity, which is designed to be triggered by an interrupt.			
Base	ARObject, BswModuleEntity , ExecutableEntity , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
interruptCategory	BswInterruptCategory	1	attr	Category of the interrupt
interruptSource	String	1	attr	Allows a textual documentation of the intended interrupt source.

Table D.52: BswInterruptEntity

Class	BswModeReceiverPolicy			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Specifies the details for the reception of a mode switch for the referred mode group.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
enhancedModeApi	Boolean	0..1	attr	This controls the creation of the enhanced mode API that returns information about the previous mode and the next mode. If set to TRUE the enhanced mode API is supposed to be generated. For more details please refer to the SWS_RTE.
requiredModeGroup	ModeDeclarationGroupPrototype	1	ref	The required mode group for which the policy is specified.
supportsAsynchronousModeSwitch	Boolean	1	attr	Specifies whether the module can handle the reception of an asynchronous mode switch (true) or not (false).

Table D.53: BswModeReceiverPolicy

Class	BswModeSenderPolicy			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Specifies the details for the sending of a mode switch for the referred mode group.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
ackRequest	BswModeSwitchAckRequest	0..1	aggr	Request for acknowledgement
enhancedModeApi	Boolean	0..1	attr	This controls the creation of the enhanced mode API that returns information about the previous mode and the next mode. If set to TRUE the enhanced mode API is supposed to be generated. For more details please refer to the SWS_RTE.





Class	BswModeSenderPolicy			
providedModeGroup	ModeDeclarationGroup Prototype	1	ref	The provided mode group for which the policy is specified.
queueLength	PositiveInteger	1	attr	Length of call queue on the sender side. The queue is implemented by the RTE resp.BswScheduler. The value shall be greater or equal to 0. Setting the value of queue Length to 0 implies non-queued communication.

Table D.54: BswModeSenderPolicy

Class	BswModeSwitchAckRequest			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Requests acknowledgements that a mode switch has been processed successfully			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
timeout	TimeValue	1	attr	Number of seconds before an error is reported.

Table D.55: BswModeSwitchAckRequest

Class	BswModeSwitchEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	A BswEvent resulting from a mode switch.			
Base	ARObject, AbstractEvent, BswEvent , BswScheduleEvent , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
activation	ModeActivationKind	1	attr	Kind of activation w.r.t. to the referred mode.
mode (ordered)	ModeDeclaration	0..2	iref	Reference to one or two Modes that initiate the Mode Switch Event. InstanceRef implemented by: ModeInBswModule DescriptionInstanceRef

Table D.56: BswModeSwitchEvent

Class	BswModeSwitchedAckEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	The event is raised after a switch of the referenced mode group has been acknowledged or an error occurs. The referenced mode group shall be provided by this module.			
Base	ARObject, AbstractEvent, BswEvent , BswScheduleEvent , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
modeGroup	ModeDeclarationGroup Prototype	1	ref	A mode group provided by this module. The acknowledgement of a switch of this group raises this event.

Table D.57: BswModeSwitchedAckEvent

Class	BswModuleCallPoint (abstract)			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Represents a point at which a BswModuleEntity handles a procedure call into a BswModuleEntry, either directly or via the BSW Scheduler.			
Base	ARObject, Referrable			





Class	BswModuleCallPoint (abstract)			
Subclasses	BswAsynchronousServerCallPoint, BswAsynchronousServerCallResultPoint, BswDirectCallPoint, BswSynchronousServerCallPoint			
Attribute	Type	Mult.	Kind	Note
context Limitation	BswDistinguishedPartition	*	ref	The existence of this reference indicates that the call point is used only in the context of the referred BswDistinguishedPartitions.

Table D.58: BswModuleCallPoint

Class	BswModuleClientServerEntry			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswInterfaces			
Note	<p>This meta-class represents a single API entry into the BSW module or cluster that has the ability to be called in client-server fashion via the BSW Scheduler.</p> <p>In this regard it is more special than BswModuleEntry and can be seen as a wrapper around the BswModuleEntry to which it refers (property encapsulatedEntry).</p> <p>Tags:atp.recommendedPackage=BswModuleEntries</p>			
Base	ARObject, Referrable			
Attribute	Type	Mult.	Kind	Note
encapsulatedEntry	BswModuleEntry	1	ref	<p>The underlying BswModuleEntry.</p> <p>Tags:xml.sequenceOffset=5</p>
isReentrant	Boolean	0..1	attr	<p>Reentrancy from the viewpoint of clients invoking the service via the BSW Scheduler:</p> <ul style="list-style-type: none"> • True: Enables the service to be invoked again, before the service has finished. • False: It is prohibited to invoke the service again before it has finished. <p>Tags:xml.sequenceOffset=10</p>
isSynchronous	Boolean	0..1	attr	<p>Synchronicity from the viewpoint of clients invoking the service via the BSW Scheduler:</p> <ul style="list-style-type: none"> • True: This calls a synchronous service, i.e. the service is completed when the call returns. • False: The service (on semantical level) may not be complete when the call returns. <p>Tags:xml.sequenceOffset=15</p>

Table D.59: BswModuleClientServerEntry

Class	BswModuleDependency			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswInterfaces			
Note	This class collects the dependencies of a BSW module or cluster on a certain other BSW module.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
targetModuleId	PositiveInteger	0..1	attr	<p>AUTOSAR identifier of the target module of which the dependencies are defined.</p> <p>This information is optional, because the target module may also be identified by targetModuleRef.</p> <p>Tags:xml.sequenceOffset=5</p>





Class	BswModuleDependency			
targetModule Ref	BswModuleDescription	0..1	ref	<p>Reference to the target module. It is an <<atpUriDef>> because the reference shall be used to identify the target module without actually needing the description of that target module.</p> <p>Stereotypes: atpUriDef; atpVariation</p> <p>Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=7</p>

Table D.60: BswModuleDependency

Class	BswModuleDescription			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswOverview			
Note	<p>Root element for the description of a single BSW module or BSW cluster. In case it describes a BSW module, the short name of this element equals the name of the BSW module.</p> <p>Tags:atp.recommendedPackage=BswModuleDescriptions</p>			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpFeature, AtpStructureElement, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
bswModule Dependency	BswModuleDependency	*	aggr	<p>Describes the dependency to another BSW module.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=bswModuleDependency.shortName, bswModuleDependency.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=20</p>
bswModule Documentation	SwComponent Documentation	0..1	aggr	<p>This adds a documentation to the BSW module.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=bswModuleDocumentation, bswModuleDocumentation.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=6</p>
expectedEntry	BswModuleEntry	*	ref	<p>Indicates an entry which is required by this module. Replacement of outgoingCallback / requiredEntry.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=expectedEntry.bswModuleEntry, expectedEntry.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
implemented Entry	BswModuleEntry	*	ref	<p>Specifies an entry provided by this module which can be called by other modules. This includes "main" functions, interrupt routines, and callbacks. Replacement of providedEntry / expectedCallback.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=implementedEntry.bswModuleEntry, implementedEntry.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>





Class	BswModuleDescription			
internalBehavior	BswInternalBehavior	*	aggr	<p>The various BswInternalBehaviors associated with a Bsw ModuleDescription can be distributed over several physical files. Therefore the aggregation is <<atp Splitable>>.</p> <p>Stereotypes: atpSplitable Tags: atp.Splitkey=internalBehavior.shortName xml.sequenceOffset=65</p>
moduleId	PositiveInteger	0..1	attr	<p>Refers to the BSW Module Identifier defined by the AUTOSAR standard. For non-standardized modules, a proprietary identifier can be optionally chosen.</p> <p>Tags:xml.sequenceOffset=5</p>
providedClientServerEntry	BswModuleClientServerEntry	*	aggr	<p>Specifies that this module provides a client server entry which can be called from another partition or core. This entry is declared locally to this context and will be connected to the requiredClientServerEntry of another or the same module via the configuration of the BSW Scheduler.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=providedClientServerEntry.shortName, providedClientServerEntry.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=45</p>
providedData	VariableDataPrototype	*	aggr	<p>Specifies a data prototype provided by this module in order to be read from another partition or core. The providedData is declared locally to this context and will be connected to the requiredData of another or the same module via the configuration of the BSW Scheduler.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=providedData.shortName, providedData.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=55</p>
providedModeGroup	ModeDeclarationGroupPrototype	*	aggr	<p>A set of modes which is owned and provided by this module or cluster. It can be connected to the required ModeGroups of other modules or clusters via the configuration of the BswScheduler. It can also be synchronized with modes provided via ports by an associated ServiceSwComponentType, EcuAbstractionSwComponentType or ComplexDeviceDriverSwComponentType.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=providedModeGroup.shortName, providedModeGroup.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=25</p>
releasedTrigger	Trigger	*	aggr	<p>A Trigger released by this module or cluster. It can be connected to the requiredTriggers of other modules or clusters via the configuration of the BswScheduler. It can also be synchronized with Triggers provided via ports by an associated ServiceSwComponentType, EcuAbstractionSwComponentType or ComplexDeviceDriverSwComponentType.</p>





Class	BswModuleDescription			
				<div>△</div> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=releasedTrigger.shortName, released Trigger.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=35
requiredClient ServerEntry	BswModuleClientServer Entry	*	aggr	<p>Specifies that this module requires a client server entry which can be implemented on another partition or core. This entry is declared locally to this context and will be connected to the providedClientServerEntry of another or the same module via the configuration of the BSW Scheduler.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=requiredClientServerEntry.shortName, requiredClientServerEntry.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=50
requiredData	VariableDataPrototype	*	aggr	<p>Specifies a data prototype required by this module in order to be provided from another partition or core. The required Data is declared locally to this context and will be connected to the providedData of another or the same module via the configuration of the BswScheduler.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=requiredData.shortName, required Data.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=60
requiredMode Group	ModeDeclarationGroup Prototype	*	aggr	<p>Specifies that this module or cluster depends on a certain mode group. The requiredModeGroup is local to this context and will be connected to the providedModeGroup of another module or cluster via the configuration of the BswScheduler.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=requiredModeGroup.shortName, required ModeGroup.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=30
requiredTrigger	Trigger	*	aggr	<p>Specifies that this module or cluster reacts upon an external trigger. This requiredTrigger is declared locally to this context and will be connected to the providedTrigger of another module or cluster via the configuration of the BswScheduler.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=requiredTrigger.shortName, required Trigger.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=40

Table D.61: BswModuleDescription

Class	BswModuleEntity (abstract)			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Specifies the smallest code fragment which can be described for a BSW module or cluster within AUTOSAR.			
Base	ARObject, ExecutableEntity, Identifiable, MultilanguageReferrable, Referrable			
Subclasses	BswCalledEntity, BswInterruptEntity, BswSchedulableEntity			
Attribute	Type	Mult.	Kind	Note
accessedMode Group	ModeDeclarationGroup Prototype	*	ref	A mode group which is accessed via API call by this entity. It shall be a ModeDeclarationGroupPrototype required by this module or cluster. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
activationPoint	BswInternalTriggering Point	*	ref	Activation point used by the module entity to activate one or more internal triggers. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
callPoint	BswModuleCallPoint	*	aggr	A call point used in the code of this entity. The variability of this association is especially targeted at debug scenarios: It is possible to have one variant calling into the AUTOSAR debug module and another one which doesn't. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
dataReceive Point	BswVariableAccess	*	aggr	The data is received via the BSW Scheduler. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
dataSendPoint	BswVariableAccess	*	aggr	The data is sent via the BSW Scheduler. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
implemented Entry	BswModuleEntry	1	ref	The entry which is implemented by this module entity.
issuedTrigger	Trigger	*	ref	A trigger issued by this entity via BSW Scheduler API call. It shall be a BswTrigger released (i.e. owned) by this module or cluster. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
managedMode Group	ModeDeclarationGroup Prototype	*	ref	A mode group which is managed by this entity. It shall be a ModeDeclarationGroupPrototype provided by this module or cluster. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
schedulerName Prefix	BswSchedulerName Prefix	0..1	ref	A prefix to be used in generated names for the Bsw ModuleScheduler in the context of this BswModuleEntity, for example entry point prototypes, macros for dealing with exclusive areas, header file names. Details are defined in the SWS RTE. The prefix supersedes default rules for the prefix of those names.

Table D.62: BswModuleEntity

Class	BswModuleEntry			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswInterfaces			
Note	<p>This class represents a single API entry (C-function prototype) into the BSW module or cluster.</p> <p>The name of the C-function is equal to the short name of this element with one exception: In case of multiple instances of a module on the same CPU, special rules for "infixes" apply, see description of class BswImplementation.</p> <p>Tags:atp.recommendedPackage=BswModuleEntries</p>			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable , Multilanguage Referrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
argument (ordered)	SwServiceArg	*	aggr	<p>An argument belonging to this BswModuleEntry.</p> <p>Stereotypes: atpVariation</p> <p>Tags: vh.latestBindingTime=blueprintDerivationTime xml.sequenceOffset=45</p>
bswEntryKind	BswEntryKindEnum	0..1	attr	<p>This describes whether the entry is concrete or abstract. If the attribute is missing the entry is considered as concrete.</p> <p>Tags:xml.sequenceOffset=40</p>
callType	BswCallType	1	attr	<p>The type of call associated with this service.</p> <p>Tags:xml.sequenceOffset=25</p>
execution Context	BswExecutionContext	1	attr	<p>Specifies the execution context which is required (in case of entries into this module) or guaranteed (in case of entries called from this module) for this service.</p> <p>Tags:xml.sequenceOffset=30</p>
function Prototype Emitter	NameToken	0..1	attr	<p>This attribute is used to control the generation of function prototypes. If set to "RTE", the RTE generates the function prototypes in the Module Interlink Header File.</p>
isReentrant	Boolean	1	attr	<p>Reentrancy from the viewpoint of function callers:</p> <ul style="list-style-type: none"> • True: Enables the service to be invoked again, before the service has finished. • False: It is prohibited to invoke the service again before it has finished. <p>Tags:xml.sequenceOffset=15</p>
isSynchronous	Boolean	1	attr	<p>Synchronicity from the viewpoint of function callers:</p> <ul style="list-style-type: none"> • True: This calls a synchronous service, i.e. the service is completed when the call returns. • False: The service (on semantical level) may not be complete when the call returns. <p>Tags:xml.sequenceOffset=20</p>
returnType	SwServiceArg	0..1	aggr	<p>The return type belonging to this bswModuleEntry.</p> <p>Tags:xml.sequenceOffset=40</p>
role	Identifier	0..1	attr	<p>Specifies the role of the entry in the given context. It shall be equal to the standardized name of the service call, especially in cases where no ServiceIdentifier is specified, e.g. for callbacks. Note that the ShortName is not always sufficient because it maybe vendor specific (e.g. for callbacks which can have more than one instance).</p> <p>Tags:xml.sequenceOffset=10</p>





Class	BswModuleEntry			
serviceId	PositiveInteger	0..1	attr	Refers to the service identifier of the Standardized Interfaces of AUTOSAR basic software. For non-standardized interfaces, it can optionally be used for proprietary identification. Tags: xml.sequenceOffset=5
swServiceImplPolicy	SwServiceImplPolicy Enum	1	attr	Denotes the implementation policy as a standard function call, inline function or macro. This has to be specified on interface level because it determines the signature of the call. Tags: xml.sequenceOffset=35

Table D.63: BswModuleEntry

Class	BswOperationInvokedEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	This event is thrown on operation invocation in Client-Server-Communication via the BSW Scheduler. Its "entry" reference provides the BswClientServerEntry that is called subsequently. Note this event is not needed in case of direct function calls.			
Base	ARObject, AbstractEvent, BswEvent , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
entry	BswModuleClientServerEntry	1	ref	The providedClientServerEntry invoked by this event.

Table D.64: BswOperationInvokedEvent

Class	BswOsTaskExecutionEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	This BswEvent is supposed to execute BswSchedulableEntitys which have to react on the execution of specific OsTasks. Therefore, this event is unconditionally raised whenever the OsTask on which it is mapped is executed. The main use case for this event is scheduling of Runnables of Complex Drivers which have to react on task executions. Tags: atp.Status=draft			
Base	ARObject, AbstractEvent, BswEvent , BswScheduleEvent , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.65: BswOsTaskExecutionEvent

Class	BswQueuedDataReceptionPolicy			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Reception policy attributes specific for queued receiving.			
Base	ARObject, BswApiOptions , BswDataReceptionPolicy			
Attribute	Type	Mult.	Kind	Note
queueLength	PositiveInteger	1	attr	Length of queue for received events.

Table D.66: BswQueuedDataReceptionPolicy

Class	BswSchedulableEntity			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	BSW module entity, which is designed for control by the BSW Scheduler. It may for example implement a so-called "main" function.			
Base	ARObject, BswModuleEntity , ExecutableEntity , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.67: BswSchedulableEntity

Class	BswScheduleEvent (abstract)			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	BswEvent that is able to start a BswSchedulableEntity.			
Base	ARObject, AbstractEvent , BswEvent , Identifiable , MultilanguageReferrable , Referrable			
Subclasses	BswAsynchronousServerCallReturnsEvent, BswBackgroundEvent , BswDataReceivedEvent , BswExternalTriggerOccurredEvent , BswInternalTriggerOccurredEvent , BswModeManagerErrorEvent , BswModeSwitchEvent , BswModeSwitchedAckEvent , BswOsTaskExecutionEvent , BswTimingEvent			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.68: BswScheduleEvent

Class	BswSchedulerNamePrefix			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	A prefix to be used in names of generated code artifacts which make up the interface of a BSW module to the BswScheduler.			
Base	ARObject, ImplementationProps , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.69: BswSchedulerNamePrefix

Class	BswSynchronousServerCallPoint			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Represents a synchronous procedure call point via the BSW Scheduler.			
Base	ARObject, BswModuleCallPoint , Referrable			
Attribute	Type	Mult.	Kind	Note
calledEntry	BswModuleClientServerEntry	1	ref	The entry to be called.
calledFrom WithinExclusive Area	ExclusiveAreaNesting Order	0..1	ref	This indicates that the call point is located at the deepest level inside one or more ExclusiveAreas that are nested in the given order.

Table D.70: BswSynchronousServerCallPoint

Class	BswTimingEvent			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	A recurring BswEvent driven by a time period.			
Base	ARObject, AbstractEvent , BswEvent , BswScheduleEvent , Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–





Class	BswTimingEvent			
period	TimeValue	1	attr	Requirement for the time period (in seconds) by which this event is triggered.

Table D.71: BswTimingEvent

Class	BswTriggerDirectImplementation			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Specifies a released trigger to be directly implemented via OS calls, for example in a Complex Driver module.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
cat2Isr	Identifier	0..1	attr	The name of the OS category 2 ISR, which is controlled by the referred trigger. This means, that the module manages the category 2 ISR (e.g. according hardware initialization and enabling of ISR). Instead of calling an RTE / SchM API to raise the appropriate events in components or modules receiving the trigger, this ISR directly schedules the triggered ExecutableEntitys. The ISR name is required by the integrator to map the Bsw Events and RTEEvents to this ISR.
masteredTrigger	Trigger	1	ref	The trigger which is directly mastered by this module. There may be several different BswTriggerDirect Implementations mastering the same Trigger. This may be required e.g. due to memory partitioning.
task	Identifier	0..1	attr	The name of the OS task, which is controlled by the referred trigger. This means, that the module uses the trigger condition to directly activate an OS task instead of calling an API of the BswScheduler. The task name is required by the RTE generator resp. BswScheduler to raise the appropriate events in components or modules receiving the trigger.

Table D.72: BswTriggerDirectImplementation

Class	BswVariableAccess			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	The presence of a BswVariableAccess implies that a BswModuleEntity needs access to a VariableData Prototype via the BSW Scheduler. The kind of access is specified by the role in which the class is used.			
Base	ARObject, <i>Referrable</i>			
Attribute	Type	Mult.	Kind	Note
accessed Variable	VariableDataPrototype	1	ref	The data accessed via the BSW Scheduler.
context Limitation	BswDistinguished Partition	*	ref	The existence of this reference indicates that the variable is received resp. sent only in the context of the referred BswDistinguishedPartitions.

Table D.73: BswVariableAccess

Class	BufferProperties			
Package	M2::AUTOSARTemplates::SystemTemplate::Transformer			
Note	Configuration of the buffer properties the transformer needs to work.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
buffer Computation	CompuScale	0..1	aggr	If the transformer changes the size of the data, the CompuScale can be used to specify a rule to derive the size of the output data based on the size of the input data.
headerLength	Integer	1	attr	Defines the length of the header (in bits) this transformer will add in front of the data.
inPlace	Boolean	1	attr	If set, the transformer uses the input buffer as output buffer.

Table D.74: BufferProperties

Class	BulkNvDataDescriptor			
Package	M2::AUTOSARTemplates::SWComponentTemplate::NvBlockComponent			
Note	This meta-class represents one bulk NV Data Block that is read-only for the application software. The purpose of a bulk NV Data Block is to provide access to information uploaded to the vehicle at e.g. the end of the production line.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
bulkNvBlock	VariableDataPrototype	0..1	aggr	This aggregation represents the actual bulk NVBlock.
nvBlockData Mapping	NvBlockDataMapping	*	aggr	<p>Defines the mapping between the VariableData Prototypes in the NvBlockComponents ports and the VariableDataPrototypes of the non-volatile memory.</p> <p>The aggregation of NvBlockDataMapping is subject to variability with the purpose to support the conditional existence of nv data ports.</p> <p>Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime</p>

Table D.75: BulkNvDataDescriptor

Enumeration	CSTransformerErrorReactionEnum
Package	M2::AUTOSARTemplates::SystemTemplate::Transformer
Note	Possible kinds of error reaction in case of a hard transformer error.
Literal	Description
applicationOnly	<p>The application is responsible for any error reaction. No autonomous error reaction of RTE and transformer.</p> <p>Tags: atp.EnumerationLiteralIndex=0</p>
autonomous	<p>RTE and Transformer coordinate an autonomous error reaction on their own.</p> <p>Tags: atp.EnumerationLiteralIndex=1</p>

Table D.76: CSTransformerErrorReactionEnum

Class	CalibrationParameterValue
Package	M2::AUTOSARTemplates::SWComponentTemplate::MeasurementAndCalibration::CalibrationParameter Values





Class	CalibrationParameterValue			
Note	<p>Specifies instance specific calibration parameter values used to initialize the memory objects implementing calibration parameters in the generated RTE code.</p> <p>RTE generator will use the implInitValue to override the initial values specified for the DataPrototypes of a component type.</p> <p>The applInitValue is used to exchange init values with the component vendor not publishing the transformation algorithm between ApplicationDataTypes and ImplementationDataTypes or defining an instance specific initialization of components which are only defined with ApplicationDataTypes.</p> <p>Note: If both representations of init values are available these need to represent the same content.</p> <p>Note further that in this case an explicit mapping of ValueSpecification is not implemented because calibration parameters are delivered back after the calibration phase.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
applInitValue	ValueSpecification	0..1	aggr	This is the initial value specification structured according to the ApplicationDataType
implInitValue	ValueSpecification	0..1	aggr	This is the initial value specification structured according to the ImplementationDataType
initialized Parameter	FlatInstanceDescriptor	0..1	ref	This represents the parameter that is initialized by the CalibrationParameterValue.

Table D.77: CalibrationParameterValue

Class	ClientIdDefinition			
Package	M2::AUTOSARTemplates::SystemTemplate			
Note	<p>Several clients in one client-ECU can communicate via inter-ECU client-server communication with a server on a different ECU, if a client identifier is used to distinguish the different clients. The Client Identifier of the transaction handle that is used by the RTE can be defined by this element.</p>			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
clientId	Numerical	1	attr	The Client Identifier of the transaction handle used for an inter-ECU client server communication is defined by this attribute. If defined the RTE generator shall use this client Id.
clientServer Operation	ClientServerOperation	1	iref	<p>Reference to the ClientServerOperation that is called by the client.</p> <p>InstanceRef implemented by: OperationInSystem InstanceRef</p>

Table D.78: ClientIdDefinition

Class	ClientServerApplicationErrorMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	This meta-class represents the ability to map ApplicationErrors onto each other.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
firstApplication Error	ApplicationError	0..1	ref	This represents the first ApplicationError in the context of the ClientServerApplicationErrorMapping.
second ApplicationError	ApplicationError	0..1	ref	This represents the second ApplicationError in the context of the ClientServerApplicationErrorMapping.

Table D.79: ClientServerApplicationErrorMapping

Class	ClientServerInterface			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	A client/server interface declares a number of operations that can be invoked on a server by a client. Tags: atp.recommendedPackage=PortInterfaces			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, PortInterface , Referrable			
Attribute	Type	Mult.	Kind	Note
operation	ClientServerOperation	*	aggr	ClientServerOperation(s) of this ClientServerInterface. Stereotypes: atpVariation Tags: vh.latestBindingTime=blueprintDerivationTime
possibleError	ApplicationError	*	aggr	Application errors that are defined as part of this interface.

Table D.80: ClientServerInterface

Class	ClientServerInterfaceMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	Defines the mapping of ClientServerOperations in context of two different ClientServerInterfaces.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, Identifiable , MultilanguageReferrable, PortInterfaceMapping , Referrable			
Attribute	Type	Mult.	Kind	Note
errorMapping	ClientServerApplicationErrorMapping	*	aggr	Map two different ApplicationErrors defined in the context of two different ClientServerInterfaces.
operation Mapping	ClientServerOperation Mapping	*	aggr	Mapping of two ClientServerOperations in two different ClientServerInterfaces

Table D.81: ClientServerInterfaceMapping

Class	ClientServerOperation			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	An operation declared within the scope of a client/server interface.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
argument (ordered)	ArgumentDataPrototype	*	aggr	An argument of this ClientServerOperation Stereotypes: atpVariation Tags: vh.latestBindingTime=blueprintDerivationTime
diagArgIntegrity	Boolean	0..1	attr	This attribute shall only be used in the implementation of diagnostic routines to support the case where input and output arguments are allocated in a shared buffer and might unintentionally overwrite input arguments by tentative write operations to output arguments. This situation can happen during sliced execution or while output parameters are arrays (call by reference). The value true means that the ClientServerOperation is aware of the usage of a shared buffer and takes precautions to avoid unintentional overwrite of input arguments. If the attribute does not exist or is set to false the Client ServerOperation does not have to consider the usage of a shared buffer.
possibleError	ApplicationError	*	ref	Possible errors that may be raised by the referring operation.

Table D.82: ClientServerOperation

Class	ClientServerToSignalMapping			
Package	M2::AUTOSARTemplates::SystemTemplate::DataMapping			
Note	This element maps the ClientServerOperation to call- and return-SystemSignals.			
Base	ARObject, DataMapping			
Attribute	Type	Mult.	Kind	Note
callSignal	SystemSignal	1	ref	Reference to the callSignal to which the IN and INOUT ArgumentDataPrototypes are mapped.
clientServerOperation	ClientServerOperation	1	iref	Reference to a ClientServerOperation, which is mapped to a call SystemSignal and a return SystemSignal. InstanceRef implemented by: OperationInSystemInstanceRef
returnSignal	SystemSignal	0..1	ref	Reference to the returnSignal to which the OUT and INOUT ArgumentDataPrototypes are mapped. Tags: atp.Status=shallBecomeMandatory

Table D.83: ClientServerToSignalMapping

Class	Code			
Package	M2::AUTOSARTemplates::CommonStructure::Implementation			
Note	A generic code descriptor. The type of the code (source or object) is defined via the category attribute of the associated engineering object.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
artifactDescriptor	AutosarEngineeringObject	*	aggr	Refers to the artifact belonging to this code descriptor.
callbackHeader	ServiceNeeds	*	ref	The association callbackHeader describes in which header files the function declarations of callback functions are provided to a service module. With this information the service module can include the appropriate header files in its configuration files.

Table D.84: Code

Class	ComplexDeviceDriverSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	The ComplexDeviceDriverSwComponentType is a special AtomicSwComponentType that has direct access to hardware on an ECU and which is therefore linked to a specific ECU or specific hardware. The ComplexDeviceDriverSwComponentType introduces the possibility to link from the software representation to its hardware description provided by the ECU Resource Template. Tags: atp.recommendedPackage=SwComponentTypes			
Base	ARElement, ARObject, AtomicSwComponentType , AtpBlueprint , AtpBlueprintable , AtpClassifier , AtpType , CollectableElement , Identifiable , MultilanguageReferrable , PackageableElement , Referrable , SwComponentType			
Attribute	Type	Mult.	Kind	Note
hardwareElement	HwDescriptionEntity	*	ref	Reference from the ComplexDeviceDriverSwComponentType to the description of the used HwElements.

Table D.85: ComplexDeviceDriverSwComponentType

Class	CompositeValueSpecification (abstract)			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	This abstract meta-class acts a base class for ValueSpecifications that have a composite form.			
Base	ARObject, ValueSpecification			
Subclasses	ArrayValueSpecification , RecordValueSpecification			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.86: CompositeValueSpecification

Class	CompositionSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	<p>A CompositionSwComponentType aggregates SwComponentPrototypes (that in turn are typed by SwComponentTypes) as well as SwConnectors for primarily connecting SwComponentPrototypes among each others and towards the surface of the CompositionSwComponentType. By this means hierarchical structures of software-components can be created.</p> <p>Tags:atp.recommendedPackage=SwComponentTypes</p>			
Base	ARElement , ARObject , AtpBlueprint , AtpBlueprintable , AtpClassifier , AtpType , CollectableElement , Identifiable , MultilanguageReferrable , PackageableElement , Referrable , SwComponentType			
Attribute	Type	Mult.	Kind	Note
component	SwComponentPrototype	*	aggr	<p>The instantiated components that are part of this composition. The aggregation of SwComponentPrototype is subject to variability with the purpose to support the conditional existence of a SwComponentPrototype. Please be aware: if the conditional existence of SwComponentPrototypes is resolved post-build the deselected SwComponentPrototypes are still contained in the ECUs build but the instances are inactive in in that they are not scheduled by the RTE.</p> <p>The aggregation is marked as atpSplitable in order to allow the addition of service components to the ECU extract during the ECU integration.</p> <p>The use case for having 0 components owned by the CompositionSwComponentType could be to deliver an empty CompositionSwComponentType to e.g. a supplier for filling the internal structure.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=component.shortName, component.variationPoint.shortLabel vh.latestBindingTime=postBuild</p>
connector	SwConnector	*	aggr	<p>SwConnectors have the principal ability to establish a connection among PortPrototypes. They can have many roles in the context of a CompositionSwComponentType. Details are refined by subclasses.</p> <p>The aggregation of SwConnectors is subject to variability with the purpose to support variant data flow.</p> <p>The aggregation is marked as atpSplitable in order to allow the extension of the ECU extract with AssemblySwConnectors between ApplicationSwComponentTypes and ServiceSwComponentTypes during the ECU integration.</p>





Class	CompositionSwComponentType			
				<div>△</div> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=connector.shortName, connector.variationPoint.shortLabel vh.latestBindingTime=postBuild
constantValue Mapping	ConstantSpecification MappingSet	*	ref	Reference to the ConstantSpecificationMapping to be applied for initValues of PPortComSpecs and RPortComSpec. Stereotypes: atpSplitable Tags: atp.Splitkey=constantValueMapping
dataType Mapping	DataTypeMappingSet	*	ref	Reference to the DataTypeMapping to be applied for the used ApplicationDataTypes in PortInterfaces. Background: when developing subsystems it may happen that ApplicationDataTypes are used on the surface of CompositionSwComponentTypes. In this case it would be reasonable to be able to also provide the intended mapping to the ImplementationDataTypes. However, this mapping shall be informal and not technically binding for the implementors mainly because the RTE generator is not concerned about the CompositionSwComponentTypes. Rationale: if the mapping of ApplicationDataTypes on the delegated and inner PortPrototype matches then the mapping to ImplementationDataTypes is not impacting compatibility. Stereotypes: atpSplitable Tags: atp.Splitkey=dataTypeMapping
instantiation RTEEventProps	InstantiationRTEEvent Props	*	aggr	This allows to define instantiation specific properties for RTE Events, in particular for instance specific scheduling. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=instantiationRTEEventProps.shortLabel, instantiationRTEEventProps.variationPoint.shortLabel vh.latestBindingTime=codeGenerationTime

Table D.87: CompositionSwComponentType

Class	CompuConst			
Package	M2::MSR::AsamHdo::ComputationMethod			
Note	This meta-class represents the fact that the value of a computation method scale is constant.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
compuConst ContentType	CompuConstContent	0..1	aggr	This is the actual content of the constant compu method scale. Tags: xml.roleElement=false xml.roleWrapperElement=false xml.sequenceOffset=10 xml.typeElement=false xml.typeWrapperElement=false

Table D.88: CompuConst

Class	CompuMethod			
Package	M2::MSR::AsamHdo::ComputationMethod			
Note	<p>This meta-class represents the ability to express the relationship between a physical value and the mathematical representation.</p> <p>Note that this is still independent of the technical implementation in data types. It only specifies the formula how the internal value corresponds to its physical pendant.</p> <p>Tags:atp.recommendedPackage=CompuMethods</p>			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable , Multilanguage Referrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
compuInternalToPhys	Compu	0..1	aggr	<p>This specifies the computation from internal values to physical values.</p> <p>Tags:xml.sequenceOffset=80</p>
compuPhysToInternal	Compu	0..1	aggr	<p>This represents the computation from physical values to the internal values.</p> <p>Tags:xml.sequenceOffset=90</p>
displayFormat	DisplayFormatString	0..1	attr	<p>This property specifies, how the physical value shall be displayed e.g. in documents or measurement and calibration tools.</p> <p>Tags:xml.sequenceOffset=20</p>
unit	Unit	0..1	ref	<p>This is the physical unit of the Physical values for which the CompuMethod applies.</p> <p>Tags:xml.sequenceOffset=30</p>

Table D.89: CompuMethod

Class	CompuNominatorDenominator			
Package	M2::MSR::AsamHdo::ComputationMethod			
Note	This class represents the ability to express a polynomial either as Nominator or as Denominator.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
v (ordered)	Numerical	*	attr	<p>this is the list of polynomial factors. Note that the first vf represents the power=0. The polynomial is $v[0] \cdot x^0 + v[1] \cdot x^1 \dots$</p> <p>Stereotypes: atpVariation</p> <p>Tags: vh.latestBindingTime=preCompileTime xml.roleElement=true xml.roleWrapperElement=false xml.sequenceOffset=20 xml.typeElement=false xml.typeWrapperElement=false</p>

Table D.90: CompuNominatorDenominator

Class	CompuRationalCoeffs			
Package	M2::MSR::AsamHdo::ComputationMethod			
Note	This meta-class represents the ability to express a rational function by specifying the coefficients of nominator and denominator.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note





Class	CompuRationalCoeffs			
compu Denominator	CompuNominator Denominator	0..1	aggr	This is the denominator of the expression. Tags: xml.sequenceOffset=30
compu Numerator	CompuNominator Denominator	0..1	aggr	This is the numerator of the rational expression. Tags: xml.sequenceOffset=20

Table D.91: CompuRationalCoeffs

Class	CompuScale			
Package	M2::MSR::AsamHdo::ComputationMethod			
Note	This meta-class represents the ability to specify one segment of a segmented computation method.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
compuInverse Value	CompuConst	0..1	aggr	This is the inverse value of the constraint. This supports the case that the scale is not reversible per se. Tags: xml.sequenceOffset=60
compuScale Contents	CompuScaleContents	0..1	aggr	This represents the computation details of the scale. Tags: xml.roleElement=false xml.roleWrapperElement=false xml.sequenceOffset=70 xml.typeElement=false xml.typeWrapperElement=false
desc	MultiLanguageOverview Paragraph	0..1	aggr	<desc> represents a general but brief description of the object in question. Tags: xml.sequenceOffset=30
lowerLimit	Limit	0..1	attr	This specifies the lower limit of the scale. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=40
mask	PositiveInteger	0..1	attr	In difference to all the other computational methods every COMPU-SCALE will be applied including the bit MASK. Therefore it is allowed for this type of COMPU-METHOD, that COMPU-SCALES overlap. To calculate the string reverse to a value, the string has to be split and the according value for each substring has to be summed up. The sum is finally transmitted. The processing has to be done in order of the COMPU-SCALE elements. Tags: xml.sequenceOffset=35
shortLabel	Identifier	0..1	attr	This element specifies a short name for the particular scale. The name can for example be used to derive a programming language identifier. Tags: xml.sequenceOffset=20
symbol	CIdentifier	0..1	attr	The symbol, if provided, is used by code generators to get a C identifier for the CompuScale. The name will be used as is for the code generation, therefore it needs to be unique within the generation context. Tags: xml.sequenceOffset=25





Class	CompuScale			
upperLimit	Limit	0..1	attr	<p>This specifies the upper limit of a of the scale.</p> <p>Stereotypes: atpVariation</p> <p>Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=50</p>

Table D.92: CompuScale

Class	CompuScaleConstantContents			
Package	M2::MSR::AsamHdo::ComputationMethod			
Note	This meta-class represents the fact that a particular scale of the computation method is constant.			
Base	ARObject, CompuScaleContents			
Attribute	Type	Mult.	Kind	Note
compuConst	CompuConst	0..1	aggr	<p>This represents the fact that the scale is a constant. The use case is mainly a non interpolated scale. It is a simplification of the fact that a constant scale can also be expressed as rational function of order 0.</p> <p>Tags:xml.sequenceOffset=90</p>

Table D.93: CompuScaleConstantContents

Class	CompuScales			
Package	M2::MSR::AsamHdo::ComputationMethod			
Note	This meta-class represents the ability to stepwise express a computation method.			
Base	ARObject, CompuContent			
Attribute	Type	Mult.	Kind	Note
compuScale (ordered)	CompuScale	*	aggr	<p>This represents one scale within the compu method. Note that it contains a Variationpoint in order to support blueprints of enumerations.</p> <p>Stereotypes: atpVariation</p> <p>Tags: vh.latestBindingTime=blueprintDerivationTime xml.roleElement=true xml.roleWrapperElement=true xml.sequenceOffset=40 xml.typeElement=false xml.typeWrapperElement=false</p>

Table D.94: CompuScales

Class	<<atpMixedString>> ConditionByFormula			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	<p>This class represents a condition which is computed based on system constants according to the specified expression. The expected result is considered as boolean value.</p> <p>The result of the expression is interpreted as a condition.</p> <ul style="list-style-type: none"> • "0" represents "false"; • a value other than zero is considered "true" 			
Base	ARObject, FormulaExpression, SwSystemconstDependentFormula			
Attribute	Type	Mult.	Kind	Note





Class	<<atpMixedString>> ConditionByFormula			
bindingTime	BindingTimeEnum	1	attr	<p>This attribute specifies the point in time when condition may be evaluated at earliest. At this point in time all referenced system constants shall have a value.</p> <p>Tags:xml.attribute=true</p>

Table D.95: ConditionByFormula

Class	ConsistencyNeeds			
Package	M2::AUTOSARTemplates::SWComponentTemplate::ImplicitCommunicationBehavior			
Note	This meta-class represents the ability to define requirements on the implicit communication behavior.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
dpgDoesNotRequireCoherency	DataPrototypeGroup	*	aggr	<p>This group of VariableDataPrototypes does not require coherency with respect to the implicit communication behavior.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=dpgDoesNotRequireCoherency.shortName, dpgDoesNotRequireCoherency.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
dpgRequiresCoherency	DataPrototypeGroup	*	aggr	<p>This group of VariableDataPrototypes requires coherency with respect to the implicit communication behavior, i.e. all read and write access to VariableDataPrototypes in the DataPrototypeGroup by the RunnableEntitys of the RunnableEntityGroup need to be handled in a coherent manner.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=dpgRequiresCoherency.shortName, dpgRequiresCoherency.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
regDoesNotRequireStability	RunnableEntityGroup	*	aggr	<p>This group of RunnableEntities does not require stability with respect to the implicit communication behavior.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=regDoesNotRequireStability.shortName, regDoesNotRequireStability.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
regRequiresStability	RunnableEntityGroup	*	aggr	<p>This group of RunnableEntities requires stability with respect to the implicit communication behavior, i.e. all read and write access to VariableDataPrototypes in the DataPrototypeGroup by the RunnableEntitys of the RunnableEntityGroup need to be handled in a stable manner.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=regRequiresStability.shortName, regRequiresStability.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>

Table D.96: ConsistencyNeeds

Class	ConstantReference			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	Instead of defining this value inline, a constant is referenced.			
Base	ARObject, ValueSpecification			
Attribute	Type	Mult.	Kind	Note
constant	ConstantSpecification	0..1	ref	The referenced constant.

Table D.97: ConstantReference

Class	ConstantSpecificationMapping			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	<p>This meta-class is used to create an association of two ConstantSpecifications. One Constant Specification is supposed to be defined in the application domain while the other should be defined in the implementation domain.</p> <p>Hence the ConstantSpecificationMapping needs to be used where a ConstantSpecification defined in one domain needs to be associated to a ConstantSpecification in the other domain.</p> <p>This information is crucial for the RTE generator.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
applConstant	ConstantSpecification	0..1	ref	A ConstantSpecification defined in the application domain.
implConstant	ConstantSpecification	0..1	ref	A ConstantSpecification defined in the implementation domain.

Table D.98: ConstantSpecificationMapping

Class	CpSoftwareCluster			
Package	M2::AUTOSARTemplates::SystemTemplate::SoftwareCluster			
Note	<p>This meta class provides the ability to define a CP Software Cluster. Each CP Software Cluster can be integrated and build individually. It defines the sub-set of hierarchical tree(s) of Software Components belonging to this CP Software Cluster. Resources required or provided by this CP Software Cluster are given in the according mappings.</p> <p>Tags: atp.Status=draft atp.recommendedPackage=CpSoftwareClusters</p>			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
swComponentAssignment	SwComponentPrototypeAssignment	*	aggr	<p>This is the collection of SwComponentPrototype Assignments</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=swComponentAssignment, swComponentAssignment.variationPoint.shortLabel atp.Status=draft vh.latestBindingTime=postBuild</p>
swComposition	CompositionSwComponentType	*	ref	<p>Software Components in the context of a CompositionSwComponentType belonging to this CP Software Cluster. This reference can be used to describe the belonging SWCs when the CP Software Cluster is described out of the context of a System, e.g. reusable CP Software Cluster.</p>





Class	CpSoftwareCluster			
				<div>△</div> Stereotypes: atpSplittable; atpVariation Tags: atp.Splitkey=swComposition.compositionSwComponent Type, swComposition.variationPoint.shortLabel atp.Status=draft vh.latestBindingTime=systemDesignTime

Table D.99: CpSoftwareCluster

Class	CpSoftwareClusterCommunicationResource			
Package	M2::AUTOSARTemplates::SystemTemplate::SoftwareCluster			
Note	Represents a single resource required or provided by a CP Software Cluster which relates to the port based communication on VFB level. Tags: atp.Status=draft			
Base	ARObject, CpSoftwareClusterResource, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
comProps	CpSoftwareClusterCommunicationResourceProps	0..1	aggr	This aggregation supports the further qualification of the enclosing CpSoftwareClusterCommunicationResource by means of additional attributes depending on the nature of the CpSoftwareClusterCommunicationResource.

Table D.100: CpSoftwareClusterCommunicationResource

Class	DataComProps			
Package	M2::AUTOSARTemplates::SystemTemplate::SoftwareCluster			
Note	Represents a single resource required or provided by a CP Software Cluster which relates to the port based communication on VFB level. Tags: atp.Status=draft			
Base	ARObject, CpSoftwareClusterCommunicationResourceProps			
Attribute	Type	Mult.	Kind	Note
sendIndication	SendIndicationEnum	0..1	attr	Send indication behavior for last-is-the best data communication.

Table D.101: DataComProps

Class	DataConstr			
Package	M2::MSR::AsamHdo::Constraints::GlobalConstraints			
Note	This meta-class represents the ability to specify constraints on data. Tags: atp.recommendedPackage=DataConstrs			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable , MultilanguageReferrable , PackageableElement , Referrable			
Attribute	Type	Mult.	Kind	Note
dataConstrRule	DataConstrRule	*	aggr	This is one particular rule within the data constraints. Tags: xml.roleElement=true xml.roleWrapperElement=true xml.sequenceOffset=30 xml.typeElement=false xml.typeWrapperElement=false

Table D.102: DataConstr

Class	DataMapping (abstract)			
Package	M2::AUTOSARTemplates::SystemTemplate::DataMapping			
Note	Mapping of port elements (data elements and parameters) to frames and signals.			
Base	ARObject			
Subclasses	ClientServerToSignalMapping , SenderReceiverCompositeElementToSignalMapping , SenderReceiverToSignalGroupMapping , SenderReceiverToSignalMapping , TriggerToSignalMapping			
Attribute	Type	Mult.	Kind	Note
communication Direction	Communication DirectionType	0..1	attr	This attribute controls the direction into which the mapped SystemSignal is communicated with respect to the kind of PortPrototype used as the context element of the Data Mapping.
introduction	DocumentationBlock	0..1	aggr	This represents introductory documentation about the data mapping.

Table D.103: DataMapping

Class	DataPrototype (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::DataPrototypes			
Note	Base class for prototypical roles of any data type.			
Base	ARObject, AtpFeature, AtpPrototype, Identifiable , MultilanguageReferrable , Referrable			
Subclasses	ApplicationCompositeElementDataPrototype , AutosarDataPrototype			
Attribute	Type	Mult.	Kind	Note
swDataDef Props	SwDataDefProps	0..1	aggr	This property allows to specify data definition properties which apply on data prototype level.

Table D.104: DataPrototype

Class	DataPrototypeGroup			
Package	M2::AUTOSARTemplates::SWComponentTemplate::ImplicitCommunicationBehavior			
Note	This meta-class represents the ability to define a collection of DataPrototypes that are subject to the formal definition of implicit communication behavior. The definition of the collection can be nested.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
dataPrototype Group	DataPrototypeGroup	*	iref	This represents the ability to define nested groups of VariableDataPrototypes. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime InstanceRef implemented by: InnerDataPrototypeGroup InCompositionInstanceRef
implicitData Access	VariableDataPrototype	*	iref	This represents a collection of VariableDataPrototypes that belong to the enclosing DataPrototypeGroup Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime InstanceRef implemented by: VariableDataPrototypeInCompositionInstanceRef

Table D.105: DataPrototypeGroup

Class	DataPrototypeMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	<p>Defines the mapping of two particular VariableDataPrototypes, ParameterDataPrototypes or Argument DataPrototypes with unequal names and/or unequal semantic (resolution or range) in context of two different SenderReceiverInterface, NvDataInterface or ParameterInterface or Operations.</p> <p>If the semantic is unequal following rules apply: The textTableMapping is only applicable if the referred DataPrototypes are typed by AutosarDataType referring to CompuMethods of category TEXTTABLE, SCALE_LINEAR_AND_TEXTTABLE or BITFIELD_TEXTTABLE.</p> <p>In the case that the DataPrototypes are typed by AutosarDataType either referring to CompuMethods of category LINEAR, IDENTICAL or referring to no CompuMethod (which is similar as IDENTICAL) the linear conversion factor is calculated out of the factorSiToUnit and offsetSiToUnit attributes of the referred Units and the CompuRationalCoeffs of a compuInternalToPhys of the referred CompuMethods.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
firstData Prototype	AutosarDataPrototype	0..1	ref	First to be mapped DataPrototype in context of a Sender ReceiverInterface, NvDataInterface, ParameterInterface or Operation.
firstToSecond Data Transformation	DataTransformation	0..1	ref	<p>This reference defines the need to execute the Data Transformation <Mip>_<transformerId> functions of the transformation chain when communicating from the Data PrototypeMapping.firstDataPrototype to the Data PrototypeMapping.secondDataPrototype.</p> <p>This reference also specifies the reverse Data Transformation <Mip>_Inv_<transformerId> functions of the transformation chain (i.e. from the DataPrototype Mapping.secondDataPrototype to the DataPrototype Mapping.firstDataPrototype) if the referenced Data Transformation is symmetric, i.e. attribute Data Transformation.dataTransformationKind is set to symmetric.</p>
secondData Prototype	AutosarDataPrototype	0..1	ref	Second to be mapped DataPrototype in context of a SenderReceiverInterface, NvDataInterface, Parameter Interface or Operation.
secondToFirst Data Transformation	DataTransformation	0..1	ref	This defines the need to execute the reverse Data Transformation <Mip>_Inv_<transformerId> functions of the transformation chain when communicating from the DataPrototypeMapping.secondDataPrototype to the Data PrototypeMapping.firstDataPrototype.
subElement Mapping	SubElementMapping	*	aggr	This represents the owned SubelementMapping.
textTable Mapping	TextTableMapping	0..2	aggr	Applied TextTableMapping(s)

Table D.106: DataPrototypeMapping

Class	DataPrototypeTransformationProps			
Package	M2::AUTOSARTemplates::SystemTemplate::Transformer			
Note	DataPrototypeTransformationProps allows to set the attributes for the different Transformation Technologies that are DataPrototype specific.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
dataProtototype InPortInterface Ref	DataPrototype Reference	0..1	aggr	<p>Reference to a DataPrototype that is transported in the serialized ISignal.</p> <p>Tags:atp.Status=obsolete</p>





Class	DataPrototypeTransformationProps			
dataPrototypeInPortInterfaceRef	DataPrototypeReference	0..1	aggr	Reference to a DataPrototype that is transported in the serialized ISignal.
networkRepresentationProps	SwDataDefProps	0..1	aggr	Specification of the actual network representation for the referenced primitive DataPrototype. If a network representation is provided then the baseType shall be used by the Transformer as input for the serialization/deserialization.
transformationProps	TransformationProps	0..1	ref	Collection of AutosarDataPrototype related configuration settings for a transformer.

Table D.107: DataPrototypeTransformationProps

Class	DataReceiveErrorEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This event is raised by the RTE when the Com layer detects and notifies an error concerning the reception of the referenced data element.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
data	VariableDataPrototype	0..1	iref	Data element referenced by event InstanceRef implemented by: RVariableInAtomicSwc InstanceRef

Table D.108: DataReceiveErrorEvent

Class	DataReceivedEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	The event is raised when the referenced data elements are received.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
data	VariableDataPrototype	0..1	iref	Data element referenced by event InstanceRef implemented by: RVariableInAtomicSwc InstanceRef

Table D.109: DataReceivedEvent

Class	DataSendCompletedEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	The event is raised when the referenced data elements have been sent or an error occurs.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
eventSource	VariableAccess	0..1	ref	The variable access that triggers the event.

Table D.110: DataSendCompletedEvent

Class	DataTransformation			
Package	M2::AUTOSARTemplates::SystemTemplate::Transformer			
Note	A DataTransformation represents a transformer chain. It is an ordered list of transformers.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
data Transformation Kind	DataTransformationKind Enum	0..1	attr	This attribute controls the kind of DataTransformation to be applied.
executeDespite Data Unavailability	Boolean	1	attr	Specifies whether the transformer chain is executed even if no input data are available.
transformer Chain (ordered)	Transformation Technology	1..*	ref	This attribute represents the definition of a chain of transformers that are supposed to be executed according to the order of being referenced from DataTransformation.

Table D.111: DataTransformation

Enumeration	DataTransformationErrorHandlingEnum
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::PortAPIOptions
Note	This enumeration defines different ways how a RunnableEntity shall handle transformer errors.
Literal	Description
noTransformerError Handling	A runnable does not handle transformer errors. Tags: atp.EnumerationLiteralIndex=0
transformerError Handling	The runnable implements the handling of transformer errors. Tags: atp.EnumerationLiteralIndex=1

Table D.112: DataTransformationErrorHandlingEnum

Enumeration	DataTransformationStatusForwardingEnum
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::PortAPIOptions
Note	This enumeration defines different ways how a RunnableEntity shall be able to forward status into the transformer chain.
Literal	Description
noTransformer StatusForwarding	The runnable is not able to forward a transformer status. Tags: atp.EnumerationLiteralIndex=0
transformerStatus Forwarding	The runnable is able to forward a transformer status. Tags: atp.EnumerationLiteralIndex=1

Table D.113: DataTransformationStatusForwardingEnum

Class	DataTypeMap			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::Datatypes			
Note	This class represents the relationship between ApplicationDataType and its implementing Abstract ImplementationDataType.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
applicationData Type	ApplicationDataType	0..1	ref	This is the corresponding ApplicationDataType
implementation DataType	AbstractImplementation DataType	0..1	ref	This is the corresponding AbstractImplementationDataType.

Table D.114: DataTypeMap

Class	DataTypeMappingSet			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::Datatypes			
Note	This class represents a list of mappings between ApplicationDataTypes and ImplementationDataTypes. In addition, it can contain mappings between ImplementationDataTypes and ModeDeclarationGroups. Tags: atp.recommendedPackage=DataTypeMappingSets			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable , Multilanguage Referrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
dataTypeMap	DataTypeMap	*	aggr	This is one particular association between an Application DataType and its AbstractImplementationDataType.
modeRequestTypeMap	ModeRequestTypeMap	*	aggr	This is one particular association between an Mode DeclarationGroup and its AbstractImplementationData Type.

Table D.115: DataTypeMappingSet

Enumeration	DataTypePolicyEnum			
Package	M2::AUTOSARTemplates::SystemTemplate::DataMapping			
Note	This class lists the supported DataTypePolicies.			
Literal	Description			
legacy	In case the System Description doesn't use a complete Software Component Description (VFB View) this value can be chosen. This supports the inclusion of legacy signals. The aggregation of SwDataDefProps shall be used to configure the "ComSignalDataInvalidValue" and the Data Semantics. Tags: atp.EnumerationLiteralIndex=0			
networkRepresentationFromComSpec	Ignore any networkRepresentationProps of this ISignal and use the networkRepresentation from the ComSpec. Please note that the usage does not imply the existence of the SwDataDefProps in the role networkRepresentation aggregated by the SenderComSpec or ReceiverComSpec if an ImplementationData Type is defined. Tags: atp.EnumerationLiteralIndex=1			
override	If this value is chosen the requirements specified in the ComSpec (networkRepresentationFromComSpec) are not fulfilled by the aggregated SwDataDefProps. In this case the networkRepresentation is specified by the aggregated swDataDefProps. Tags: atp.EnumerationLiteralIndex=2			
transformingISignal	This literal indicates that a transformer chain shall be used to communicate the ISignal as UINT8_N over the bus. Tags: atp.EnumerationLiteralIndex=4			

Table D.116: DataTypePolicyEnum

Class	DataWriteCompletedEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This event is raised if an implicit write access was successful or an error occurred.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
eventSource	VariableAccess	0..1	ref	The variable access that triggers the event.

Table D.117: DataWriteCompletedEvent

Class	DelegationSwConnector			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	A delegation connector delegates one inner PortPrototype (a port of a component that is used inside the composition) to a outer PortPrototype of compatible type that belongs directly to the composition (a port that is owned by the composition).			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable , SwConnector			
Attribute	Type	Mult.	Kind	Note
innerPort	PortPrototype	0..1	iref	The port that belongs to the ComponentPrototype in the composition Tags: xml.typeElement=true InstanceRef implemented by: PortInCompositionType InstanceRef
outerPort	PortPrototype	0..1	ref	The port that is located on the outside of the Composition Type

Table D.118: DelegationSwConnector

Class	DependencyOnArtifact			
Package	M2::AUTOSARTemplates::CommonStructure::Implementation			
Note	Dependency on the existence of another artifact, e.g. a library.			
Base	ARObject, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
artifact Descriptor	AutosarEngineering Object	0..1	aggr	The specified artifact needs to exist.
usage	DependencyUsage Enum	1..*	attr	Specification for which process step(s) this dependency is required.

Table D.119: DependencyOnArtifact

Class	EcuAbstractionSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	The ECUAbstraction is a special AtomicSwComponentType that resides between a software-component that wants to access ECU periphery and the Microcontroller Abstraction. The EcuAbstractionSw ComponentType introduces the possibility to link from the software representation to its hardware description provided by the ECU Resource Template. Tags: atp.recommendedPackage=SwComponentTypes			
Base	ARElement, ARObject, AtomicSwComponentType , AtpBlueprint, AtpBlueprintable, AtpClassifier, Atp Type, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable , Sw ComponentType			
Attribute	Type	Mult.	Kind	Note
hardware Element	HwDescriptionEntity	*	ref	Reference from the EcuAbstractionComponentType to the description of the used HwElements.

Table D.120: EcuAbstractionSwComponentType

Class	EcuInstance			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreTopology			
Note	ECUInstances are used to define the ECUs used in the topology. The type of the ECU is defined by a reference to an ECU specified with the ECU resource description. Tags: atp.recommendedPackage=EcuInstances			





Class	EcuInstance			
Base	ARObject, CollectableElement, FibexElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
associatedComIPduGroup	ISignalIPduGroup	*	ref	With this reference it is possible to identify which ISignalIPduGroups are applicable for which Communication Connector/ ECU. Only top level ISignalIPduGroups shall be referenced by an EcuInstance. If an ISignalIPduGroup contains other ISignalIPduGroups than these contained ISignalIPduGroups shall not be referenced by the EcuInstance. Contained ISignalIPduGroups are associated to an Ecu Instance via the top level ISignalIPduGroup.
associatedConsumedProvidedServiceInstanceGroup	ConsumedProvidedServiceInstanceGroup	*	ref	With this reference it is possible to identify which ConsumedProvidedServiceInstanceGroups are applicable for which ECUInstance. Stereotypes: atpVariation Tags: vh.latestBindingTime=postBuild
associatedPdurIPduGroup	PdurIPduGroup	*	ref	With this reference it is possible to identify which PdurIPdu Groups are applicable for which Communication Connector/ ECU.
clientIdRange	ClientIdRange	0..1	aggr	Restriction of the Client Identifier for this Ecu to an allowed range of numerical values. The Client Identifier of the transaction handle is generated by the client RTE for inter-Ecu Client/Server communication.
comConfigurationGwTimeBase	TimeValue	0..1	attr	The period between successive calls to Com_Main FunctionRouteSignals of the AUTOSAR COM module in seconds.
comConfigurationRxTimeBase	TimeValue	0..1	attr	The period between successive calls to Com_Main FunctionRx of the AUTOSAR COM module in seconds.
comConfigurationTxTimeBase	TimeValue	0..1	attr	The period between successive calls to Com_Main FunctionTx of the AUTOSAR COM module in seconds.
comEnableMDTForCyclicTransmission	Boolean	0..1	attr	Enables for the Com module of this EcuInstance the minimum delay time monitoring for cyclic and repeated transmissions (TransmissionModeTiming has cyclic Timing assigned or eventControlledTiming with numberOfRepetitions > 0).
commController	CommunicationController	1..*	aggr	CommunicationControllers of the ECU. Stereotypes: atpVariation Tags: vh.latestBindingTime=postBuild
connector	CommunicationConnector	*	aggr	All channels controlled by a single controller. Stereotypes: atpVariation Tags: vh.latestBindingTime=postBuild
dltConfig	DltConfig	0..1	aggr	Describes the Dlt configuration on this EcuInstance.
dolpConfig	DolpConfig	0..1	aggr	Dolp configuration on this EcuInstance. Tags: atp.Status=draft
ethSwitchPortGroupDerivation	Boolean	0..1	attr	Defines whether the derivation of SwitchPortGroups based on VLAN and/or CouplingPort.pncMapping shall be performed for this EcuInstance. If not defined the derivation shall not be done.
partition	EcuPartition	*	aggr	Optional definition of Partitions within an Ecu.
pncPrepareSleepTimer	TimeValue	0..1	attr	Time in seconds the PNC state machine shall wait in PNC_PREPARE_SLEEP.





Class	EcuInstance			
pnc Synchronous Wakeup	Boolean	0..1	attr	If this parameter is available and set to true then all available PNCs will be woken up as soon as a channel wakeup occurs. This is ensured by adding all PNCs to all channel wakeup sources during upstream mapping.
pnResetTime	TimeValue	0..1	attr	Specifies the runtime of the reset timer in seconds. This reset time is valid for the reset of PN requests in the EIRA and in the ERA.
sleepMode Supported	Boolean	1	attr	Specifies whether the ECU instance may be put to a "low power mode" <ul style="list-style-type: none"> • true: sleep mode is supported • false: sleep mode is not supported Note: This flag may only be set to "true" if the feature is supported by both hardware and basic software.
tcplplcmpProps	EthTcplplcmpProps	0..1	ref	EcuInstance specific ICMP (Internet Control Message Protocol) attributes
tcplpProps	EthTcplpProps	0..1	ref	EcuInstance specific Tcplp Stack attributes.
v2xSupported	V2xSupportEnum	0..1	attr	This attribute is used to control the existence of the V2X stack on the given EcuInstance.
wakeUpOver BusSupported	Boolean	1	attr	Driver support for wakeup over Bus.

Table D.121: EcuInstance

Class	EcucContainerValue			
Package	M2::AUTOSARTemplates::ECUCDescriptionTemplate			
Note	Represents a Container definition in the ECU Configuration Description.			
Base	ARObject, EcucIndexableValue, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
definition	EcucContainerDef	0..1	ref	Reference to the definition of this Container in the ECU Configuration Parameter Definition. Stereotypes: atpIdentityContributor Tags: xml.sequenceOffset=-10
parameterValue	EcucParameterValue	*	aggr	Aggregates all ECU Configuration Values within this Container. atpVariation: [RS_ECUC_00079] Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=parameterValue.definition, parameter Value.variationPoint.shortLabel vh.latestBindingTime=postBuild
referenceValue	EcucAbstractReference Value	*	aggr	Aggregates all References with this container. atpVariation: [RS_ECUC_00079] Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=referenceValue.definition, reference Value.variationPoint.shortLabel vh.latestBindingTime=postBuild





Class	EcucContainerValue			
subContainer	EcucContainerValue	*	aggr	Aggregates all sub-containers within this container. atpVariation: [RS_ECUC_00078] Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=subContainer.definition, subContainer.shortName, subContainer.variationPoint.shortLabel vh.latestBindingTime=postBuild

Table D.122: EcucContainerValue

Class	EcucDestinationUriDef			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Description of an EcucDestinationUriDef that is used as target of EcucUriReferenceDefs.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
destinationUriPolicy	EcucDestinationUriPolicy	0..1	aggr	Description of the targeted EcucContainerDef.

Table D.123: EcucDestinationUriDef

Class	EcucForeignReferenceDef			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Specify a reference to an XML description of an entity described in another AUTOSAR template.			
Base	ARObject, AtpDefinition, EcucAbstractExternalReferenceDef, EcucAbstractReferenceDef, EcucCommonAttributes, EcucDefinitionElement, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
destinationType	String	0..1	attr	The type in the AUTOSAR Metamodel to which instance this reference is allowed to point to.

Table D.124: EcucForeignReferenceDef

Class	EcucModuleConfigurationValues			
Package	M2::AUTOSARTemplates::ECUCDescriptionTemplate			
Note	<p>Head of the configuration of one Module. A Module can be a BSW module as well as the RTE and ECU Infrastructure.</p> <p>As part of the BSW module description, the EcucModuleConfigurationValues element has two different roles:</p> <p>The recommendedConfiguration contains parameter values recommended by the BSW module vendor.</p> <p>The preconfiguredConfiguration contains values for those parameters which are fixed by the implementation and cannot be changed.</p> <p>These two EcucModuleConfigurationValues are used when the base EcucModuleConfigurationValues (as part of the base ECU configuration) is created to fill parameters with initial values.</p> <p>Tags:atp.recommendedPackage=EcucModuleConfigurationValues</p>			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable , PackageableElement , Referrable			
Attribute	Type	Mult.	Kind	Note





Class	EcucModuleConfigurationValues			
container	EcucContainerValue	*	aggr	Aggregates all containers that belong to this module configuration. atpVariation: [RS_ECUC_00078] Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=container.definition, container.shortName, container.variationPoint.shortLabel vh.latestBindingTime=postBuild xml.sequenceOffset=10
definition	EcucModuleDef	0..1	ref	Reference to the definition of this EcucModule ConfigurationValues element. Typically, this is a vendor specific module configuration. Stereotypes: atpIdentityContributor Tags: xml.sequenceOffset=-10
ecucDefEdition	RevisionLabelString	0..1	attr	This is the version info of the ModuleDef ECUC Parameter definition to which this values conform to / are based on. For the Definition of ModuleDef ECUC Parameters the AdminData shall be used to express the semantic changes. The compatibility rules between the definition and value revision labels is up to the module's vendor.
implementation ConfigVariant	EcucConfiguration VariantEnum	0..1	attr	Specifies the kind of deliverable this EcucModule ConfigurationValues element provides. If this element is not used in a particular role (e.g. preconfigured Configuration or recommendedConfiguration) then the value shall be one of VariantPreCompile, VariantLink Time, VariantPostBuild.
module Description	BswImplementation	0..1	ref	Referencing the BSW module description, which this EcucModuleConfigurationValues element is configuring. This is optional because the EcucModuleConfiguration Values element is also used to configure the ECU infrastructure (memory map) or Application SW-Cs. However in case the EcucModuleConfigurationValues are used to configure the module, the reference is mandatory in order to fetch module specific "common" published information.
postBuildVariant Used	Boolean	0..1	attr	Indicates whether a module implementation has or plans to have (i.e., introduced at link or post-build time) new post-build variation points. TRUE means yes, FALSE means no. If the attribute is not defined, FALSE semantics shall be assumed.

Table D.125: EcucModuleConfigurationValues

Class	EcucModuleDef			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Used as the top-level element for configuration definition for Software Modules, including BSW and RTE as well as ECU Infrastructure. Tags: atp.recommendedPackage=EcucModuleDefs			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpDefinition, CollectableElement, Ecuc DefinitionElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note





Class	EcucModuleDef			
apiServicePrefix	CIdentifier	0..1	attr	For CDD modules this attribute holds the apiService Prefix. The shortName of the module definition of a Complex Driver is always "Cdd". Therefore for CDD modules the module apiServicePrefix is described with this attribute.
container	EcucContainerDef	*	aggr	Aggregates the top-level container definitions of this specific module definition. Stereotypes: atpSplitable Tags: atp.Splitkey=container.shortName xml.sequenceOffset=11
postBuildVariant Support	Boolean	0..1	attr	Indicates if a module supports different post-build variants (previously known as post-build selectable configuration sets). TRUE means yes, FALSE means no.
refinedModule Def	EcucModuleDef	0..1	ref	Optional reference from the Vendor Specific Module Definition to the Standardized Module Definition it refines. In case this EcucModuleDef has the category STANDARDIZED_MODULE_DEFINITION this reference shall not be provided. In case this EcucModuleDef has the category VENDOR_SPECIFIC_MODULE_DEFINITION this reference is mandatory. Stereotypes: atpUriDef
supported ConfigVariant	EcucConfiguration VariantEnum	*	attr	Specifies which ConfigurationVariants are supported by this software module. This attribute is optional if the Ecuc ModuleDef has the category STANDARDIZED_MODULE_DEFINITION. If the category attribute of the EcucModuleDef is set to VENDOR_SPECIFIC_MODULE_DEFINITION then this attribute is mandatory.

Table D.126: EcucModuleDef

Class	EcucUriReferenceDef			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Definition of reference with a destination that is specified via a destinationUri. With such a reference it is possible to define a reference to a EcucContainerDef in a different module independent from the concrete definition of the target container.			
Base	ARObject, AtpDefinition, EcucAbstractInternalReferenceDef, EcucAbstractReferenceDef, EcucCommon Attributes, EcucDefinitionElement, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
destinationUri	EcucDestinationUriDef	0..1	ref	Any EcucContainerDef with a destinationUri that is identical to the destinationUri that is referenced here defines a valid target. Stereotypes: atpUriDef

Table D.127: EcucUriReferenceDef

Class	EngineeringObject (abstract)
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::EngineeringObject
Note	This class specifies an engineering object. Usually such an object is represented by a file artifact. The properties of engineering object are such that the artifact can be found by querying an ASAM catalog file. The engineering object is uniquely identified by domain+category+shortLabel+revisionLabel.
Base	ARObject





Class	EngineeringObject (abstract)			
Subclasses	AutosarEngineeringObject, BuildEngineeringObject, Graphic			
Attribute	Type	Mult.	Kind	Note
category	NameToken	1	attr	<p>This denotes the role of the engineering object in the development cycle. Categories are such as</p> <ul style="list-style-type: none"> • SWSRC for source code • SWOBJ for object code • SWHDR for a C-header file <p>Further roles need to be defined via Methodology.</p> <p>Tags:xml.sequenceOffset=20</p>
domain	NameToken	0..1	attr	<p>This denotes the domain in which the engineering object is stored. This allows to indicate various segments in the repository keeping the engineering objects. The domain may segregate companies, as well as automotive domains. Details need to be defined by the Methodology.</p> <p>Attribute is optional to support a default domain.</p> <p>Tags:xml.sequenceOffset=40</p>
revisionLabel	RevisionLabelString	*	attr	<p>This is a revision label denoting a particular version of the engineering object.</p> <p>Tags:xml.sequenceOffset=30</p>
shortLabel	NameToken	1	attr	<p>This is the short name of the engineering object. Note that it is modeled as NameToken and not as Identifier since in ASAM-CC it is also a NameToken.</p> <p>Tags:xml.sequenceOffset=10</p>

Table D.128: EngineeringObject

Class	ExclusiveArea			
Package	M2::AUTOSARTemplates::CommonStructure::InternalBehavior			
Note	Prevents an executable entity running in the area from being preempted.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
—	—	—	—	—

Table D.129: ExclusiveArea

Class	ExecutableEntity (abstract)			
Package	M2::AUTOSARTemplates::CommonStructure::InternalBehavior			
Note	Abstraction of executable code.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Subclasses	BswModuleEntity , RunnableEntity			
Attribute	Type	Mult.	Kind	Note
activation Reason	ExecutableEntity ActivationReason	*	aggr	<p>If the ExecutableEntity provides at least one activation Reason element the RTE resp. BSW Scheduler shall provide means to read the activation vector of this executable entity execution.</p> <p>If no activationReason element is provided the feature of being able to determine the activating RTEEvent is disabled for this ExecutableEntity.</p>





Class	ExecutableEntity (abstract)			
canEnterExclusiveArea	ExclusiveArea	*	ref	This means that the executable entity can enter/leave the referenced exclusive area through explicit API calls.
exclusiveAreaNestingOrder	ExclusiveAreaNestingOrder	*	ref	This represents the set of ExclusiveAreaNestingOrders recognized by this ExecutableEntity.
minimumStartInterval	TimeValue	0..1	attr	Specifies the time in seconds by which two consecutive starts of an ExecutableEntity are guaranteed to be separated.
reentrancyLevel	ReentrancyLevelEnum	0..1	attr	The reentrancy level of this ExecutableEntity. See the documentation of the enumeration type ReentrancyLevel Enum for details. Please note that nonReentrant interfaces can have also reentrant or multicoreReentrant implementations, and reentrant interfaces can also have multicoreReentrant implementations.
runsInsideExclusiveArea	ExclusiveArea	*	ref	The executable entity runs completely inside the referenced exclusive area.
swAddrMethod	SwAddrMethod	0..1	ref	Addressing method related to this code entity. Via an association to the same SwAddrMethod, it can be specified that several code entities (even of different modules or components) shall be located in the same memory without already specifying the memory section itself.

Table D.130: ExecutableEntity

Class	ExecutableEntityActivationReason			
Package	M2::AUTOSARTemplates::CommonStructure::InternalBehavior			
Note	This meta-class represents the ability to define the reason for the activation of the enclosing Executable Entity.			
Base	ARObject, ImplementationProps , Referrable			
Attribute	Type	Mult.	Kind	Note
bitPosition	PositiveInteger	0..1	attr	This attribute allows for defining the position of the enclosing ExecutableEntityActivationReason in the activation vector.

Table D.131: ExecutableEntityActivationReason

Class	ExternalTriggerOccurredEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	The event is raised when the referenced trigger have been occurred.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
trigger	Trigger	0..1	iref	Reference to the applicable Trigger. InstanceRef implemented by: RTriggerInAtomicSwc InstanceRef

Table D.132: ExternalTriggerOccurredEvent

Class	ExternalTriggeringPoint			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::Trigger			
Note	If a RunnableEntity owns an ExternalTriggeringPoint it is entitled to raise an ExternalTriggerOccurred Event.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
ident	ExternalTriggeringPoint Ident	0..1	aggr	<p>The aggregation in the role ident provides the ability to make the ExternalTriggeringPoint identifiable.</p> <p>From the semantical point of view, the ExternalTriggeringPoint is considered a first-class Identifiable and therefore the aggregation in the role ident shall always exist (until it may be possible to let ModeAccessPoint directly inherit from Identifiable).</p> <p>Stereotypes: atpIdentityContributor Tags: atp.Status=shallBecomeMandatory xml.sequenceOffset=-100</p>
trigger	Trigger	0..1	iref	<p>The trigger taken for the ExternalTriggeringPoint.</p> <p>Tags: xml.namePlural=TRIGGER-IREF xml.roleElement=false xml.roleWrapperElement=true xml.typeElement=true xml.typeWrapperElement=false InstanceRef implemented by: PTriggerInAtomicSwcType InstanceRef</p>

Table D.133: ExternalTriggeringPoint

Class	FlatInstanceDescriptor			
Package	M2::AUTOSARTemplates::CommonStructure::FlatMap			
Note	<p>Represents exactly one node (e.g. a component instance or data element) of the instance tree of a software system. The purpose of this element is to map the various nested representations of this instance to a flat representation and assign a unique name (shortName) to it.</p> <p>Use cases:</p> <ul style="list-style-type: none"> Specify unique names of measurable data to be used by MCD tools Specify unique names of calibration data to be used by MCD tool Specify a unique name for an instance of a component prototype in the ECU extract of the system description <p>Note that in addition it is possible to assign alias names via AliasNameAssignment.</p>			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
ecuExtract Reference	AtpFeature	0..1	iref	<p>Refers to the instance in the ECU extract. This is valid only, if the FlatMap is used in the context of an ECU extract.</p> <p>The reference shall be such that it uniquely defines the object instance. For example, if a data prototype is declared as a role within an SwcInternalBehavior, it is not enough to state the SwcInternalBehavior as context and the aggregated data prototype as target. In addition, the reference shall also include the complete path identifying instance of the component prototype and the Atomic</p>





Class	FlatInstanceDescriptor			
				SoftwareComponentType, which is referred by the particular SwcInternalBehavior. Tags: xml.sequenceOffset=40 InstanceRef implemented by: AnyInstanceRef
role	Identifier	0..1	attr	The role denotes the particular role of the downstream memory location described by this FlatInstanceDescriptor. It applies to use case where one upstream object results in multiple downstream objects, e.g. ModeDeclaration GroupPrototypes which are measurable. In this case the RTE will provide locations for current mode, previous mode and next mode.
rtePluginProps	RtePluginProps	0..1	aggr	The properties of a communication graph with respect to the utilization of RTE Implementation Plug-in. Stereotypes: atpSplitable Tags: atp.Splitkey=rtePluginProps
swDataDef Props	SwDataDefProps	0..1	aggr	The properties of this FlatInstanceDescriptor.
upstream Reference	AtpFeature	0..1	iref	Refers to the instance in the context of an "upstream" descriptions, which could be the system or system extract description, the basic software module description or (if a flat map is used in preliminary context) a description of an atomic component or composition. This reference is optional in case the flat map is used in ECU context. The reference shall be such that it uniquely defines the object instance in the given context. For example, if a data prototype is declared as a role within an SwcInternal Behavior, it is not enough to state the SwcInternal Behavior as context and the aggregated data prototype as target. In addition, the reference shall also include the complete path identifying the instance of the component prototype that contains the particular instance of Swc InternalBehavior. Tags: xml.sequenceOffset=20 InstanceRef implemented by: AnyInstanceRef

Table D.134: FlatInstanceDescriptor

Class	FlatMap			
Package	M2::AUTOSARTemplates::CommonStructure::FlatMap			
Note	Contains a flat list of references to software objects. This list is used to identify instances and to resolve name conflicts. The scope is given by the RootSwCompositionPrototype for which it is used, i.e. it can be applied to a system, system extract or ECU-extract. An instance of FlatMap may also be used in a preliminary context, e.g. in the scope of a software component before integration into a system. In this case it is not referred by a RootSwComposition Prototype. Tags: atp.recommendedPackage=FlatMaps			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, Multilanguage Referrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note





Class	FlatMap			
instance	FlatInstanceDescriptor	1..*	aggr	<p>A descriptor instance aggregated in the flat map.</p> <p>The variation point accounts for the fact, that the system in scope can be subject to variability, and thus the existence of some instances is variable.</p> <p>The aggregation has been made splittable because the content might be contributed by different stakeholders at different times in the workflow. Plus, the overall size might be so big that eventually it becomes more manageable if it is distributed over several files.</p> <p>Stereotypes: atpSplittable; atpVariation Tags: atp.Splitkey=instance.shortName, instance.variation Point.shortLabel vh.latestBindingTime=postBuild</p>

Table D.135: FlatMap

Enumeration	HandleInvalidEnum
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication
Note	Strategies of handling the reception of invalidValue.
Literal	Description
dontInvalidate	<p>Invalidation is switched off.</p> <p>Tags:atp.EnumerationLiteralIndex=0</p>
external Replacement	<p>Replace a received invalidValue. The replacement value is sourced from the externalReplacement.</p> <p>Tags:atp.EnumerationLiteralIndex=1</p>
keep	<p>The application software is supposed to handle signal invalidation on RTE API level either by Data ReceiveErrorEvent or check of error code on read access.</p> <p>Tags:atp.EnumerationLiteralIndex=2</p>
replace	<p>Replace a received invalidValue. The replacement value is specified by the initValue.</p> <p>Tags:atp.EnumerationLiteralIndex=3</p>

Table D.136: HandleInvalidEnum

Enumeration	HandleOutOfRangeEnum
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication
Note	A value of this type is taken for controlling the range checking behavior of the AUTOSAR RTE.
Literal	Description
default	<p>The RTE will use the initValue if the actual value is out of the specified bounds.</p> <p>Tags:atp.EnumerationLiteralIndex=0</p>
external Replacement	<p>This indicates that the value replacement is sourced from the attribute replaceWith.</p> <p>Tags:atp.EnumerationLiteralIndex=1</p>
ignore	<p>The RTE will ignore any attempt to send or receive the corresponding dataElement if the value is out of the specified range.</p> <p>Tags:atp.EnumerationLiteralIndex=2</p>
invalid	<p>The RTE will use the invalidValue if the value is out of the specified bounds.</p> <p>Tags:atp.EnumerationLiteralIndex=3</p>
none	<p>A range check is not required.</p> <p>Tags:atp.EnumerationLiteralIndex=4</p>





Enumeration	HandleOutOfRangeEnum
saturate	The RTE will saturate the value of the dataElement such that it is limited to the applicable upper bound if it is greater than the upper bound. Consequently, it is limited to the applicable lower bound if the value is less than the lower bound. Tags: atp.EnumerationLiteralIndex=5

Table D.137: HandleOutOfRangeEnum

Enumeration	HandleOutOfRangeStatusEnum
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication
Note	This enumeration defines how the RTE handles values that are out of range.
Literal	Description
indicate	The RTE sets the return status to RTE_E_OUT_OF_RANGE if the received value is out of range and the attribute handleOutOfRange is not set to "none" or "invalid". Tags: atp.EnumerationLiteralIndex=0
silent	The RTE sets the return status to RTE_E_OK Tags: atp.EnumerationLiteralIndex=1

Table D.138: HandleOutOfRangeStatusEnum

Enumeration	HandleTimeoutEnum
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication
Note	Strategies of handling a reception timeout violation.
Literal	Description
none	If set to none no replacement shall take place. Tags: atp.EnumerationLiteralIndex=0
replace	If set to replace, the replacement value shall be the ComInitValue. Tags: atp.EnumerationLiteralIndex=1
replaceByTimeoutSubstitutionValue	If set to replace, the replacement value shall be the timeout substitution value. Tags: atp.EnumerationLiteralIndex=2

Table D.139: HandleTimeoutEnum

Class	HwElement			
Package	M2::AUTOSARTemplates::EcuResourceTemplate			
Note	This represents the ability to describe Hardware Elements on an instance level. The particular types of hardware are distinguished by the category. This category determines the applicable attributes. The possible categories and attributes are defined in HwCategory. Tags: atp.recommendedPackage=HwElements			
Base	ARElement, ARObject, CollectableElement, HwDescriptionEntity, Identifiable , MultilanguageReferrable , PackageableElement , Referrable			
Attribute	Type	Mult.	Kind	Note
hwElementConnection	HwElementConnector	*	aggr	This represents one particular connection between two hardware elements. Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime xml.sequenceOffset=110





Class	HwElement			
hwPinGroup	HwPinGroup	*	aggr	<p>This aggregation is used to describe the connection facilities of a hardware element. Note that hardware element has no pins but only pingroups.</p> <p>Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime xml.sequenceOffset=90</p>
nestedElement	HwElement	*	ref	<p>This association is used to establish hierarchies of hw elements. Note that one particular HwElement can be target of this association only once. I.e. multiple instantiation of the same HwElement is not supported (at any hierarchy level).</p> <p>Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime xml.sequenceOffset=70</p>

Table D.140: HwElement

Class	ISignal			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreCommunication			
Note	<p>Signal of the Interaction Layer. The RTE supports a "signal fan-out" where the same System Signal is sent in different SignalIPdus to multiple receivers.</p> <p>To support the RTE "signal fan-out" each SignalIPdu contains ISignals. If the same System Signal is to be mapped into several SignalIPdus there is one ISignal needed for each ISignalToIPduMapping.</p> <p>ISignals describe the Interface between the Precompile configured RTE and the potentially Postbuild configured Com Stack (see ECUC Parameter Mapping).</p> <p>In case of the SystemSignalGroup an ISignal shall be created for each SystemSignal contained in the SystemSignalGroup.</p> <p>Tags:atp.recommendedPackage=ISignals</p>			
Base	ARObject, CollectableElement, FibexElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
dataTransformation	DataTransformation	0..1	ref	<p>Optional reference to a DataTransformation which represents the transformer chain that is used to transform the data that shall be placed inside this ISignal.</p> <p>Stereotypes: atpSplittable; atpVariation Tags: atp.Splitkey=dataTransformation.dataTransformation, dataTransformation.variationPoint.shortLabel vh.latestBindingTime=codeGenerationTime</p>
dataTypePolicy	DataTypePolicyEnum	1	attr	<p>With the aggregation of SwDataDefProps an ISignal specifies how it is represented on the network. This representation follows a particular policy. Note that this causes some redundancy which is intended and can be used to support flexible development methodology as well as subsequent integrity checks.</p> <p>If the policy "networkRepresentationFromComSpec" is chosen the network representation from the ComSpec that is aggregated by the PortPrototype shall be used. If the "override" policy is chosen the requirements specified</p>





Class	ISignal			
				<p>△</p> <p>in the PortInterface and in the ComSpec are not fulfilled by the networkRepresentationProps. In case the System Description doesn't use a complete Software Component Description (VFB View) the "legacy" policy can be chosen.</p>
initValue	ValueSpecification	0..1	aggr	<p>Optional definition of a ISignal's initValue in case the System Description doesn't use a complete Software Component Description (VFB View). This supports the inclusion of legacy system signals.</p> <p>This value can be used to configure the Signal's "Init Value".</p> <p>If a full DataMapping exist for the SystemSignal this information may be available from a configured Sender ComSpec and ReceiverComSpec. In this case the initvalues in SenderComSpec and/or ReceiverComSpec override this optional value specification. Further restrictions apply from the RTE specification.</p>
iSignalProps	ISignalProps	0..1	aggr	<p>Additional optional ISignal properties that may be stored in different files.</p> <p>Stereotypes: atpSplitable Tags: atp.Splitkey=iSignalProps</p>
iSignalType	ISignalTypeEnum	0..1	attr	<p>This attribute defines whether this iSignal is an array that results in a UINT8_N / UINT8_DYN ComSignalType in the COM configuration or a primitive type.</p>
length	Integer	1	attr	<p>Size of the signal in bits. The size needs to be derived from the mapped VariableDataPrototype according to the mapping of primitive DataTypes to BaseTypes as used in the RTE. Indicates maximum size for dynamic length signals.</p> <p>The ISignal length of zero bits is allowed.</p>
network Representation Props	SwDataDefProps	0..1	aggr	<p>Specification of the actual network representation. The usage of SwDataDefProps for this purpose is restricted to the attributes compuMethod and baseType. The optional baseType attributes "memAlignment" and "byteOrder" shall not be used.</p> <p>The attribute "dataTypePolicy" in the SystemTemplate element defines whether this network representation shall be ignored and the information shall be taken over from the network representation of the ComSpec.</p> <p>If "override" is chosen by the system integrator the network representation can violate against the requirements defined in the PortInterface and in the network representation of the ComSpec.</p> <p>In case that the System Description doesn't use a complete Software Component Description (VFB View) this element is used to configure "ComSignalDataInvalid Value" and the Data Semantics.</p>
systemSignal	SystemSignal	1	ref	<p>Reference to the System Signal that is supposed to be transmitted in the ISignal.</p>
timeout Substitution Value	ValueSpecification	0..1	aggr	<p>Defines and enables the ComTimeoutSubstitution for this ISignal.</p>





Class	ISignal			
transformation ISignalProps	TransformationISignalProps	*	aggr	A transformer chain consists of an ordered list of transformers. The ISignal specific configuration properties for each transformer are defined in the TransformationISignalProps class. The transformer configuration properties that are common for all ISignals are described in the TransformationTechnology class.

Table D.141: ISignal

Class	ISignalGroup			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreCommunication			
Note	<p>SignalGroup of the Interaction Layer. The RTE supports a "signal fan-out" where the same System Signal Group is sent in different SignalIPdus to multiple receivers.</p> <p>An ISignalGroup refers to a set of ISignals that shall always be kept together. A ISignalGroup represents a COM Signal Group.</p> <p>Therefore it is recommended to put the ISignalGroup in the same Package as ISignals (see atp.recommendedPackage)</p> <p>Tags:atp.recommendedPackage=ISignalGroup</p>			
Base	ARObject, CollectableElement, FibexElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
comBased SignalGroup Transformation	DataTransformation	0..1	ref	<p>Optional reference to a DataTransformation which represents the transformer chain that is used to transform the data that shall be placed inside this ISignalGroup based on the COMBasedTransformer approach.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=comBasedSignalGroupTransformation.dataTransformation, comBasedSignalGroupTransformation.variationPoint.shortLabel vh.latestBindingTime=codeGenerationTime</p>
iSignal	ISignal	*	ref	Reference to a set of ISignals that shall always be kept together.
systemSignal Group	SystemSignalGroup	1	ref	Reference to the SystemSignalGroup that is defined on VFB level and that is supposed to be transmitted in the ISignalGroup.
transformation ISignalProps	TransformationISignalProps	*	aggr	A transformer chain consists of an ordered list of transformers. The ISignalGroup specific configuration properties for each transformer are defined in the TransformationISignalProps class. The transformer configuration properties that are common for all ISignal Groups are described in the TransformationTechnology class.

Table D.142: ISignalGroup

Class	ISignalIPdu			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreCommunication			
Note	<p>Represents the IPdus handled by Com. The ISignalIPdu assembled and disassembled in AUTOSAR COM consists of one or more signals. In case no multiplexing is performed this IPdu is routed to/from the Interface Layer.</p> <p>A maximum of one dynamic length signal per IPdu is allowed.</p> <p>Tags:atp.recommendedPackage=Pdus</p>			





Class	ISignalIPdu			
Base	ARObject, CollectableElement, FibexElement, IPdu, Identifiable , MultilanguageReferrable, PackageableElement, Pdu, Referrable			
Attribute	Type	Mult.	Kind	Note
iPduTiming Specification	IPduTiming	0..1	aggr	Timing specification for Com IPdus (Transmission Modes). This information is mandatory for the sender in a System Extract. This information may be omitted on receivers in a System Extract. atpVariation: The timing of a Pdu can vary. Stereotypes: atpVariation Tags: vh.latestBindingTime=postBuild
iSignalToPdu Mapping	ISignalToIPduMapping	*	aggr	Definition of SignalToIPduMappings included in the Signal IPdu. atpVariation: The content of a PDU can be variable. Stereotypes: atpVariation Tags: vh.latestBindingTime=postBuild
pduCounter	SignalIPduCounter	0..1	aggr	An included Pdu counter is used to ensure that a sequence of Pdus is maintained. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
pduReplication	SignalIPduReplication	0..1	aggr	Pdu Replication is a form of redundancy where the data content of one ISignalIPdu (source) is transmitted inside a set of replica ISignalIPdus. These ISignalIPdus (copies) have different Pdu IDs, identical PduCounters, identical data content and are transmitted with the same frequency. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
unusedBit Pattern	Integer	1	attr	AUTOSAR COM and AUTOSAR IPDUM are filling not used areas of an IPDU with this bit-pattern. This attribute is mandatory to avoid undefined behavior. This byte-pattern will be repeated throughout the IPdu.

Table D.143: ISignalIPdu

Class	ISignalProps			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreCommunication			
Note	Additional ISignal properties that may be stored in different files.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
handleOutOf Range	HandleOutOfRangeEnum	1	attr	This attribute defines the outOfRangeHandling for received and sent signals.

Table D.144: ISignalProps

Class	ISignalToIPduMapping			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreCommunication			
Note	An ISignalToIPduMapping describes the mapping of ISignals to ISignalIPdus and defines the position of the ISignal within an ISignalIPdu.			
Base	ARObject, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note





Class	ISignalToIPduMapping			
iSignal	ISignal	0..1	ref	<p>Reference to a ISignal that is mapped into the ISignal IPdu.</p> <p>Each ISignal contained in the ISignalGroup shall be mapped into an IPdu by an own ISignalToIPduMapping. The references to the ISignal and to the ISignalGroup in an ISignalToIPduMapping are mutually exclusive.</p>
iSignalGroup	ISignalGroup	0..1	ref	<p>Reference to an ISignalGroup that is mapped into the SignalIPdu. If an ISignalToIPduMapping for an ISignal Group is defined, only the UpdateIndicationBitPosition and the transferProperty is relevant. The startPosition and the packingByteOrder shall be ignored.</p> <p>Each ISignal contained in the ISignalGroup shall be mapped into an IPdu by an own ISignalToIPduMapping. The references to the ISignal and to the ISignalGroup in an ISignalToIPduMapping are mutually exclusive.</p>
packingByte Order	ByteOrderEnum	0..1	attr	<p>This parameter defines the order of the bytes of the signal and the packing into the SignalIPdu. The byte ordering "Little Endian" (MostSignificantByteLast), "Big Endian" (MostSignificantByteFirst) and "Opaque" can be selected. For opaque data endianness conversion shall be configured to Opaque. The value of this attribute impacts the absolute position of the signal into the SignalIPdu (see the startPosition attribute description).</p> <p>For an ISignalGroup the packingByteOrder is irrelevant and shall be ignored.</p>
startPosition	Integer	0..1	attr	<p>This parameter is necessary to describe the bitposition of a signal within an SignalIPdu. It denotes the least significant bit for "Little Endian" and the most significant bit for "Big Endian" packed signals within the IPdu (see the description of the packingByteOrder attribute). In AUTOSAR the bit counting is always set to "sawtooth" and the bit order is set to "Decreasing". The bit counting in byte 0 starts with bit 0 (least significant bit). The most significant bit in byte 0 is bit 7.</p> <p>Please note that the way the bytes will be actually sent on the bus does not impact this representation: they will always be seen by the software as a byte array.</p> <p>If a mapping for the ISignalGroup is defined, this attribute is irrelevant and shall be ignored.</p>
transferProperty	TransferPropertyEnum	0..1	attr	<p>Defines how the referenced ISignal contributes to the send triggering of the ISignalIPdu.</p>
update IndicationBit Position	Integer	0..1	attr	<p>The UpdateIndicationBit indicates to the receivers that the signal (or the signal group) was updated by the sender. Length is always one bit. The UpdateIndicationBitPosition attribute describes the position of the update bit within the SignalIPdu. For Signals of a ISignalGroup this attribute is irrelevant and shall be ignored.</p> <p>Note that the exact bit position of the updateIndicationBit Position is linked to the value of the attribute packingByte Order because the method of finding the bit position is different for the values mostSignificantByteFirst and most SignificantByteLast. This means that if the value of packingByteOrder is changed while the value of update IndicationBitPosition remains unchanged the exact bit position of updateIndicationBitPosition within the enclosing ISignalIPdu still undergoes a change.</p>





Class	ISignalToIPduMapping		
			<p style="text-align: center;">△</p> <p>This attribute denotes the least significant bit for "Little Endian" and the most significant bit for "Big Endian" packed signals within the IPdu (see the description of the packingByteOrder attribute). In AUTOSAR the bit counting is always set to "sawtooth" and the bit order is set to "Decreasing". The bit counting in byte 0 starts with bit 0 (least significant bit). The most significant bit in byte 0 is bit 7.</p>

Table D.145: ISignalToIPduMapping

Class	Identifiable (abstract)
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable
Note	Instances of this class can be referred to by their identifier (within the namespace borders). In addition to this, Identifiables are objects which contribute significantly to the overall structure of an AUTOSAR description. In particular, Identifiables might contain Identifiables.
Base	ARObject, MultilanguageReferrable, Referrable
Subclasses	ARPackage , AbstractDolpLogicAddressProps , AbstractEvent , AbstractImplementationDataTypeElement , AbstractSecurityEventFilter , AbstractSecurityIdsmInstanceFilter , AbstractServiceInstance , ApplicationEndpoint , ApplicationError , ApplicationPartitionToEcuPartitionMapping , AsynchronousServerCallResultPoint , AtpBlueprint , AtpBlueprintable , AtpClassifier , AtpFeature , AutosarOperationArgumentInstance , AutosarVariableInstance , BinaryManifestAddressableObject , BinaryManifestItemDefinition , BinaryManifestResource , BinaryManifestResourceDefinition , BlockState , BswInternalTriggeringPoint , BswModuleDependency , BuildActionEntity , BuildActionEnvironment , CanTpAddress , CanTpChannel , CanTpNode , Chapter , ClassContentConditional , ClientIdDefinition , ClientServerOperation , Code , CollectableElement , ComManagementMapping , CommConnectorPort , CommunicationConnector , CommunicationController , Compiler , ConsistencyNeeds , ConsumedEventGroup , CouplingPort , CouplingPortStructuralElement , CpSoftwareClusterResource , CpSoftwareClusterResourceToApplicationPartitionMapping , CpSoftwareClusterToEcuInstanceMapping , CpSoftwareClusterToResourceMapping , CryptoServiceMapping , DataPrototypeGroup , DataTransformation , DependencyOnArtifact , DiagEventDebounceAlgorithm , DiagnosticConnectedIndicator , DiagnosticDataElement , DiagnosticFunctionInhibitSource , DiagnosticRoutineSubfunction , DltArgument , DltLogChannel , DltMessage , DolpInterface , DolpLogicAddress , DolpRoutingActivation , ECUMapping , EOCExecutableEntityRefAbstract , EcuPartition , EcucContainerValue , EcucDefinitionElement , EcucDestinationUriDef , EcucEnumerationLiteralDef , EcucQuery , EcucValidationCondition , EndToEndProtection , EthernetWakeupSleepOnDataLineConfig , ExclusiveArea , ExecutableEntity , ExecutionTime , FMAAttributeDef , FMFeatureMapAssertion , FMFeatureMapCondition , FMFeatureMapElement , FMFeatureRelation , FMFeatureRestriction , FMFeatureSelection , FlatInstanceDescriptor , FlexrayArTpNode , FlexrayTpConnectionControl , FlexrayTpNode , FlexrayTpPduPool , FrameTriggering , GeneralParameter , GlobalTimeGateway , GlobalTimeMaster , GlobalTimeSlave , HeapUsage , HwAttributeDef , HwAttributeLiteralDef , HwPin , HwPinGroup , IPSecRule , IPv6ExtHeaderFilterList , ISignalToIPduMapping , ISignalTriggering , IdentCaption , InternalTriggeringPoint , J1939SharedAddressCluster , J1939TpNode , Keyword , LifeCycleState , LinScheduleTable , LinTpNode , Linker , MacMulticastGroup , McDataInstance , MemorySection , ModeDeclaration , ModeDeclarationMapping , ModeSwitchPoint , NetworkEndpoint , NmCluster , NmEcu , NmNode , NvBlockDescriptor , PackageableElement , ParameterAccess , PduToFrameMapping , PduTriggering , PerInstanceMemory , PhysicalChannel , PortElementToCommunicationResourceMapping , PortGroup , PortInterfaceMapping , PossibleErrorReaction , ResourceConsumption , RootSwCompositionPrototype , RptComponent , RptExecutableEntity , RptExecutableEntityEvent , RptExecutionContext , RptProfile , RptServicePoint , RunnableEntityGroup , SdgAttribute , SdgClass , SecureCommunicationAuthenticationProps , SecureCommunicationFreshnessProps , SecurityEventContextProps , ServerCallPoint , ServiceNeeds , SignalServiceTranslationElementProps , SignalServiceTranslationEventProps , SignalServiceTranslationProps , SocketAddress , SomeipTpChannel , SpecElementReference , StackUsage , StaticSocketConnection , StructuredReq , SwGenericAxisParamType , SwServiceArg , SwcServiceDependency , SwcToApplicationPartitionMapping , SwcToEcuMapping , SwcToImplMapping , SystemMapping , TDCpSoftwareClusterMapping , TDCpSoftwareClusterResourceMapping , TcpOptionFilterList , TimingCondition , TimingConstraint , TimingDescription , TimingExtensionResource , TimingModelInstance , TlsCryptoCipherSuite , Topic1 , TpAddress , TraceableTable , TraceableText , TracedFailure , TransformationProps , TransformationTechnology , Trigger , VariableAccess , VariationPointProxy , ViewMap , VlanConfig , WaitPoint





Class	Identifiable (abstract)			
Attribute	Type	Mult.	Kind	Note
adminData	AdminData	0..1	aggr	This represents the administrative data for the identifiable object. Tags: xml.sequenceOffset=-40
annotation	Annotation	*	aggr	Possibility to provide additional notes while defining a model element (e.g. the ECU Configuration Parameter Values). These are not intended as documentation but are mere design notes. Tags: xml.sequenceOffset=-25
category	CategoryString	0..1	attr	The category is a keyword that specializes the semantics of the Identifiable. It affects the expected existence of attributes and the applicability of constraints. Tags: xml.sequenceOffset=-50
desc	MultiLanguageOverviewParagraph	0..1	aggr	This represents a general but brief (one paragraph) description what the object in question is about. It is only one paragraph! Desc is intended to be collected into overview tables. This property helps a human reader to identify the object in question. More elaborate documentation, (in particular how the object is built or used) should go to "introduction". Tags: xml.sequenceOffset=-60
introduction	DocumentationBlock	0..1	aggr	This represents more information about how the object in question is built or is used. Therefore it is a DocumentationBlock. Tags: xml.sequenceOffset=-30
uuid	String	0..1	attr	The purpose of this attribute is to provide a globally unique identifier for an instance of a meta-class. The values of this attribute should be globally unique strings prefixed by the type of identifier. For example, to include a DCE UUID as defined by The Open Group, the UUID would be preceded by "DCE:". The values of this attribute may be used to support merging of different AUTOSAR models. The form of the UUID (Universally Unique Identifier) is taken from a standard defined by the Open Group (was Open Software Foundation). This standard is widely used, including by Microsoft for COM (GUIDs) and by many companies for DCE, which is based on CORBA. The method for generating these 128-bit IDs is published in the standard and the effectiveness and uniqueness of the IDs is not in practice disputed. If the id namespace is omitted, DCE is assumed. An example is "DCE:2fac1234-31f8-11b4-a222-08002b34c003". The uuid attribute has no semantic meaning for an AUTOSAR model and there is no requirement for AUTOSAR tools to manage the timestamp. Tags: xml.attribute=true

Table D.146: Identifiable

Class	Implementation (abstract)
Package	M2::AUTOSARTemplates::CommonStructure::Implementation
Note	Description of an implementation a single software component or module.
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable





Class	Implementation (abstract)			
Subclasses	BswImplementation, SwcImplementation			
Attribute	Type	Mult.	Kind	Note
buildActionManifest	BuildActionManifest	0..1	ref	A manifest specifying the intended build actions for the software delivered with this implementation. Stereotypes: atpVariation Tags: vh.latestBindingTime=codeGenerationTime
codeDescriptor	Code	*	aggr	Specifies the provided implementation code.
compiler	Compiler	*	aggr	Specifies the compiler for which this implementation has been released
generatedArtifact	DependencyOnArtifact	*	aggr	Relates to an artifact that will be generated during the integration of this Implementation by an associated generator tool. Note that this is an optional information since it might not always be in the scope of a single module or component to provide this information. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
hwElement	HwElement	*	ref	The hardware elements (e.g. the processor) required for this implementation.
linker	Linker	*	aggr	Specifies the linker for which this implementation has been released.
mcSupport	McSupportData	0..1	aggr	The measurement & calibration support data belonging to this implementation. The aggregation is <<atpSplitable>> because in case of an already existing BSW Implementation model, this description will be added later in the process, namely at code generation time. Stereotypes: atpSplitable Tags: atp.Splitkey=mcSupport
programmingLanguage	ProgramminglanguageEnum	0..1	attr	Programming language the implementation was created in.
requiredArtifact	DependencyOnArtifact	*	aggr	Specifies that this Implementation depends on the existence of another artifact (e.g. a library). This aggregation of DependencyOnArtifact is subject to variability with the purpose to support variability in the implementations. Different algorithms in the implementation might cause different dependencies, e.g. the number of used libraries. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
requiredGeneratorTool	DependencyOnArtifact	*	aggr	Relates this Implementation to a generator tool in order to generate additional artifacts during integration. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
resourceConsumption	ResourceConsumption	0..1	aggr	All static and dynamic resources for each implementation are described within the ResourceConsumption class. Stereotypes: atpSplitable Tags: atp.Splitkey=resourceConsumption.shortName
swcBswMapping	SwcBswMapping	0..1	ref	This allows a mapping between an SWC and a BSW behavior to be attached to an implementation description (for AUTOSAR Service, ECU Abstraction and Complex Driver Components). It is up to the methodology to define whether this reference has to be set for the Swc- or Bsw Implementation or for both.





Class	Implementation (abstract)			
swVersion	RevisionLabelString	0..1	attr	Software version of this implementation. The numbering contains three levels (like major, minor, patch), its values are vendor specific.
usedCodeGenerator	String	0..1	attr	Optional: code generator used.
vendorId	PositiveInteger	0..1	attr	Vendor ID of this Implementation according to the AUTOSAR vendor list

Table D.147: Implementation

Class	ImplementationDataType			
Package	M2::AUTOSARTemplates::CommonStructure::ImplementationDataTypes			
Note	Describes a reusable data type on the implementation level. This will typically correspond to a typedef in C-code. Tags: atp.recommendedPackage=ImplementationDataTypes			
Base	<i>ARElement</i> , <i>ARObject</i> , <i>AbstractImplementationDataType</i> , <i>AtpBlueprint</i> , <i>AtpBlueprintable</i> , <i>AtpClassifier</i> , <i>AtpType</i> , AutosarDataType , <i>CollectableElement</i> , <i>Identifiable</i> , <i>MultilanguageReferrable</i> , <i>PackageableElement</i> , Referrable			
Attribute	Type	Mult.	Kind	Note
dynamicArraySizeProfile	String	0..1	attr	Specifies the profile which the array will follow in case this data type is a variable size array.
isStructWithOptionalElement	Boolean	0..1	attr	This attribute is only valid if the attribute category is set to STRUCTURE. If set to True, this attribute indicates that the ImplementationDataType has been created with the intention to define at least one element of the structure as optional.
subElement (ordered)	ImplementationDataTypeElement	*	aggr	Specifies an element of an array, struct, or union data type. The aggregation of ImplementationDataTypeElement is subject to variability with the purpose to support the conditional existence of elements inside a ImplementationDataType representing a structure. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
symbolProps	SymbolProps	0..1	aggr	This represents the SymbolProps for the ImplementationDataType. Stereotypes: atpSplittable Tags: atp.Splitkey=symbolProps.shortName
typeEmitter	NameToken	0..1	attr	This attribute is used to control which part of the AUTOSAR toolchain is supposed to trigger data type definitions.

Table D.148: ImplementationDataType

Class	ImplementationDataTypeElement
Package	M2::AUTOSARTemplates::CommonStructure::ImplementationDataTypes
Note	Declares a data object which is locally aggregated. Such an element can only be used within the scope where it is aggregated. This element either consists of further subElements or it is further defined via its swDataDefProps. There are several use cases within the system of ImplementationDataTypes for such a local declaration:





Class	ImplementationDataTypeElement			
	<div>△</div> <ul style="list-style-type: none"> It can represent the elements of an array, defining the element type and array size It can represent an element of a struct, defining its type It can be the local declaration of a debug element. 			
Base	ARObject, AbstractImplementationDataTypeElement, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
arrayImplPolicy	ArrayImplPolicyEnum	0..1	attr	This attribute controls the implementation of the payload of an array. It shall only be used if the enclosing ImplementationDataType constitutes an array.
arraySize	PositiveInteger	0..1	attr	The existence of this attributes (if bigger than 0) defines the size of an array and declares that this ImplementationDataTypeElement represents the type of each single array element. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
arraySize Handling	ArraySizeHandling Enum	0..1	attr	The way how the size of the array is handled in case of a variable size array.
arraySize Semantics	ArraySizeSemantics Enum	0..1	attr	This attribute controls the meaning of the value of the array size.
isOptional	Boolean	0..1	attr	This attribute represents the ability to declare the enclosing ImplementationDataTypeElement as optional. This means that, at runtime, the ImplementationDataTypeElement may or may not have a valid value and shall therefore be ignored. The underlying runtime software provides means to set the CppImplementationDataTypeElement as not valid at the sending end of a communication and determine its validity at the receiving end.
subElement (ordered)	ImplementationDataTypeElement	*	aggr	Element of an array, struct, or union in case of a nested declaration (i.e. without using "typedefs"). The aggregation of ImplementationDataTypeElement is subject to variability with the purpose to support the conditional existence of elements inside a ImplementationDataType representing a structure. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
swDataDef Props	SwDataDefProps	0..1	aggr	The properties of this ImplementationDataTypeElement.

Table D.149: ImplementationDataTypeElement

Class	ImplementationProps (abstract)			
Package	M2::AUTOSARTemplates::CommonStructure::Implementation			
Note	Defines a symbol to be used as (depending on the concrete case) either a complete replacement or a prefix when generating code artifacts.			
Base	ARObject, Referrable			
Subclasses	BswSchedulerNamePrefix, ExecutableEntityActivationReason, SectionNamePrefix, SymbolProps, SymbolicNameProps			
Attribute	Type	Mult.	Kind	Note





Class	ImplementationProps (abstract)			
symbol	CIdentifier	0..1	attr	The symbol to be used as (depending on the concrete case) either a complete replacement or a prefix.

Table D.150: ImplementationProps

Class	IncludedDataTypeSet			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::IncludedDataTypes			
Note	<p>An includedDataTypeSet declares that a set of AutosarDataType is used by a basic software module or a software component for its implementation and the AutosarDataType becomes part of the contract.</p> <p>This information is required if the AutosarDataType is not used for any DataPrototype owned by this software component or if the enumeration literals, lowerLimit and upperLimit constants shall be generated with a literalPrefix.</p> <p>The optional literalPrefix is used to add a common prefix on enumeration literals, lowerLimit and upperLimit constants created by the RTE.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
dataType	AutosarDataType	*	ref	AutosarDataType belonging to the includedDataTypeSet
literalPrefix	Identifier	0..1	attr	LiteralPrefix defines a common prefix for all AutosarDataTypes of the includedDataTypeSet to be added on enumeration literals, lowerLimit and upperLimit constants created by the RTE.

Table D.151: IncludedDataTypeSet

Class	IncludedModeDeclarationGroupSet			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ModeDeclarationGroup			
Note	An IncludedModeDeclarationGroupSet declares that a set of ModeDeclarationGroups used by the software component for its implementation and consequently these ModeDeclarationGroups become part of the contract.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
mode Declaration Group	ModeDeclarationGroup	*	ref	This represents the referenced ModeDeclarationGroup.
prefix	Identifier	0..1	attr	The prefix shall be used by the RTE generator as a prefix for the creation of symbols related to the referenced ModeDeclarationGroups, e.g RTE_TRANSITION_<ModeDeclarationGroup>.

Table D.152: IncludedModeDeclarationGroupSet

Class	InitEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This RTEEvent is supposed to be used for initialization purposes, i.e. for starting and restarting a partition. It is not guaranteed that all RunnableEntities referenced by this InitEvent are executed before the 'regular' RunnableEntities are executed for the first time. The execution order depends on the task mapping.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
—	—	—	—	—

Table D.153: InitEvent

Class	InstantiationDataDefProps			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::InstantiationDataDefProps			
Note	<p>This is a general class allowing to apply additional SwDataDefProps to particular instantiations of a Data Prototype.</p> <p>Typically the accessibility and further information like alias names for a particular data is modeled on the level of DataPrototypes (especially VariableDataPrototypes, ParameterDataPrototypes). But due to the recursive structure of the meta-model concerning data types (a composite (data) type consists out of data prototypes) a part of the MCD information is described in the data type (in case of Application CompositeDataType).</p> <p>This is a strong restriction in the reuse of data typed because the data type should be re-used for different VariableDataPrototypes and ParameterDataPrototypes to guarantee type compatibility on C-implementation level (e.g. data of a Port is stored in PIM or a ParameterDataPrototype used as ROM Block and shall be typed by the same data type as NVRAM Block).</p> <p>This class overcomes such a restriction if applied properly.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
parameter Instance	AutosarParameterRef	0..1	aggr	This is the particular ParameterDataPrototypes on which the swDataDefProps shall be applied.
swDataDef Props	SwDataDefProps	0..1	aggr	These are the particular data definition properties which shall be applied
variableInstance	AutosarVariableRef	0..1	aggr	This is the particular VariableDataPrototypes on which the swDataDefProps shall be applied.

Table D.154: InstantiationDataDefProps

Class	InstantiationRTEEventProps (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	This meta class represents the ability to refine the properties of RTEEvents for particular instances of a software component.			
Base	ARObject			
Subclasses	InstantiationTimingEventProps			
Attribute	Type	Mult.	Kind	Note
refinedEvent	RTEEvent	0..1	iref	<p>This instance ref denotes the Timing Event for which the period shall be refined on an instance level.</p> <p>InstanceRef implemented by: InstanceEventIn CompositionInstanceRef</p>
shortLabel	Identifier	0..1	attr	<p>The main purpose of the shortLabel is to contribute to the splitkey of aggregations that are <<atpSplittable>>.</p> <p>Stereotypes: atpIdentityContributor</p>

Table D.155: InstantiationRTEEventProps

Class	InternalBehavior (abstract)			
Package	M2::AUTOSARTemplates::CommonStructure::InternalBehavior			
Note	Common base class (abstract) for the internal behavior of both software components and basic software modules/clusters.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Subclasses	BswInternalBehavior , SwcInternalBehavior			
Attribute	Type	Mult.	Kind	Note





Class	InternalBehavior (abstract)			
constantMemory	ParameterDataPrototype	*	aggr	<p>Describes a read only memory object containing characteristic value(s) implemented by this InternalBehavior.</p> <p>The shortName of ParameterDataPrototype has to be equal to the 'C' identifier of the described constant.</p> <p>The characteristic value(s) might be shared between SwComponentPrototypes of the same SwComponentType.</p> <p>The aggregation of constantMemory is subject to variability with the purpose to support variability in the software component or module implementations. Typically different algorithms in the implementation are requiring different number of memory objects.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=constantMemory.shortName, constantMemory.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
constantValueMapping	ConstantSpecificationMappingSet	*	ref	<p>Reference to the ConstantSpecificationMapping to be applied for the particular InternalBehavior</p> <p>Stereotypes: atpSplitable</p> <p>Tags:atp.Splitkey=constantValueMapping</p>
dataTypeMapping	DataTypeMappingSet	*	ref	<p>Reference to the DataTypeMapping to be applied for the particular InternalBehavior</p> <p>Stereotypes: atpSplitable</p> <p>Tags:atp.Splitkey=dataTypeMapping</p>
exclusiveArea	ExclusiveArea	*	aggr	<p>This specifies an ExclusiveArea for this InternalBehavior. The exclusiveArea is local to the component resp. module. The aggregation of ExclusiveAreas is subject to variability. Note: the number of ExclusiveAreas might vary due to the conditional existence of RunnableEntities or BswModuleEntities.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=exclusiveArea.shortName, exclusiveArea.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
exclusiveAreaNestingOrder	ExclusiveAreaNestingOrder	*	aggr	<p>This represents the set of ExclusiveAreaNestingOrder owned by the InternalBehavior.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=exclusiveAreaNestingOrder.shortName, exclusiveAreaNestingOrder.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
staticMemory	VariableDataPrototype	*	aggr	<p>Describes a read and writeable static memory object representing measurement variables implemented by this software component. The term "static" is used in the meaning of "non-temporary" and does not necessarily specify a linker encapsulation. This kind of memory is only supported if supportsMultipleInstantiation is FALSE.</p> <p>The shortName of the VariableDataPrototype has to be equal with the 'C' identifier of the described variable.</p> <p>The aggregation of staticMemory is subject to variability with the purpose to support variability in the software component's implementations.</p>





Class	InternalBehavior (abstract)			
				<p>△</p> <p>Typically different algorithms in the implementation are requiring different number of memory objects.</p> <p>Stereotypes: atpSplittable; atpVariation</p> <p>Tags: atp.Splitkey=staticMemory.shortName, static Memory.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>

Table D.156: InternalBehavior

Class	InternalTriggerOccurredEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	The event is raised when the referenced internal trigger have been occurred.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
eventSource	InternalTriggeringPoint	0..1	ref	Internal Triggering Point that triggers the event.

Table D.157: InternalTriggerOccurredEvent

Class	InternalTriggeringPoint			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::Trigger			
Note	If a RunnableEntity owns an InternalTriggeringPoint it is entitled to trigger the execution of Runnable Entities of the corresponding software-component.			
Base	ARObject, AbstractAccessPoint , AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
swImplPolicy	SwImplPolicyEnum	0..1	attr	This attribute, when set to value queued, allows for a queued processing of Triggers.

Table D.158: InternalTriggeringPoint

Class	InvalidationPolicy			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	<p>Specifies whether the component can actively invalidate a particular dataElement.</p> <p>If no invalidationPolicy points to a dataElement this is considered to yield the identical result as if the handleInvalid attribute was set to dontInvalidate.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
dataElement	VariableDataPrototype	0..1	ref	Reference to the dataElement for which the Invalidation Policy applies.
handleInvalid	HandleInvalidEnum	0..1	attr	This attribute controls how invalidation is applied to the dataElement.

Table D.159: InvalidationPolicy

Class	McDataInstance			
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport			
Note	<p>Describes the specific properties of one data instance in order to support measurement and/or calibration of this data instance.</p> <p>The most important attributes are:</p> <ul style="list-style-type: none"> • Its shortName is copied from the ECU Flat map (if applicable) and will be used as identifier and for display by the MC system. • The category is copied from the corresponding data type (ApplicationDataType if defined, otherwise ImplementationDataType) as far as applicable. • The symbol is the one used in the programming language. It will be used to find out the actual memory address by the final generation tool with the help of linker generated information. <p>It is assumed that in the M1 model this part and all the aggregated and referred elements (with the exception of the Flat Map and the references from ImplementationElementInParameterInstanceRef and McAccessDetails) are completely generated from "upstream" information. This means, that even if an element like e.g. a CompuMethod is only used via reference here, it will be copied into the M1 artifact which holds the complete McSupportData for a given Implementation.</p>			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
arraySize	PositiveInteger	0..1	attr	The existence of this attribute turns the data instance into an array of data. The attribute determines the size of the array in terms of number of elements.
displayIdentifier	McIdentifier	0..1	attr	An optional attribute to be used to set the ASAM ASAP2 DISPLAY_IDENTIFIER attribute.
flatMapEntry	FlatInstanceDescriptor	0..1	ref	<p>Reference to the corresponding entry in the ECU Flat Map. This allows to trace back to the original specification of the generated data instance. This link shall be added by the RTE generator mainly for documentation purposes.</p> <p>The reference is optional because</p> <ul style="list-style-type: none"> • The McDataInstance may represent an array or struct in which only the subElements correspond to FlatMap entries. • The McDataInstance may represent a task local buffer for rapid prototyping access which is different from the "main instance" used for measurement access.
instanceInMemory	ImplementationElementInParameterInstanceRef	0..1	aggr	Reference to the corresponding data instance in the description of calibration data structures published by the RTE generator. This is used to support emulation methods inside the ECU, it is not required for A2L generation.
mcDataAccessDetails	McDataAccessDetails	0..1	aggr	Refers to "upstream" information on how the RTE uses this data instance. Use Case: Rapid Prototyping
mcDataAssignment	RoleBasedMcDataAssignment	*	aggr	An assignment between McDataInstances. This supports the indication of related McDataElement implementing the of "RP global buffer", "RP global measurement buffer", "RP enabler flag".
resultingProperties	SwDataDefProps	0..1	aggr	These are the generated properties resulting from decisions taken by the RTE generator for the actually implemented data instance. Only those properties are relevant here, which are needed for the measurement and calibration system.
resultingRptSwPrototypingAccess	RptSwPrototypingAccess	0..1	aggr	Describes the implemented accessibility of data and modes by the rapid prototyping tooling.





Class	McDataInstance			
role	Identifier	0..1	attr	An optional attribute to be used for additional information on the role of this data instance, for example in the context of rapid prototyping.
rptImplPolicy	RptImplPolicy	0..1	aggr	Describes the implemented code preparation for rapid prototyping at data accesses for a hook based bypassing.
subElement (ordered)	McDataInstance	*	aggr	This relation indicates, that the target element is part of a "struct" which is given by the source element. This information will be used by the final generator to set up the correct addressing scheme. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
symbol	SymbolString	0..1	attr	This String is used to determine the memory address during final generation of the MC configuration data (e.g. "A2L" file) . It shall be the name of the element in the programming language such that it can be identified in linker generated information. In case the McDataInstance is part of composite data in the programming language, the symbol String may include parts denoting the element context, unless the context is given by the symbol attribute of an enclosing McDataInstance. This means in particular for the C language that the "." character shall be used as a separator between the name of a "struct" variable the name of one of its elements. The symbol can differ from the shortName in case of generated C data declarations. It is an optional attribute since it may be missing in case the instance represents an element (e.g. a single array element) which has no name in the linker map. Stereotypes: atpSplitable Tags: atp.Splitkey=symbol

Table D.160: McDataInstance

Class	McParameterElementGroup			
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport			
Note	Denotes a group of calibration parameters which are handled by the RTE as one data structure.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
ramLocation	VariableDataPrototype	1	ref	Refers to the RAM location of this parameter group. To be used for the init-RAM method.
romLocation	ParameterDataPrototype	1	ref	Refers to the ROM location of this parameter group. To be used for the init-RAM method.
shortLabel	Identifier	1	attr	Assigns a name to this element. Tags: xml.sequenceOffset=-100

Table D.161: McParameterElementGroup

Class	McSupportData
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport
Note	Root element for all measurement and calibration support data related to one Implementation artifact on an ECU. There shall be one such element related to the RTE implementation (if it owns MC data) and a separate one for each module or component, which owns private MC data.





Class	McSupportData			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
emulation Support	McSwEmulationMethodSupport	*	aggr	Describes the calibration method used by the RTE. This information is not needed for A2L generation, but to setup software emulation in the ECU. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
mcParameter Instance	McDataInstance	*	aggr	A data instance to be used for calibration. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=mcParameterInstance.shortName, mcParameterInstance.variationPoint.shortLabel vh.latestBindingTime=postBuild
mcVariable Instance	McDataInstance	*	aggr	A data instance to be used for measurement. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=mcVariableInstance.shortName, mcVariableInstance.variationPoint.shortLabel vh.latestBindingTime=postBuild
measurable System ConstantValues	SwSystemconstant ValueSet	*	ref	Sets of system constant values to be transferred to the MCD system, because the system constants have been specified with "swCalibrationAccess" = readonly.
rptSupportData	RptSupportData	0..1	aggr	The rapid prototyping support data belonging to this implementation. The aggregation is <<atpSplitable>> because in case of an already existing BSW Implementation model, this description will be added later in the process, namely at code generation time. Stereotypes: atpSplitable Tags: atp.Splitkey=rptSupportData

Table D.162: McSupportData

Class	McSwEmulationMethodSupport			
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport			
Note	<p>This denotes the method used by the RTE to handle the calibration data. It is published by the RTE generator and can be used e.g. to generate the corresponding emulation method in a Complex Driver.</p> <p>According to the actual method given by the category attribute, not all attributes are always needed:</p> <ul style="list-style-type: none"> double pointered method: only baseReference is mandatory single pointered method: only referenceTable is mandatory initRam method: only elementGroup(s) are mandatory <p>Note: For single/double pointered method the group locations are implicitly accessed via the reference table and their location can be found from the initial values in the M1 model of the respective pointers. Therefore, the description of elementGroups is not needed in these cases. Likewise, for double pointered method the reference table description can be accessed via the M1 model under baseReference.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
baseReference	VariableDataPrototype	0..1	ref	Refers to the base pointer in case of the double-pointered method.





Class	McSwEmulationMethodSupport			
category	Identifier	1	attr	Identifies the actual method. The possible names shall correspond to the symbols of the ECU configuration parameter for the calibration method of the RTE, and can include vendor specific methods. Tags: xml.sequenceOffset=-90
elementGroup	McParameterElement Group	*	aggr	Denotes the grouping of calibration parameters in the actual RTE code. Depending on the category, this information maybe required to set up the emulation code.
referenceTable	VariableDataPrototype	0..1	ref	Refers to the pointer table in case of the single-pointered method.
shortLabel	Identifier	1	attr	Assigns a name to this element. Tags: xml.sequenceOffset=-100

Table D.163: McSwEmulationMethodSupport

Enumeration	MemoryAllocationKeywordPolicyType
Package	M2::MSR::DataDictionary::AuxiliaryObjects
Note	Enumeration to specify the name pattern of the Memory Allocation Keyword.
Literal	Description
addrMethodShort Name	The MemorySection shortNames of referring MemorySections and therefore the belonging Memory Allocation Keywords in the code are build with the shortName of the SwAddrMethod. This is the default value if the attribute does not exist. Tags: atp.EnumerationLiteralIndex=0
addrMethodShort NameAndAlignment	The MemorySection shortNames of referring MemorySections and therefore the belonging Memory Allocation Keywords in the code are build with the shortName of the SwAddrMethod and a variable alignment postfix. Thereby the alignment postfix needs to be consistent with the alignment attribute of the related MemorySection. Tags: atp.EnumerationLiteralIndex=1

Table D.164: MemoryAllocationKeywordPolicyType

Class	MemorySection
Package	M2::AUTOSARTemplates::CommonStructure::ResourceConsumption::MemorySectionUsage
Note	<p>Provides a description of an abstract memory section used in the Implementation for code or data. It shall be declared by the Implementation Description of the module or component, which actually allocates the memory in its code. This means in case of data prototypes which are allocated by the RTE, that the generated Implementation Description of the RTE shall contain the corresponding MemorySections.</p> <p>The attribute "symbol" (if symbol is missing: "shortName") defines the module or component specific section name used in the code. For details see the document "Specification of Memory Mapping". Typically the section name is build according the pattern:</p> <p><SwAddrMethod shortName>[_<further specialization nominator>][_<alignment>] where</p> <ul style="list-style-type: none"> • [<SwAddrMethod shortName>] is the shortName of the referenced SwAddrMethod • [<further specialization nominator>] is an optional infix to indicate the specialization in the case that several MemorySections for different purpose of the same Implementation Description referring to the same or equally named SwAddrMethods. • [<alignment>] is the alignment attributes value and is only applicable in the case that the memoryAllocationKeywordPolicy value of the referenced SwAddrMethod is set to addrMethod ShortNameAndAlignment





Class				
MemorySection				
<p>MemorySection used to Implement the code of RunnableEntitys and BswSchedulableEntitys shall have a symbol (if missing: shortName) identical to the referred SwAddrMethod to conform to the generated RTE header files.</p> <p>In addition to the section name described above, a prefix is used in the corresponding macro code in order to define a name space. This prefix is by default given by the shortName of the BswModule Description resp. the SwComponentType. It can be superseded by the prefix attribute.</p>				
Base				
ARObject, Identifiable , MultilanguageReferrable , Referrable				
Attribute	Type	Mult.	Kind	Note
alignment	AlignmentType	0..1	attr	The attribute describes the alignment of objects within this memory section.
executableEntity	ExecutableEntity	*	ref	Reference to the ExecutableEntitiies located in this section. This allows to locate different Executable Entities in different sections even if the associated Sw Addrmethod is the same. This is applicable to code sections only.
memClass Symbol	CIdentifier	0..1	attr	Defines a specific symbol in order to generate the compiler abstraction "memclass" code for this Memory Section. The existence of this attribute supersedes the usage of swAddrmethod.shortName for this purpose. The complete name of the "memclass" preprocessor symbol is constructed as <prefix>_<memClassSymbol> where prefix is defined in the same way as for the enclosing MemorySection. See also AUTOSAR_SWS_CompilerAbstraction SWS_COMPILER_00040.
option	Identifier	*	attr	This attribute introduces the ability to specify further intended properties of this MemorySection. The following two values are standardized (to be used for code sections only and exclusively to each other): <ul style="list-style-type: none"> • INLINE - The code section is declared with the compiler abstraction macro INLINE. • LOCAL_INLINE - The code section is declared with the compiler abstraction macro LOCAL_INLINE In both cases (INLINE and LOCAL_INLINE) the inline expansion depends on the compiler specific implementation of these macros. Depending on this, the code section either corresponds to an actual section in memory or is put into the section of the caller. See AUTOSAR_SWS_CompilerAbstraction for more details.
prefix	SectionNamePrefix	0..1	ref	The prefix used to set the memory section's namespace in the code. The existence of a prefix element supersedes rules for a default prefix (such as the Bsw ModuleDescription's shortName). This allows the user to define several name spaces for memory sections within the scope of one module, cluster or SWC.
size	PositiveInteger	0..1	attr	The size in bytes of the section.
swAddrmethod	SwAddrMethod	0..1	ref	This association indicates that this module specific (abstract) memory section is part of an overall SwAddr Method, referred by the upstream declarations (e.g. calibration parameters, data element prototypes, code entities) which share a common addressing strategy. This can be evaluated for the ECU configuration of the build support.





Class	MemorySection			
				<p>△</p> <p>This association shall always be declared by the Implementation description of the module or component, which allocates the memory in its code. This means in case of data prototypes which are allocated by the RTE, that the software components only declare the grouping of its data prototypes to SwAddrMethods, and the generated Implementation Description of the RTE actually sets up this association.</p>
symbol	Identifier	0..1	attr	<p>Defines the section name as explained in the main description. By using this attribute for code generation (instead of the shortName) it is possible to define several different MemorySections having the same name - e.g. symbol = CODE - but using different sectionName Prefixes.</p>

Table D.165: MemorySection

Class	MetaDataItem			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	This meta-class represents a single meta-data item.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
length	PositiveInteger	0..1	attr	This attribute determines the length of the MetaDataItem at run-time.
metaDataItem Type	TextValueSpecification	0..1	aggr	This aggregation contributes the specification of the concrete meta-data item type.

Table D.166: MetaDataItem

Class	MetaDataItemSet			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	This meta-class represents the ability to define a set of meta-data items to be used in SenderReceiver Interfaces.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
dataElement	VariableDataPrototype	*	ref	This reference identifies the dataElement for which the ordered list of meta-data items is defined.
metaDataItem (ordered)	MetaDataItem	*	aggr	This aggregation represents the ordered definition of meta-data items.

Table D.167: MetaDataItemSet

Class	ModeAccessPoint			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ModeDeclarationGroup			
Note	A ModeAccessPoint is required by a RunnableEntity owned by a Mode Manager or Mode User. Its semantics implies the ability to access the current mode (provided by the RTE) of a ModeDeclaration GroupPrototype's ModeDeclarationGroup.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note





Class	ModeAccessPoint			
ident	ModeAccessPointIdent	0..1	aggr	<p>The aggregation in the role ident provides the ability to make the ModeAccessPoint identifiable.</p> <p>From the semantical point of view, the ModeAccessPoint is considered a first-class Identifiable and therefore the aggregation in the role ident shall always exist (until it may be possible to let ModeAccessPoint directly inherit from Identifiable).</p> <p>Stereotypes: atpIdentityContributor</p> <p>Tags: atp.Status=shallBecomeMandatory xml.sequenceOffset=-100</p>
modeGroup	ModeDeclarationGroup Prototype	0..1	iref	<p>The mode declaration group that is accessed by this runnable.</p> <p>Tags:xml.typeElement=true</p> <p>InstanceRef implemented by:ModeGroupInAtomicSwc InstanceRef</p>

Table D.168: ModeAccessPoint

Enumeration	ModeActivationKind
Package	M2::AUTOSARTemplates::CommonStructure::ModeDeclaration
Note	Kind of mode switch condition used for activation of an event, as further described for each enumeration field.
Literal	Description
onEntry	<p>On entering the referred mode.</p> <p>Tags:atp.EnumerationLiteralIndex=0</p>
onExit	<p>On exiting the referred mode.</p> <p>Tags:atp.EnumerationLiteralIndex=1</p>
onTransition	<p>On transition of the 1st referred mode to the 2nd referred mode.</p> <p>Tags:atp.EnumerationLiteralIndex=2</p>

Table D.169: ModeActivationKind

Class	ModeDeclaration			
Package	M2::AUTOSARTemplates::CommonStructure::ModeDeclaration			
Note	Declaration of one Mode. The name and semantics of a specific mode is not defined in the meta-model.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
value	PositiveInteger	0..1	attr	The RTE shall take the value of this attribute for generating the source code representation of this Mode Declaration.

Table D.170: ModeDeclaration

Class	ModeDeclarationGroup			
Package	M2::AUTOSARTemplates::CommonStructure::ModeDeclaration			
Note	<p>A collection of Mode Declarations. Also, the initial mode is explicitly identified.</p> <p>Tags:atp.recommendedPackage=ModeDeclarationGroups</p>			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			





Class	ModeDeclarationGroup			
Attribute	Type	Mult.	Kind	Note
initialMode	ModeDeclaration	0..1	ref	The initial mode of the ModeDeclarationGroup. This mode is active before any mode switches occurred.
mode Declaration	ModeDeclaration	*	aggr	The ModeDeclarations collected in this ModeDeclaration Group. Stereotypes: atpVariation Tags: vh.latestBindingTime=blueprintDerivationTime
modeManager ErrorBehavior	ModeErrorBehavior	0..1	aggr	This represents the ability to define the error behavior expected by the mode manager in case of errors on the mode user side (e.g. terminated mode user).
modeTransition	ModeTransition	*	aggr	This represents the available ModeTransitions of the ModeDeclarationGroup
modeUserError Behavior	ModeErrorBehavior	0..1	aggr	This represents the definition of the error behavior expected by the mode user in case of errors on the mode manager side (e.g. terminated mode manager).
onTransition Value	PositiveInteger	0..1	attr	The value of this attribute shall be taken into account by the RTE generator for programmatically representing a value used for the transition between two statuses.

Table D.171: ModeDeclarationGroup

Class	ModeDeclarationGroupPrototype			
Package	M2::AUTOSARTemplates::CommonStructure::ModeDeclaration			
Note	The ModeDeclarationGroupPrototype specifies a set of Modes (ModeDeclarationGroup) which is provided or required in the given context.			
Base	ARObject, AtpFeature, AtpPrototype, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
swCalibration Access	SwCalibrationAccess Enum	0..1	attr	This allows for specifying whether or not the enclosing ModeDeclarationGroupPrototype can be measured at run-time.
type	ModeDeclarationGroup	0..1	trf	The "collection of ModeDeclarations" (= ModeDeclaration Group) supported by a component Stereotypes: isOfType

Table D.172: ModeDeclarationGroupPrototype

Class	ModeDeclarationMappingSet			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	This meta-class implements a container for ModeDeclarationGroupMappings Tags: atp.recommendedPackage=PortInterfaceMappingSets			
Base	ARElement, ARObject, AtpClassifier, AtpType, CollectableElement, Identifiable , Multilanguage Referrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
mode Declaration Mapping	ModeDeclaration Mapping	*	aggr	This represents the collection of ModeDeclaration Mappings owned by the enclosing ModeDeclaration MappingSet.

Table D.173: ModeDeclarationMappingSet

Class	ModeErrorBehavior			
Package	M2::AUTOSARTemplates::CommonStructure::ModeDeclaration			
Note	This represents the ability to define the error behavior in the context of mode handling.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
defaultMode	ModeDeclaration	0..1	ref	This represents the ModeDeclaration that is considered the error mode in the context of the enclosing Mode DeclarationGroup.
errorReaction Policy	ModeErrorReaction PolicyEnum	0..1	attr	This represents the ability to define the policy in terms of which default model shall apply in case an error occurs.

Table D.174: ModeErrorBehavior

Enumeration	ModeErrorReactionPolicyEnum			
Package	M2::AUTOSARTemplates::CommonStructure::ModeDeclaration			
Note	This represents the ability to specify the reaction on a mode error.			
Literal	Description			
defaultMode	This represents the ability to switch to the defaultMode in case of a mode error. Tags: atp.EnumerationLiteralIndex=0			
lastMode	This represents the ability to keep the last mode in case of a mode error. Tags: atp.EnumerationLiteralIndex=1			

Table D.175: ModeErrorReactionPolicyEnum

Class	ModelInterfaceMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	Defines the mapping of ModeDeclarationGroupPrototypes in context of two different ModelInterfaces.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, Identifiable , MultilanguageReferrable , PortInterfaceMapping , Referrable			
Attribute	Type	Mult.	Kind	Note
modeMapping	ModeDeclarationGroup PrototypeMapping	0..1	aggr	Mapping of two ModeDeclarationGroupPrototypes in two different ModelInterfaces

Table D.176: ModelInterfaceMapping

Class	ModeRequestTypeMap			
Package	M2::AUTOSARTemplates::CommonStructure::ModeDeclaration			
Note	Specifies a mapping between a ModeDeclarationGroup and an ImplementationDataType. This ImplementationDataType shall be used to implement the ModeDeclarationGroup.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
implementation DataType	AbstractImplementation DataType	0..1	ref	This is the corresponding AbstractImplementationDataType. It shall be modeled along the idea of an "unsigned integer-like" data type.
modeGroup	ModeDeclarationGroup	0..1	ref	This is the corresponding ModeDeclarationGroup.

Table D.177: ModeRequestTypeMap

Class	ModeSwitchInterface			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	A mode switch interface declares a ModeDeclarationGroupPrototype to be sent and received. Tags: atp.recommendedPackage=PortInterfaces			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, PortInterface, Referrable			
Attribute	Type	Mult.	Kind	Note
modeGroup	ModeDeclarationGroupPrototype	0..1	aggr	The ModeDeclarationGroupPrototype of this mode interface.

Table D.178: ModeSwitchInterface

Class	ModeSwitchPoint			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ModeDeclarationGroup			
Note	A ModeSwitchPoint is required by a RunnableEntity owned a Mode Manager. Its semantics implies the ability to initiate a mode switch.			
Base	ARObject, AbstractAccessPoint, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
modeGroup	ModeDeclarationGroupPrototype	0..1	iref	The mode declaration group that is switched by this runnable. InstanceRef implemented by: PModeGroupInAtomicSwcInstanceRef

Table D.179: ModeSwitchPoint

Class	ModeSwitchReceiverComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Communication attributes of RPortPrototypes with respect to mode communication			
Base	ARObject, RPortComSpec			
Attribute	Type	Mult.	Kind	Note
enhancedModeApi	Boolean	0..1	attr	This controls the creation of the enhanced mode API that returns information about the previous mode and the next mode. If set to "true" the enhanced mode API is supposed to be generated. For more details please refer to the SWS_RTE.
modeGroup	ModeDeclarationGroupPrototype	0..1	ref	ModeDeclarationGroupPrototype (of the same Port Interface) to which these communication attributes apply. Tags: atp.Status=shallBecomeMandatory
supportsAsynchronousModeSwitch	Boolean	0..1	attr	This attribute controls the behavior of the corresponding RPortPrototype with respect to the question whether it can deal with asynchronous mode switch requests, i.e. if set to true, the RPortPrototype is able to deal with an asynchronous mode switch request.

Table D.180: ModeSwitchReceiverComSpec

Class	ModeSwitchSenderComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Communication attributes of PPortPrototypes with respect to mode communication			
Base	ARObject, PPortComSpec			





Class	ModeSwitchSenderComSpec			
Attribute	Type	Mult.	Kind	Note
enhancedModeApi	Boolean	0..1	attr	This controls the creation of the enhanced mode API that returns information about the previous mode and the next mode. If set to "true" the enhanced mode API is supposed to be generated. For more details please refer to the SWS_RTE.
modeGroup	ModeDeclarationGroupPrototype	0..1	ref	ModeDeclarationGroupPrototype (of the same Port Interface) to which these communication attributes apply.
modeSwitchedAck	ModeSwitchedAckRequest	0..1	aggr	If this aggregation exists an acknowledgement for the successful processing of the mode switch request is required.
queueLength	PositiveInteger	0..1	attr	Length of call queue on the mode user side. The queue is implemented by the RTE. The value shall be greater or equal to 1. Setting the value of queueLength to 1 implies that incoming requests are rejected while another request that arrived earlier is being processed.

Table D.181: ModeSwitchSenderComSpec

Class	ModeSwitchedAckEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	The event is raised when the referenced modes have been received or an error occurs.			
Base	<i>ARObject</i> , <i>AbstractEvent</i> , <i>AtpClassifier</i> , <i>AtpFeature</i> , <i>AtpStructureElement</i> , Identifiable , <i>MultilanguageReferrable</i> , <i>RTEEvent</i> , Referrable			
Attribute	Type	Mult.	Kind	Note
eventSource	ModeSwitchPoint	0..1	ref	Mode switch point that triggers the event.

Table D.182: ModeSwitchedAckEvent

Class	ModeSwitchedAckRequest			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Requests acknowledgements that a mode switch has been proceeded successfully			
Base	<i>ARObject</i>			
Attribute	Type	Mult.	Kind	Note
timeout	TimeValue	0..1	attr	Number of seconds before an error is reported or in case of allowed redundancy, the value is sent again.

Table D.183: ModeSwitchedAckRequest

Class	NonqueuedReceiverComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Communication attributes specific to non-queued receiving.			
Base	<i>ARObject</i> , <i>RPortComSpec</i> , ReceiverComSpec			
Attribute	Type	Mult.	Kind	Note
aliveTimeout	TimeValue	0..1	attr	Specify the amount of time (in seconds) after which the software component (via the RTE) needs to be notified if the corresponding data item have not been received according to the specified timing description. If the aliveTimeout attribute is 0 no timeout monitoring shall be performed.





Class	NonqueuedReceiverComSpec			
enableUpdate	Boolean	0..1	attr	This attribute controls whether application code is entitled to check whether the value of the corresponding VariableDataPrototype has been updated.
filter	DataFilter	0..1	aggr	The applicable filter algorithm for filtering the value of the corresponding dataElement.
handleData Status	Boolean	0..1	attr	If this attribute is set to true than the Rte_IStatus API shall exist. If the attribute does not exist or is set to false then the Rte_IStatus API may still exist in response to the existence of further conditions.
handleNever Received	Boolean	0..1	attr	<p>This attribute specifies whether for the corresponding VariableDataPrototype the "never received" flag is available. If yes, the RTE is supposed to assume that initially the VariableDataPrototype has not been received before. After the first reception of the corresponding VariableDataPrototype the flag is cleared.</p> <ul style="list-style-type: none"> • If the value of this attribute is set to "true" the flag is required. • If set to "false", the RTE shall not support the "never received" functionality for the corresponding VariableDataPrototype.
handleTimeout Type	HandleTimeoutEnum	0..1	attr	This attribute controls the behavior with respect to the handling of timeouts.
initValue	ValueSpecification	0..1	aggr	Initial value to be used in case the sending component is not yet initialized. If the sender also specifies an initial value the receiver's value will be used.
timeout Substitution Value	ValueSpecification	0..1	aggr	This attribute represents the substitution value applicable in the case of a timeout.

Table D.184: NonqueuedReceiverComSpec

Class	NonqueuedSenderComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Communication attributes for non-queued sender/receiver communication (sender side)			
Base	ARObject, PPortComSpec, SenderComSpec			
Attribute	Type	Mult.	Kind	Note
dataFilter	DataFilter	0..1	aggr	The applicable filter algorithm for filtering the value of the corresponding dataElement.
initValue	ValueSpecification	0..1	aggr	Initial value to be sent if sender component is not yet fully initialized, but receiver needs data already.

Table D.185: NonqueuedSenderComSpec

Class	NotAvailableValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	<p>This meta-class provides the ability to specify a ValueSpecification to state that the respective element is not available. This ability is needed to support the existence of ApplicationRecordElements where attribute isOptional ist set to the value True.</p> <p>Tags:atp.Status=draft</p>			
Base	ARObject, ValueSpecification			
Attribute	Type	Mult.	Kind	Note





Class	NotAvailableValueSpecification			
defaultPattern	PositiveInteger	0..1	attr	The content of this attribute shall be used to initialize gaps in the memory occupied by a structured data type in the case that an NotAvailableValueSpecification is used. Note that this pattern is only applied during initialization!

Table D.186: NotAvailableValueSpecification

Class	NumericalRuleBasedValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	This meta-class is used to support a rule-based initialization approach for data types with an array-nature (ImplementationDataType of category ARRAY).			
Base	ARObject, AbstractRuleBasedValueSpecification, ValueSpecification			
Attribute	Type	Mult.	Kind	Note
ruleBasedValues	RuleBasedValueSpecification	0..1	aggr	This represents the rule based value specification for the array. Tags: xml.roleElement=true xml.roleWrapperElement=false xml.typeWrapperElement=false

Table D.187: NumericalRuleBasedValueSpecification

Class	NumericalValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	A numerical ValueSpecification which is intended to be assigned to a Primitive data element. Note that the numerical value is a variant, it can be computed by a formula.			
Base	ARObject, ValueSpecification			
Attribute	Type	Mult.	Kind	Note
value	Numerical	0..1	attr	This is the value itself. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime

Table D.188: NumericalValueSpecification

Class	NvBlockDataMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::NvBlockComponent			
Note	Defines the mapping between the VariableDataPrototypes in the NvBlockComponents ports and the VariableDataPrototypes of the RAM Block. The data types of the referenced VariableDataPrototypes in the ports and the referenced sub-element (inside a CompositeDataType) of the VariableDataPrototype representing the RAM Block shall be compatible.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
bitfieldTextTableMaskNvBlockDescriptor	PositiveInteger	0..1	attr	This attribute identifies the applicable bit mask on the side of the Nv Block.
bitfieldTextTableMaskPortPrototype	PositiveInteger	0..1	attr	This attribute identifies the applicable bit mask on the side of the PortPrototype.
nvRamBlockElement	AutosarVariableRef	0..1	aggr	Reference to a VariableDataPrototype of a RAM Block.





Class	NvBlockDataMapping			
readNvData	AutosarVariableRef	0..1	aggr	Reference to a VariableDataPrototype of a pPort of the NvBlockComponent providing read access to the RAM Block. If there is no PortPrototype providing read access (write-only) the reference can be omitted.
writtenNvData	AutosarVariableRef	0..1	aggr	Reference to a VariableDataPrototype of a rPort of the NvBlockComponent providing write access to the RAM Block. If there is no port providing write access (read-only) the reference can be omitted.
writtenReadNvData	AutosarVariableRef	0..1	aggr	Reference to a VariableDataPrototype of a PRPort Prototype of the NvBlockSwComponentType providing write and read access to the RAM Block.

Table D.189: NvBlockDataMapping

Class	NvBlockDescriptor			
Package	M2::AUTOSARTemplates::SWComponentTemplate::NvBlockComponent			
Note	Specifies the properties of exactly on NVRAM Block.			
Base	AObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
clientServerPort	RoleBasedPortAssignment	*	aggr	<p>The RoleBasedPortAssignment defines which client server port of the NvBlockSwComponentType serves for which kind of service or notification. In case of notifications one common callback function is provided by the RTE for each individual kind of notification defined by the "role".</p> <p>The aggregation of RoleBasedPortAssignment is subject to variability with the purpose to support the conditional existence of ports.</p> <p>Stereotypes: atpVariation Tags:vh.latestBindingTime=preCompileTime</p>
constantValueMapping	ConstantSpecificationMappingSet	*	ref	<p>Reference to the ConstantSpecificationMapping to be applied for the particular NVRAM Block</p> <p>Stereotypes: atpSplittable Tags:atp.Splitkey=constantValueMapping</p>
dataTypeMapping	DataTypeMappingSet	*	ref	<p>Reference to the DataTypeMapping to be applied for the particular NVRAM Block.</p> <p>Stereotypes: atpSplittable Tags:atp.Splitkey=dataTypeMapping</p>
instantiationDataDefProps	InstantiationDataDefProps	*	aggr	<p>The purpose of InstantiationDataDefProps are the refinement of some data def properties of individual instantiations within the context of a NvBlockSwComponentType.</p> <p>The aggregation of InstantiationDataDefProps is subject to variability with the purpose to support the conditional existence of ports, component internal memory objects and those attributes.</p> <p>Stereotypes: atpVariation Tags:vh.latestBindingTime=preCompileTime</p>





Class	NvBlockDescriptor			
modeSwitchEventTriggeredActivity	ModeSwitchEventTriggeredActivity	*	aggr	<p>This represents the collection of ModeSwitchEventTriggeredActivities related to the enclosing NvBlockDescriptor.</p> <p>Stereotypes: atpSplittable; atpVariation</p> <p>Tags: atp.Splitkey=modeSwitchEventTriggeredActivity, modeSwitchEventTriggeredActivity.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
nvBlockDataMapping	NvBlockDataMapping	*	aggr	<p>Defines the mapping between the VariableDataPrototypes in the NvBlockComponents ports and the VariableDataPrototypes of the RAM Block.</p> <p>The aggregation of NvBlockDataMapping is subject to variability with the purpose to support the conditional existence of nv data ports.</p> <p>Stereotypes: atpVariation</p> <p>Tags:vh.latestBindingTime=preCompileTime</p>
nvBlockNeeds	NvBlockNeeds	0..1	aggr	<p>Specifies the abstract needs on the configuration of the NVRAM Manager for the single NVRAM Block described by this NvBlockDescriptor.</p> <p>In addition, it may define requirements for writing strategies in an implementation of an NvBlockSwComponentType by the RTE.</p> <p>Please note that the attributes nDataSets and nRomBlocks are not relevant for this aggregation because the RTE will allocate just one block anyway. In a different context, however, they do make sense.</p>
ramBlock	VariableDataPrototype	0..1	aggr	Defines the RAM Block of the NVRAM Block provided by NvBlockSwComponentType.
romBlock	ParameterDataPrototype	0..1	aggr	Defines the ROM Block of the NVRAM Block provided by NvBlockSwComponentType.
supportDirtyFlag	Boolean	0..1	attr	Specifies whether calling of NvM functions for writing and/or status control of potentially modified RAM Blocks to NV memory shall be controlled by the RTE.
timingEvent	TimingEvent	0..1	ref	this reference can be taken to identify the TimingEvent to be used by the RTE for implementing a cyclic writing strategy for this block
writingStrategyRole	RoleBasedDataAssignment	0..1	aggr	This attribute allows for assigning a specific writing strategy for an incoming AutosarDataPrototype.

Table D.190: NvBlockDescriptor

Class	NvBlockNeeds			
Package	M2::AUTOSARTemplates::CommonStructure::ServiceNeeds			
Note	Specifies the abstract needs on the configuration of a single NVRAM Block.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable , ServiceNeeds			
Attribute	Type	Mult.	Kind	Note
calcRamBlockCrc	Boolean	0..1	attr	Defines if CRC (re)calculation for the permanent RAM Block is required.
checkStaticBlockId	Boolean	0..1	attr	Defines if the Static Block Id check shall be enabled.
cyclicWritingPeriod	TimeValue	0..1	attr	This represents the period for cyclic writing of NvData to store the associated RAM Block.





Class	NvBlockNeeds			
nDataSets	PositiveInteger	0..1	attr	Number of data sets to be provided by the NVRAM manager for this block. This is the total number of ROM Blocks and RAM Blocks.
nRomBlocks	PositiveInteger	0..1	attr	Number of ROM Blocks to be provided by the NVRAM manager for this block. Please note that these multiple ROM Blocks are given in a contiguous area.
ramBlockStatusControl	RamBlockStatusControlEnum	0..1	attr	This attribute defines how the management of the RAM Block status is controlled.
readonly	Boolean	0..1	attr	True: data of this NVRAM Block are write protected for normal operation (but protection can be disabled) false: no restriction
reliability	NvBlockNeedsReliabilityEnum	0..1	attr	Reliability against data loss on the non-volatile medium.
resistantToChangedSw	Boolean	0..1	attr	Defines whether an NVRAM Block shall be treated resistant to configuration changes (true) or not (false). For details how to handle initialization in the latter case, please refer to the NVRAM specification.
restoreAtStart	Boolean	0..1	attr	Defines whether the associated RAM Block shall be implicitly restored during startup by the basic software.
selectBlockForFirstInitAll	Boolean	0..1	attr	If this attribute is set to true the NvM shall process this block in the NvM_FirstInitAll() function.
storeAtShutdown	Boolean	0..1	attr	Defines whether or not the associated RAM Block shall be implicitly stored during shutdown by the basic software.
storeCyclic	Boolean	0..1	attr	Defines whether or not the associated RAM Block shall be implicitly stored periodically by the basic software.
storeEmergency	Boolean	0..1	attr	Defines whether or not the associated RAM Block shall be implicitly stored in case of ECU failure (e.g. loss of power) by the basic software. If the attribute storeEmergency is set to true the associated RAM Block shall be configured to have immediate priority.
storeImmediate	Boolean	0..1	attr	Defines whether or not the associated RAM Block shall be implicitly stored immediately during or after execution of the according SW-C RunnableEntity by the basic software.
useAutoValidationAtShutDown	Boolean	0..1	attr	If set to true the RAM Block shall be auto validated during shutdown phase.
useCRCCompMechanism	Boolean	0..1	attr	If set to true the CRC of the RAM Block shall be compared during a write job with the CRC which was calculated during the last successful read or write job in order to skip unnecessary NVRAM writings.
writeOnlyOnce	Boolean	0..1	attr	Defines write protection after first write: true: This block is prevented from being changed/erased or being replaced with the default ROM data after first initialization by the software-component. false: No such restriction.
writeVerification	Boolean	0..1	attr	Defines if Write Verification shall be enabled for this NVRAM Block.
writingFrequency	PositiveInteger	0..1	attr	Provides the amount of updates to this block from the application point of view. It has to be provided in "number of write access per year".
writingPriority	NvBlockNeedsWritingPriorityEnum	0..1	attr	Requires the priority of writing this block in case of concurrent requests to write other blocks.

Table D.191: NvBlockNeeds

Class	NvBlockSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	<p>The NvBlockSwComponentType defines non volatile data which data can be shared between Sw ComponentPrototypes. The non volatile data of the NvBlockSwComponentType are accessible via provided and required ports.</p> <p>Tags:atp.recommendedPackage=SwComponentTypes</p>			
Base	ARElement, ARObject, AtomicSwComponentType , AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable , SwComponentType			
Attribute	Type	Mult.	Kind	Note
bulkNvDataDescriptor	BulkNvDataDescriptor	*	aggr	<p>This aggregation formally defines the bulk Nv Blocks that are provided to the application software by the enclosing NvBlockSwComponentType.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=bulkNvDataDescriptor.shortName, bulkNvDataDescriptor.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
nvBlockDescriptor	NvBlockDescriptor	*	aggr	<p>Specification of the properties of exactly one NVRAM Block.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=nvBlockDescriptor.shortName, nvBlockDescriptor.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>

Table D.192: NvBlockSwComponentType

Class	NvDataInterface			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	<p>A non volatile data interface declares a number of VariableDataPrototypes to be exchanged between non volatile block components and atomic software components.</p> <p>Tags:atp.recommendedPackage=PortInterfaces</p>			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, DataInterface, Identifiable , MultilanguageReferrable, PackageableElement, PortInterface , Referrable			
Attribute	Type	Mult.	Kind	Note
nvData	VariableDataPrototype	*	aggr	The VariableDataPrototype of this nv data interface.

Table D.193: NvDataInterface

Class	NvRequireComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Communication attributes of RPortPrototypes with respect to Nv data communication on the required side.			
Base	ARObject, RPortComSpec			
Attribute	Type	Mult.	Kind	Note
initValue	ValueSpecification	0..1	aggr	The initial value owned by the NvComSpec
variable	VariableDataPrototype	0..1	ref	The VariableDataPrototype the ComSpec applies for.

Table D.194: NvRequireComSpec

Class	OperationInvokedEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	The OperationInvokedEvent references the ClientServerOperation invoked by the client.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
operation	ClientServerOperation	0..1	iref	The operation to be executed as the consequence of the event. InstanceRef implemented by: POperationInAtomicSwc InstanceRef

Table D.195: OperationInvokedEvent

Class	OsTaskExecutionEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This RTEEvent is supposed to execute RunnableEntities which have to react on the execution of specific OsTasks. Therefore, this event is unconditionally raised whenever the OsTask on which it is mapped is executed. The main use case for this event is scheduling of Runnables of Complex Drivers which have to react on task executions. Tags: atp.Status=draft			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.196: OsTaskExecutionEvent

Class	PPortPrototype			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	Component port providing a certain port interface.			
Base	ARObject, AbstractProvidedPortPrototype , AtpBlueprintable, AtpFeature, AtpPrototype, Identifiable , MultilanguageReferrable, PortPrototype , Referrable			
Attribute	Type	Mult.	Kind	Note
provided Interface	PortInterface	0..1	tref	The interface that this port provides. Stereotypes: isOfType

Table D.197: PPortPrototype

Class	PRPortPrototype			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	This kind of PortPrototype can take the role of both a required and a provided PortPrototype.			
Base	ARObject, AbstractProvidedPortPrototype , AbstractRequiredPortPrototype , AtpBlueprintable, Atp Feature, AtpPrototype, Identifiable , MultilanguageReferrable, PortPrototype , Referrable			
Attribute	Type	Mult.	Kind	Note
provided Required Interface	PortInterface	0..1	tref	This represents the PortInterface used to type the PRPort Prototype Stereotypes: isOfType

Table D.198: PRPortPrototype

Class	ParameterAccess			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::DataElements			
Note	The presence of a ParameterAccess implies that a RunnableEntity needs access to a ParameterData Prototype.			
Base	ARObject, AbstractAccessPoint , AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
accessed Parameter	AutosarParameterRef	0..1	aggr	Reference to the accessed calibration parameter.
swDataDef Props	SwDataDefProps	0..1	aggr	This allows denote instance and access specific properties, mainly input values and common axis.

Table D.199: ParameterAccess

Class	ParameterDataPrototype			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::DataPrototypes			
Note	A parameter element used for parameter interface and internal behavior, supporting signal like parameter and characteristic value communication patterns and parameter and characteristic value definition.			
Base	ARObject, AtpFeature, AtpPrototype, AutosarDataPrototype , DataPrototype , Identifiable , Multilanguage Referrable, Referrable			
Attribute	Type	Mult.	Kind	Note
initValue	ValueSpecification	0..1	aggr	Specifies initial value(s) of the ParameterDataPrototype

Table D.200: ParameterDataPrototype

Class	ParameterInterface			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	A parameter interface declares a number of parameter and characteristic values to be exchanged between parameter components and software components. Tags: atp.recommendedPackage=PortInterfaces			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, DataInterface, Identifiable , MultilanguageReferrable, PackageableElement, PortInterface , Referrable			
Attribute	Type	Mult.	Kind	Note
parameter	ParameterData Prototype	*	aggr	The ParameterDataPrototype of this ParameterInterface.

Table D.201: ParameterInterface

Class	ParameterProvideComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	"Communication" specification that applies to parameters on the provided side of a connection.			
Base	ARObject, PPortComSpec			
Attribute	Type	Mult.	Kind	Note
initValue	ValueSpecification	0..1	aggr	The initial value applicable for the corresponding ParameterDataPrototype.
parameter	ParameterData Prototype	0..1	ref	The ParameterDataPrototype to which the Parameter ComSpec applies.

Table D.202: ParameterProvideComSpec

Class	ParameterRequireComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	"Communication" specification that applies to parameters on the required side of a connection.			
Base	ARObject, RPortComSpec			
Attribute	Type	Mult.	Kind	Note
initValue	ValueSpecification	0..1	aggr	The initial value applicable for the corresponding ParameterDataPrototype.
parameter	ParameterDataPrototype	0..1	ref	The ParameterDataPrototype to which the Parameter RequireComSpec applies.

Table D.203: ParameterRequireComSpec

Class	ParameterSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	The ParameterSwComponentType defines parameters and characteristic values accessible via provided Ports. The provided values are the same for all connected SwComponentPrototypes Tags: atp.recommendedPackage=SwComponentTypes			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable, SwComponentType			
Attribute	Type	Mult.	Kind	Note
constant Mapping	ConstantSpecification MappingSet	*	ref	Reference to the ConstantSpecificationMapping to be applied for the particular ParameterSwComponentType Stereotypes: atp.Splittable Tags: atp.Splitkey=constantMapping
data Type Mapping	DataTypeMappingSet	*	ref	Reference to the DataTypeMapping to be applied for the particular ParameterSwComponentType Stereotypes: atp.Splittable Tags: atp.Splitkey=dataTypeMapping
instantiation DataDefProps	InstantiationDataDef Props	*	aggr	The purpose of this is that within the context of a given SwComponentType some data def properties of individual instantiations can be modified. The aggregation of InstantiationDataDefProps is subject to variability with the purpose to support the conditional existence of PortPrototypes Stereotypes: atp.Variation Tags: vh.latestBindingTime=preCompileTime

Table D.204: ParameterSwComponentType

Class	PerInstanceMemory			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::PerInstanceMemory			
Note	Defines a 'C' typed memory-block that needs to be available for each instance of the SW-component. This is typically only useful if supportsMultipleInstantiation is set to "true" or if the software-component defines NVRAM access via permanent blocks.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
initValue	String	0..1	attr	Specifies initial value(s) of the PerInstanceMemory
swDataDef Props	SwDataDefProps	0..1	aggr	This represents the ability to allocate RAM at specific memory sections, for example, to support the RAM Block recovery strategy by mapping to uninitialized RAM.





Class	PerInstanceMemory			
type	CIdentifier	0..1	attr	The name of the "C"-type
typeDefinition	String	0..1	attr	A definition of the type with the syntax of a 'C' typedef.

Table D.205: PerInstanceMemory

Class	PortAPIOption			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::PortAPIOptions			
Note	Options how to generate the signatures of calls for an AtomicSwComponentType in order to communicate over a PortPrototype (for calls into a RunnableEntity as well as for calls from a RunnableEntity to the PortPrototype).			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
enableTakeAddress	Boolean	0..1	attr	If set to true, the software-component is able to use the API reference for deriving a pointer to an object.
errorHandling	DataTransformationErrorHandlingEnum	0..1	attr	This specifies whether a RunnableEntity accessing a PortPrototype that is referenced by this PortAPIOption shall specifically handle transformer errors or not.
indirectAPI	Boolean	0..1	attr	If set to true this attribute specifies an "indirect API" to be generated for the associated port which means that the software-component is able to access the actions on a port via a pointer to an object representing a port. This allows e.g. iterating over ports in a loop. This option has no effect for PPortPrototypes of client/server interfaces.
port	PortPrototype	0..1	ref	The option is valid for generated functions related to communication over this port
portArgValue (ordered)	PortDefinedArgumentValue	*	aggr	An argument value defined by this port.
supportedFeature	SwcSupportedFeature	*	aggr	This collection specifies which features are supported by the RunnableEntitys which access a PortPrototype that it referenced by this PortAPIOption.
transformerStatusForwarding	DataTransformationStatusForwardingEnum	0..1	attr	This specifies whether a RunnableEntity accessing a PortPrototype that is referenced by this PortAPIOption shall be able to forward a status to the transformer chain.

Table D.206: PortAPIOption

Class	PortDefinedArgumentValue			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::PortAPIOptions			
Note	A PortDefinedArgumentValue is passed to a RunnableEntity dealing with the ClientServerOperations provided by a given PortPrototype. Note that this is restricted to PPortPrototypes of a ClientServerInterface.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
value	ValueSpecification	0..1	aggr	Specifies the actual value.
valueType	ImplementationDataType	0..1	trf	The implementation type of this argument value. It should not be composite type or a pointer. Stereotypes: isOfType

Table D.207: PortDefinedArgumentValue

Class	PortInterface (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	Abstract base class for an interface that is either provided or required by a port of a software component.			
Base	ARElement , ARObject , AtpBlueprint , AtpBlueprintable , AtpClassifier , AtpType , CollectableElement , Identifiable , MultilanguageReferrable , PackageableElement , Referrable			
Subclasses	ClientServerInterface , DataInterface , ModeSwitchInterface , TriggerInterface			
Attribute	Type	Mult.	Kind	Note
isService	Boolean	0..1	attr	<p>This flag is set if the PortInterface is to be used for communication between an</p> <ul style="list-style-type: none"> • ApplicationSwComponentType or • ServiceProxySwComponentType or • SensorActuatorSwComponentType or • ComplexDeviceDriverSwComponentType • ServiceSwComponentType • EcuAbstractionSwComponentType <p>and a ServiceSwComponentType (namely an AUTOSAR Service) located on the same ECU. Otherwise the flag is not set.</p>
serviceKind	ServiceProviderEnum	0..1	attr	This attribute provides further details about the nature of the applied service.

Table D.208: PortInterface

Class	PortInterfaceMapping (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	Specifies one PortInterfaceMapping to support the connection of Ports typed by two different Port Interfaces with PortInterface elements having unequal names and/or unequal semantic (resolution or range).			
Base	ARObject , AtpBlueprint , AtpBlueprintable , Identifiable , MultilanguageReferrable , Referrable			
Subclasses	ClientServerInterfaceMapping , ModelInterfaceMapping , TriggerInterfaceMapping , VariableAndParameterInterfaceMapping			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.209: PortInterfaceMapping

Class	PortPrototype (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	<p>Base class for the ports of an AUTOSAR software component.</p> <p>The aggregation of PortPrototypes is subject to variability with the purpose to support the conditional existence of ports.</p>			
Base	ARObject , AtpBlueprintable , AtpFeature , AtpPrototype , Identifiable , MultilanguageReferrable , Referrable			
Subclasses	AbstractProvidedPortPrototype , AbstractRequiredPortPrototype			
Attribute	Type	Mult.	Kind	Note
clientServerAnnotation	ClientServerAnnotation	*	aggr	Annotation of this PortPrototype with respect to client/server communication.
delegatedPortAnnotation	DelegatedPortAnnotation	0..1	aggr	Annotations on this delegated port.





Class	PortPrototype (abstract)			
ioHwAbstractionServerAnnotation	IoHwAbstractionServerAnnotation	*	aggr	Annotations on this IO Hardware Abstraction port.
modePortAnnotation	ModePortAnnotation	*	aggr	Annotations on this mode port.
nvDataPortAnnotation	NvDataPortAnnotation	*	aggr	Annotations on this non volatile data port.
parameterPortAnnotation	ParameterPortAnnotation	*	aggr	Annotations on this parameter port.
senderReceiverAnnotation	SenderReceiverAnnotation	*	aggr	Collection of annotations of this ports sender/receiver communication.
triggerPortAnnotation	TriggerPortAnnotation	*	aggr	Annotations on this trigger port.

Table D.210: PortPrototype

Class	PostBuildVariantCondition			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	<p>This class specifies the value which shall be assigned to a particular variant criterion in order to bind the variation point. If multiple criterion/value pairs are specified, they shall all match to bind the variation point.</p> <p>In other words binding can be represented by (criterion1 == value1) && (condition2 == value2) ...</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
matchingCriterion	PostBuildVariantCriterion	1	ref	This is the criterion which needs to match the value in order to make the PostbuildVariantCondition to be true.
value	Integer	1	attr	<p>This is the particular value of the post-build variant criterion.</p> <p>Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime</p>

Table D.211: PostBuildVariantCondition

Class	PostBuildVariantCriterion			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	<p>This class specifies one particular PostBuildVariantSelector.</p> <p>Tags: atp.recommendedPackage=PostBuildVariantCriteria</p>			
Base	ARElement, ARObject, AtpDefinition, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
compuMethod	CompuMethod	1	ref	The compuMethod specifies the possible values for the variant criterion serving as an enumerator.

Table D.212: PostBuildVariantCriterion

Class	PostBuildVariantCriterionValue			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	<p>This class specifies the value which shall be assigned to a particular variant criterion in order to bind the variation point. If multiple criterion/value pairs are specified, they all shall match to bind the variation point.</p>			





Class				
PostBuildVariantCriterionValue				
Base				
ARObject				
Attribute	Type	Mult.	Kind	Note
annotation	Annotation	*	aggr	This provides the ability to add information why the value is set like it is. Tags: xml.sequenceOffset=30
value	Integer	1	attr	This is the particular value of the post-build variant criterion. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=20
variantCriterion	PostBuildVariantCriterion	1	ref	This association selects the variant criterion whose value is specified. Tags: xml.sequenceOffset=10

Table D.213: PostBuildVariantCriterionValue

Class				
PostBuildVariantCriterionValueSet				
Package				
M2::AUTOSARTemplates::GenericStructure::VariantHandling				
Note				
This meta-class represents the ability to denote one set of postBuildVariantCriterionValues. Tags: atp.recommendedPackage=PostBuildVariantCriterionValueSets				
Base				
ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable				
Attribute	Type	Mult.	Kind	Note
postBuildVariantCriterionValue	PostBuildVariantCriterionValue	*	aggr	This is one particular postbuild variant criterion/value pair being part of the PostBuildVariantSet.

Table D.214: PostBuildVariantCriterionValueSet

Class				
PredefinedVariant				
Package				
M2::AUTOSARTemplates::GenericStructure::VariantHandling				
Note				
This specifies one predefined variant. It is characterized by the union of all system constant values and post-build variant criterion values aggregated within all referenced system constant value sets and post build variant criterion value sets plus the value sets of the included variants. Tags: atp.recommendedPackage=PredefinedVariants				
Base				
ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable				
Attribute	Type	Mult.	Kind	Note
includedVariant	PredefinedVariant	*	ref	The associated variants are considered part of this PredefinedVariant. This means the settings of the included variants are included in the settings of the referencing PredefinedVariant. Nevertheless the included variants might be included in several predefined variants.
postBuildVariantCriterionValueSet	PostBuildVariantCriterionValueSet	*	ref	This is the postBuildVariantCriterionValueSet contributing to the predefined variant.
swSystemconstantValueSet	SwSystemconstantValueSet	*	ref	This is the set of Systemconstant Values contributing to the predefined variant.

Table D.215: PredefinedVariant

Class	QueuedReceiverComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Communication attributes specific to queued receiving.			
Base	ARObject, RPortComSpec, ReceiverComSpec			
Attribute	Type	Mult.	Kind	Note
queueLength	PositiveInteger	0..1	attr	Length of queue for received events.

Table D.216: QueuedReceiverComSpec

Class	QueuedSenderComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Communication attributes specific to distribution of events (PPortPrototype, SenderReceiverInterface and dataElement carries an "event").			
Base	ARObject, PPortComSpec, SenderComSpec			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.217: QueuedSenderComSpec

Class	RPortPrototype			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	Component port requiring a certain port interface.			
Base	ARObject, AbstractRequiredPortPrototype , AtpBlueprintable, AtpFeature, AtpPrototype, Identifiable , MultilanguageReferrable, PortPrototype , Referrable			
Attribute	Type	Mult.	Kind	Note
required Interface	PortInterface	0..1	tref	The interface that this port requires. Stereotypes: isOfType

Table D.218: RPortPrototype

Class	RTEEvent (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	Abstract base class for all RTE-related events			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Subclasses	AsynchronousServerCallReturnsEvent , BackgroundEvent , DataReceiveErrorEvent , DataReceivedEvent , DataSendCompletedEvent , DataWriteCompletedEvent , ExternalTriggerOccurredEvent , InitEvent , InternalTriggerOccurredEvent , ModeSwitchedAckEvent , OperationInvokedEvent , OsTaskExecutionEvent , SwcModeManagerErrorEvent , SwcModeSwitchEvent , TimingEvent , TransformerHardErrorEvent			
Attribute	Type	Mult.	Kind	Note
disabledMode	ModeDeclaration	*	iref	Reference to the Modes that disable the Event. Stereotypes: atpSplitable Tags: atp.Splitkey=disabledMode.contextModeDeclaration GroupPrototype, disabledMode.contextPort, disabled Mode.targetModeDeclaration InstanceRef implemented by: RModelInAtomicSwc InstanceRef
startOnEvent	RunnableEntity	0..1	ref	RunnableEntity starts when the corresponding RTEEvent occurs.

Table D.219: RTEEvent

Class	RapidPrototypingScenario			
Package	M2::AUTOSARTemplates::SWComponentTemplate::RPTScenario			
Note	<p>This meta class provides the ability to describe a Rapid Prototyping Scenario. Such a Rapid Prototyping Scenario consist out of two main aspects, the description of the byPassPoints and the relation to an rpt Hook.</p> <p>Tags:atp.recommendedPackage=RapidPrototypingScenarios</p>			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
hostSystem	System	0..1	ref	System which describes the software components of the host ECU.
rptContainer	RptContainer	*	aggr	<p>Top-level rptContainer definitions of this specific rapid prototyping scenario.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=rptContainer.shortName, rptContainer.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
rptProfile	RptProfile	*	aggr	<p>Defiens the applicable Rapid Prototyping profls which are especially defining the smbol of the service functions and the valid id range. The order of the RptProfiles determines the order of the service function invocation by RTE.</p> <p>Stereotypes: atpSplitable</p> <p>Tags:atp.Splitkey=rptProfile.shortName</p>
rptSystem	System	0..1	ref	<p>System which describes the rapid prototyping algorithm in the format of AUTOSAR Software Components.</p> <p>Stereotypes: atpSplitable</p> <p>Tags:atp.Splitkey=rptSystem</p>

Table D.220: RapidPrototypingScenario

Class	ReceiverComSpec (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Receiver-specific communication attributes (RPortPrototype typed by SenderReceiverInterface).			
Base	ARObject, RPortComSpec			
Subclasses	NonqueuedReceiverComSpec , QueuedReceiverComSpec			
Attribute	Type	Mult.	Kind	Note
compositeNetworkRepresentation	CompositeNetworkRepresentation	*	aggr	This represents a CompositeNetworkRepresentation defined in the context of a ReceiverComSpec. The purpose of this aggregation is to be able to specify the network representation of leaf elements of Application CompositeDataTypes.
dataElement	AutosarDataPrototype	0..1	ref	Data element these attributes belong to.
handleOutOfRange	HandleOutOfRangeEnum	0..1	attr	This attribute controls how values that are out of the specified range are handled according to the values of HandleOutOfRangeEnum.
handleOutOfRangeStatus	HandleOutOfRangeStatusEnum	0..1	attr	Control the way how return values are created in case of an out-of-range situation.





Class	ReceiverComSpec (abstract)			
maxDeltaCounterInit	PositiveInteger	0..1	attr	<p>Initial maximum allowed gap between two counter values of two consecutively received valid Data, i.e. how many subsequent lost data is accepted. For example, if the receiver gets Data with counter 1 and MaxDeltaCounterInit is 1, then at the next reception the receiver can accept Counters with values 2 and 3, but not 4.</p> <p>Note that if the receiver does not receive new Data at a consecutive read, then the receiver increments the tolerance by 1.</p> <p>Caveat: The E2E wrapper approach involves technologies that are not subjected to the AUTOSAR standard and is superseded by the superior E2E transformer approach (which is fully standardized by AUTOSAR). Hence, new projects (without legacy constraints due to carry-over parts) shall use the fully standardized E2E transformer approach.</p> <p>Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime</p>
maxNoNewOrRepeatedData	PositiveInteger	0..1	attr	<p>The maximum amount of missing or repeated Data which the receiver does not expect to exceed under normal communication conditions.</p> <p>Caveat: The E2E wrapper approach involves technologies that are not subjected to the AUTOSAR standard and is superseded by the superior E2E transformer approach (which is fully standardized by AUTOSAR). Hence, new projects (without legacy constraints due to carry-over parts) shall use the fully standardized E2E transformer approach.</p>
networkRepresentation	SwDataDefProps	0..1	aggr	A networkRepresentation is used to define how the data Element is mapped to a communication bus.
receptionProps	ReceptionComSpecProps	0..1	aggr	"This aggregation represents the definition transmission props in the context of the enclosing ReceiverComSpec.
replaceWith	VariableAccess	0..1	aggr	This aggregation is used to identify the AutosarData Prototype to be taken for sourcing an external replacement in the out-of-range handling.
syncCounterInit	PositiveInteger	0..1	attr	<p>Number of Data required for validating the consistency of the counter that shall be received with a valid counter (i.e. counter within the allowed lock-in range) after the detection of an unexpected behavior of a received counter.</p> <p>Caveat: The E2E wrapper approach involves technologies that are not subjected to the AUTOSAR standard and is superseded by the superior E2E transformer approach (which is fully standardized by AUTOSAR). Hence, new projects (without legacy constraints due to carry-over parts) shall use the fully standardized E2E transformer approach.</p>
transformationComSpecProps	TransformationComSpecProps	*	aggr	This references the TransformationComSpecProps which define port-specific configuration for data transformation.
usesEndToEndProtection	Boolean	0..1	attr	<p>This indicates whether the corresponding dataElement shall be transmitted using end-to-end protection.</p> <p>Caveat: The E2E wrapper approach involves technologies that are not subjected to the AUTOSAR standard and is superseded by the superior E2E transformer approach (which is fully standardized by</p>





Class	<i>ReceiverComSpec</i> (abstract)			
				<p>△</p> <p>AUTOSAR). Hence, new projects (without legacy constraints due to carry-over parts) shall use the fully standardized E2E transformer approach.</p> <p>Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime</p>

Table D.221: ReceiverComSpec

Class	ReferenceValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	Specifies a reference to a data prototype to be used as an initial value for a pointer in the software.			
Base	ARObject, ValueSpecification			
Attribute	Type	Mult.	Kind	Note
referenceValue	DataPrototype	0..1	ref	The referenced data prototype.

Table D.222: ReferenceValueSpecification

Class	<i>Referrable</i> (abstract)			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable			
Note	Instances of this class can be referred to by their identifier (while adhering to namespace borders).			
Base	ARObject			
Subclasses	<i>AtpDefinition</i> , <i>BswDistinguishedPartition</i> , BswModuleCallPoint , BswModuleClientServerEntry , BswVariableAccess , <i>CouplingPortTrafficClassAssignment</i> , <i>DiagnosticDebounceAlgorithmProps</i> , <i>DiagnosticEnvModeElement</i> , <i>EthernetPriorityRegeneration</i> , <i>EventHandler</i> , <i>ExclusiveAreaNestingOrder</i> , <i>HwDescriptionEntity</i> , ImplementationProps , <i>LinSlaveConfigIdent</i> , <i>ModeTransition</i> , MultilanguageReferrable , <i>PduActivationRoutingGroup</i> , <i>PncMappingIdent</i> , SingleLanguageReferrable , <i>SoConIPdulIdentifier</i> , <i>SocketConnectionBundle</i> , <i>TimeSyncServerConfiguration</i> , <i>TpConnectionIdent</i>			
Attribute	Type	Mult.	Kind	Note
shortName	Identifier	1	attr	<p>This specifies an identifying shortName for the object. It needs to be unique within its context and is intended for humans but even more for technical reference.</p> <p>Stereotypes: atpIdentityContributor Tags: xml.enforceMinMultiplicity=true xml.sequenceOffset=-100</p>
shortName Fragment	ShortNameFragment	*	aggr	<p>This specifies how the Referrable.shortName is composed of several shortNameFragments.</p> <p>Tags: xml.sequenceOffset=-90</p>

Table D.223: Referrable

Primitive	RevisionLabelString			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes			
Note	<p>This primitive represents an internal AUTOSAR revision label which identifies an engineering object. It represents a pattern which</p> <ul style="list-style-type: none"> • supports three integers representing from left to right MajorVersion, MinorVersion, PatchVersion. • may add an application specific suffix separated by one of ".", "_", ";". <p>Legal patterns are for example:</p>			





Primitive	RevisionLabelString
	<div style="text-align: right;">△</div> <ul style="list-style-type: none"> • 4.0.0 • 4.0.0.1234565 • 4.0.0_vendor specific;13 • 4.0.0;12 <p>Tags: xml.xsd.customType=REVISION-LABEL-STRING xml.xsd.pattern=[0-9]+\.[0-9]+\.[0-9]+([\._;]*)? xml.xsd.type=string</p>

Table D.224: RevisionLabelString

Class	RoleBasedDataAssignment			
Package	M2::AUTOSARTemplates::CommonStructure::ServiceNeeds			
Note	<p>This class specifies an assignment of a role to a particular data object in the SwcInternalBehavior of a software component (or in the BswModuleBehavior of a module or cluster) in the context of an AUTOSAR Service.</p> <p>With this assignment, the role of the data can be mapped to a specific ServiceNeeds element, so that a tool is able to create the correct access.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
role	Identifier	0..1	attr	<p>This is the role of the assigned data in the given context, for example for an NVRAM Block it is used to distinguish between an mirror block and a ROM default block. Possible values need to be specified on M1 level.</p> <p>This also is intended to support the so called "Signal based Approach" of the DCM. In this use case the name of the involved data element is required. This name shall be taken from the DataElement referenced by the property usedDataElement.</p> <p>The following values are standardized:</p> <ul style="list-style-type: none"> • ramBlock indicates data to be used as a mirror for an NVRAM Block. • defaultValue indicates constant data to be used as default in the context of this ServiceNeeds, e.g. for an NVRAM Block. • signalBasedDiagnostics indicates the Role BasedDataAssignment shall be used for signal based diagnostics.
usedDataElement	AutosarVariableRef	0..1	aggr	<p>The VariableDataPrototype used in this role, e.g.</p> <ul style="list-style-type: none"> • Permanent RAM Block of an NVRAM Block which shall belong to the same SwcInternalBehavior or BswInternalBehavior. • In the role signalBasedDiagnostics it has to refer to a VariableDataPrototype in a SenderReceiver Interface or a NvDataInterface.





Class	RoleBasedDataAssignment			
usedParameterElement	AutosarParameterRef	0..1	aggr	The ParameterDataPrototype used in this role, e.g. <ul style="list-style-type: none"> ROM Block of an NVRAM Block. It shall belong to the same SwcInternalBehavior or Bsw Internalbehavior. In the role signalBasedDiagnostics it has to refer to a ParameterDataPrototype in a Parameter Interface.
usedPim	PerInstanceMemory	0..1	ref	The (untyped) PerInstanceMemory used in this role (e.g. as a Permanent RAM Block for an NVRAM Block).

Table D.225: RoleBasedDataAssignment

Class	RoleBasedPortAssignment			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ServiceMapping			
Note	This class specifies an assignment of a role to a particular service port (RPortPrototype or PPort Prototype) of an AtomicSwComponentType. With this assignment, the role of the service port can be mapped to a specific ServiceNeeds element, so that a tool is able to create the correct connector.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
portPrototype	PortPrototype	0..1	ref	Service PortPrototype used in the assigned role. This PortPrototype shall either belong to the same AtomicSw ComponentType as the SwcInternalBehavior which owns the ServiceDependency or to the same NvBlockSw ComponentType as the NvBlockDescriptor.
role	Identifier	0..1	attr	This is the role of the assigned Port in the given context. The value shall be a shortName of the Blueprint of a Port Interface as standardized in the Software Specification of the related AUTOSAR Service.

Table D.226: RoleBasedPortAssignment

Class	RootSwCompositionPrototype			
Package	M2::AUTOSARTemplates::SystemTemplate			
Note	<p>The RootSwCompositionPrototype represents the top-level-composition of software components within a given System.</p> <p>According to the use case of the System, this may for example be a more or less complete VFB description, the software of a System Extract or the software of a flat ECU Extract with only atomic SWCs.</p> <p>Therefore the RootSwComposition will only occasionally contain all atomic software components that are used in a complete VFB System. The OEM is primarily interested in the required functionality and the interfaces defining the integration of the Software Component into the System. The internal structure of such a component contains often substantial intellectual property of a supplier. Therefore a top-level software composition will often contain empty compositions which represent subsystems.</p> <p>The contained SwComponentPrototypes are fully specified by their SwComponentTypes (including Port Prototypes, PortInterfaces, VariableDataPrototypes, SwcInternalBehavior etc.), and their ports are interconnected using SwConnectorPrototypes.</p>			
Base	ARObject, AtpFeature, AtpPrototype, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
calibrationParameterValueSet	CalibrationParameter ValueSet	*	ref	Used CalibrationParameterValueSet for instance specific initialization of calibration parameters. Stereotypes: atpSplitable Tags: atp.Splitkey=calibrationParameterValueSet





Class	RootSwCompositionPrototype			
flatMap	FlatMap	0..1	ref	The FlatMap used in the scope of this RootSw CompositionPrototype. Stereotypes: atpSplitable Tags: atp.Splitkey=flatMap
software Composition	CompositionSw ComponentType	1	tref	We assume that there is exactly one top-level composition that includes all Component instances of the system Stereotypes: isOfType

Table D.227: RootSwCompositionPrototype

Enumeration	RptAccessEnum
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport::RptSupport
Note	Determines the access rights to a data object with respect to rapid prototyping.
Literal	Description
enabled	The related data element is accessible by RP tool. Tags: atp.EnumerationLiteralIndex=0
none	The related data element is not accessible by RP tool. Tags: atp.EnumerationLiteralIndex=1
protected	The data element is known to the RP tool however its usage for RP can be restricted. Use case: limitation based on access rights Tags: atp.EnumerationLiteralIndex=2

Table D.228: RptAccessEnum

Class	RptContainer			
Package	M2::AUTOSARTemplates::SWComponentTemplate::RPTScenario			
Note	This meta class defines a byPassPoint and the relation to a rptHook. Additionally it may contain further rptContainers if the byPassPoint is not atomic. For example a byPass Point refereing to a RunnableEntity may contain rptContainers referring to the data access points of the RunnableEntity. The RptContainer structure on M1 shall follow the M1 structure of the Software Component Descriptions. The category attribute denotes which level of the Software Component Description is annotated.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
byPassPoint	AtpFeature	*	iref	byPassPoint describes the required preparation of the host ECU. At a byPassPoint the host ECU shall be capable to communicate with a RPT System in order to support the execution of the rapid prototyping algorithms with the original data calculated by the host system and to replace dedicated results of the host system by the results of the rapid prototyping algorithm. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=byPassPoint.contextElement, byPass Point.target, byPassPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime InstanceRef implemented by: AnyInstanceRef





Class	RptContainer			
explicitRpt ProfileSelection	RptProfile	*	ref	This attribute defines the applicable RptProfiles for the specific RptContainer. If not any references to a specific RptProfile is defined, all RptProfiles defined in the Rapid PrototypingScenario are applicable. Stereotypes: atpSplitable Tags: atp.Splitkey=explicitRptProfileSelection
rptContainer	RptContainer	*	aggr	Sub-level rptContainer definitions of this specific rapid prototyping scenario. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=rptContainer.shortName, rptContainer.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
rptExecutable EntityProperties	RptExecutableEntity Properties	0..1	aggr	Describes the required code preparation for rapid prototyping at ExecutableEntity invocation.
rptHook	RptHook	0..1	aggr	The rptHook describes the link between a byPassPoint and the rapid prototyping algorithm. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=rptHook, rptHook.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
rptImplPolicy	RptImplPolicy	0..1	aggr	Describes the required code preparation for rapid prototyping at data accesses.
rptSw Prototyping Access	RptSwPrototyping Access	0..1	aggr	Describes the required accessibility of data and modes by the rapid prototyping tooling.

Table D.229: RptContainer

Enumeration	RptEnablerImplTypeEnum
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport::RptSupport
Note	Describes the required / implemented usage of enabler flags for data access in the code.
Literal	Description
none	No "RP enabler" is implemented. Tags: atp.EnumerationLiteralIndex=0
rptEnablerRam	"RP enabler" is implemented as a RAM variable Tags: atp.EnumerationLiteralIndex=1
rptEnablerRamAnd Rom	The RTE generator implements both the RAM and ROM "RP enabler". Tags: atp.EnumerationLiteralIndex=3
rptEnablerRom	"RP enabler" is implemented as a calibrateable ROM variable. Tags: atp.EnumerationLiteralIndex=2

Table D.230: RptEnablerImplTypeEnum

Class	RptExecutableEntityEvent			
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport::RptSupport			
Note	This describes an ExecutableEntity event instance which can be bypassed.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note





Class	RptExecutableEntityEvent			
execution Context	RptExecutionContext	1..*	ref	This describes the context in which the event of the executable entity is executed.
mcData Assignment	RoleBasedMcData Assignment	*	aggr	Reference to related McDataElements describing the implementation of "RP runnable disabler flag" and "stimulation enabler flag" The possible roles of the RoleBasedMcData Assignment.role attribute are: <ul style="list-style-type: none"> RpRunnableDisablerFlag"
rptEventId	PositiveInteger	1	attr	RPT event id used for service points call.
rptExecutable EntityProperties	RptExecutableEntity Properties	1	aggr	Describes the implemented code preparation for rapid prototyping at ExecutableEntity invocation.
rptImplPolicy	RptImplPolicy	0..1	aggr	Describes the RptImplPolicy of a RptExecutableEvent for service based bypassing.
rptServicePoint Post	RptServicePoint	1..*	ref	This describes the applicable Post Service Points for a RTEEvent / BswEvent of a bypassed ExecutableEntity.
rptServicePoint Pre	RptServicePoint	1..*	ref	This describes the applicable Pre Service Points for a RTEEvent / BswEvent of a bypassed ExecutableEntity.

Table D.231: RptExecutableEntityEvent

Class	RptExecutableEntityProperties			
Package	M2::AUTOSARTemplates::SWComponentTemplate::RPTScenario			
Note	Describes the code preparation for rapid prototyping at ExecutableEntity invocation.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
maxRptEventId	PositiveInteger	0..1	attr	Highest RPT event id useable for RTE generated service points. This attribute is relevant, if dedicated id range shall be applied to the ExecutableEntitys of a software component or specific ExecutableEntities.
minRptEventId	PositiveInteger	0..1	attr	Lowest RPT event id useable for RTE generated service points. This attribute is relevant, if dedicated id range shall be applied to the ExecutableEntitys of a software component or specific ExecutableEntities.
rptExecution Control	RptExecutionControl Enum	0..1	attr	This attribute specifies the rapid prototyping control of the executable
rptServicePoint	RptServicePointEnum	0..1	attr	Enables generation of service points by the RTE generator.

Table D.232: RptExecutableEntityProperties

Enumeration	RptExecutionControlEnum
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport::RptSupport
Note	Determines rapid prototyping preparation of an ExecutableEntity.
Literal	Description
conditional	The ExecutableEntity is only executed when the rapid prototyping disable flag is NOT set. Tags: atp.EnumerationLiteralIndex=0
none	The ExecutableEntity is executed without specific rapid prototyping condition. Tags: atp.EnumerationLiteralIndex=1

Table D.233: RptExecutionControlEnum

Class	RptImplPolicy			
Package	M2::AUTOSARTemplates::SWComponentTemplate::RPTScenario			
Note	Describes the code preparation for rapid prototyping at data accesses.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
rptEnablerImplType	RptEnablerImplType Enum	0..1	attr	For Level 2 or Level3 this property determines how the RTE implements the additional "RP enabler" flag.
rptPreparationLevel	RptPreparationEnum	0..1	attr	Mandates RP preparation level for access to VariableData Prototype within generated RTE implementation.

Table D.234: RptImplPolicy

Enumeration	RptPreparationEnum
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport::RptSupport
Note	Determines the RP preparation level for access to VariableDataPrototypes within the generated RTE implementation.
Literal	Description
none	No RP preparation for VariableDataPrototype. Tags: atp.EnumerationLiteralIndex=0
rptLevel1	The RTE implementation uses an "RP global buffer" for measurement and post-build hooking purposes. Tags: atp.EnumerationLiteralIndex=1
rptLevel2	As rptLevel1 but the RTE implementation also uses both "RP enabler flag" to permit RP overwrite at run-time. Tags: atp.EnumerationLiteralIndex=2
rptLevel3	As rptLevel2 but the RTE implementation also uses "RP global measurement buffer" to record the original ECU-generated value in addition to the RP value. Tags: atp.EnumerationLiteralIndex=3

Table D.235: RptPreparationEnum

Class	RptProfile			
Package	M2::AUTOSARTemplates::SWComponentTemplate::RPTScenario			
Note	The RptProfile describes the common properties of a Rapid Prototyping method.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
maxServicePointId	PositiveInteger	0..1	attr	Highest service point id useable for RTE generated service points.
minServicePointId	PositiveInteger	0..1	attr	Lowest service point id useable for RTE generated service points.
servicePointSymbolPost	CIdentifier	0..1	attr	Complete symbol of the function implementing the post service point. This symbol is used for post-build hooking purposes.
servicePointSymbolPre	CIdentifier	0..1	attr	Complete symbol of the function implementing the pre service point. This symbol is used for post-build hooking purposes.





Class	RptProfile			
stimEnabler	RptEnablerImplType Enum	0..1	attr	Defines if the service points support the stimulation enabler. If RptProfile.stimEnabler is "none" then no stimulation enabler is passed to the service function. Otherwise the stimulation enabler will be passed as a parameter.

Table D.236: RptProfile

Class	RptSupportData			
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport::RptSupport			
Note	Root element for rapid prototyping support data related to one Implementation artifact on an ECU, in particular the RTE. The rapid prototyping support data may reference to elements provided for Mc SupportData.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
executionContext	RptExecutionContext	1..*	aggr	Defines an environment for the execution of Executable Entites.
rptComponent	RptComponent	1..*	aggr	Description of components for which rapid prototyping support is implemented. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
rptServicePoint	RptServicePoint	1..*	aggr	This aggregation represents the collection of service points associated with the enclosing RptSupportData Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime

Table D.237: RptSupportData

Class	RptSwPrototypingAccess			
Package	M2::AUTOSARTemplates::CommonStructure::MeasurementCalibrationSupport::RptSupport			
Note	Describes the accessibility of data and modes by the rapid prototyping tooling.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
rptHookAccess	RptAccessEnum	0..1	attr	The related data element can be modified using a post-build hooking tool. An ENABLED VariableData Prototype is implicitly READABLE/WRITABLE.
rptReadAccess	RptAccessEnum	0..1	attr	The related data element can be used as input for bypass functionality by RP tool. If rptImplPolicy is not specified then RTE generation shall ensure at least suitable MC read points are created.
rptWriteAccess	RptAccessEnum	0..1	attr	The related data element can be used as output for bypass functionality by RP tool. The data element shall be prepared to rptLevel2 and related write service points are present.

Table D.238: RptSwPrototypingAccess

Enumeration	RteApiReturnValueProvisionEnum
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::AccessCount
Note	This meta-class provides values to control how return values from RTE APIs are provided.
Literal	Description





Enumeration	RteApiReturnValueProvisionEnum
noReturnValueProvided	The RTE API shall not provide a return value. Tags: atp.EnumerationLiteralIndex=1
returnValueProvided	The RTE API shall provide a return value. Tags: atp.EnumerationLiteralIndex=0

Table D.239: RteApiReturnValueProvisionEnum

Class	RtePluginProps			
Package	M2::AUTOSARTemplates::CommonStructure::FlatMap			
Note	The properties of a communication graph with respect to the utilization of RTE Implementation Plug-in.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
associatedCrossSwClusterComRtePlugin	EcucContainerValue	0..1	ref	This associates a communication graph to a specific RTE Implementation Plug-in handling cross Software Cluster communication.
associatedRtePlugin	EcucContainerValue	0..1	ref	This associates a communication graph to a specific RTE Implementation Plug-in handling local Software Cluster communication or communication in a non-cluster ECU.

Table D.240: RtePluginProps

Class	RuleBasedValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	This meta-class is used to support a rule-based initialization approach for data types with an array-nature (ApplicationArrayDataType and ImplementationDataType of category ARRAY) or a compound Application PrimitiveDataType (which also boils down to an array-nature).			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
arguments	RuleArguments	0..1	aggr	This represents the arguments for the RuleBasedValue Specification. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=30
maxSizeToFill	Integer	0..1	attr	If a rule is chosen which does not fill until the end, this determines until which size the rule shall fill the values. Tags: xml.sequenceOffset=40
rule	Identifier	0..1	attr	This denotes the name of the rule of the RuleBasedValue Specification. The rule determines the calculation specification according which the arguments are used to calculated the values. Tags: xml.sequenceOffset=20

Table D.241: RuleBasedValueSpecification

Class	RunnableEntity
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior
Note	A RunnableEntity represents the smallest code-fragment that is provided by an AtomicSwComponent Type and are executed under control of the RTE. RunnableEntities are for instance set up to respond to data reception or operation invocation on a server.





Class	RunnableEntity			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, ExecutableEntity, Identifiable, Multilanguage Referrable, Referrable			
Attribute	Type	Mult.	Kind	Note
argument (ordered)	RunnableEntity Argument	*	aggr	This represents the formal definition of a an argument to a RunnableEntity.
asynchronous ServerCall ResultPoint	AsynchronousServerCallResultPoint	*	aggr	<p>The server call result point admits a runnable to fetch the result of an asynchronous server call.</p> <p>The aggregation of AsynchronousServerCallResultPoint is subject to variability with the purpose to support the conditional existence of client server PortPrototypes and the variant existence of server call result points in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=asynchronousServerCallResultPoint.shortName, asynchronousServerCallResultPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
canBeInvoked Concurrently	Boolean	0..1	attr	If the value of this attribute is set to "true" the enclosing RunnableEntity can be invoked concurrently (even for one instance of the corresponding AtomicSwComponent Type). This implies that it is the responsibility of the implementation of the RunnableEntity to take care of this form of concurrency. Note that the default value of this attribute is set to "false".
dataRead Access	VariableAccess	*	aggr	<p>RunnableEntity has implicit read access to dataElement of a sender-receiver PortPrototype or nv data of a nv data PortPrototype.</p> <p>The aggregation of dataReadAccess is subject to variability with the purpose to support the conditional existence of sender receiver ports or the variant existence of dataReadAccess in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=dataReadAccess.shortName, dataReadAccess.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
dataReceive PointBy Argument	VariableAccess	*	aggr	<p>RunnableEntity has explicit read access to dataElement of a sender-receiver PortPrototype or nv data of a nv data PortPrototype. The result is passed back to the application by means of an argument in the function signature.</p> <p>The aggregation of dataReceivePointByArgument is subject to variability with the purpose to support the conditional existence of sender receiver PortPrototype or the variant existence of data receive points in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=dataReceivePointByArgument.shortName, dataReceivePointByArgument.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>





Class	RunnableEntity			
dataReceivePointByValue	VariableAccess	*	aggr	<p>RunnableEntity has explicit read access to dataElement of a sender-receiver PortPrototype or nv data of a nv data PortPrototype.</p> <p>The result is passed back to the application by means of the return value. The aggregation of dataReceivePointByValue is subject to variability with the purpose to support the conditional existence of sender receiver ports or the variant existence of data receive points in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=dataReceivePointByValue.shortName, dataReceivePointByValue.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
dataSendPoint	VariableAccess	*	aggr	<p>RunnableEntity has explicit write access to dataElement of a sender-receiver PortPrototype or nv data of a nv data PortPrototype.</p> <p>The aggregation of dataSendPoint is subject to variability with the purpose to support the conditional existence of sender receiver PortPrototype or the variant existence of data send points in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=dataSendPoint.shortName, dataSendPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
dataWriteAccess	VariableAccess	*	aggr	<p>RunnableEntity has implicit write access to dataElement of a sender-receiver PortPrototype or nv data of a nv data PortPrototype.</p> <p>The aggregation of dataWriteAccess is subject to variability with the purpose to support the conditional existence of sender receiver ports or the variant existence of dataWriteAccess in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=dataWriteAccess.shortName, dataWriteAccess.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
externalTriggeringPoint	ExternalTriggeringPoint	*	aggr	<p>The aggregation of ExternalTriggeringPoint is subject to variability with the purpose to support the conditional existence of trigger ports or the variant existence of external triggering points in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=externalTriggeringPoint.ident.shortName, externalTriggeringPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
internalTriggeringPoint	InternalTriggeringPoint	*	aggr	<p>The aggregation of InternalTriggeringPoint is subject to variability with the purpose to support the variant existence of internal triggering points in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=internalTriggeringPoint.shortName, internalTriggeringPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>





Class	RunnableEntity			
modeAccess Point	ModeAccessPoint	*	aggr	<p>The runnable has a mode access point. The aggregation of ModeAccessPoint is subject to variability with the purpose to support the conditional existence of mode ports or the variant existence of mode access points in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=modeAccessPoint.ident.shortName, modeAccessPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
modeSwitch Point	ModeSwitchPoint	*	aggr	<p>The runnable has a mode switch point. The aggregation of ModeSwitchPoint is subject to variability with the purpose to support the conditional existence of mode ports or the variant existence of mode switch points in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=modeSwitchPoint.shortName, modeSwitchPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
parameter Access	ParameterAccess	*	aggr	<p>The presence of a ParameterAccess implies that a RunnableEntity needs read only access to a Parameter DataPrototype which may either be local or within a Port Prototype.</p> <p>The aggregation of ParameterAccess is subject to variability with the purpose to support the conditional existence of parameter ports and component local parameters as well as the variant existence of Parameter Access (points) in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=parameterAccess.shortName, parameterAccess.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
readLocal Variable	VariableAccess	*	aggr	<p>The presence of a readLocalVariable implies that a RunnableEntity needs read access to a VariableData Prototype in the role of implicitInterRunnableVariable or explicitInterRunnableVariable.</p> <p>The aggregation of readLocalVariable is subject to variability with the purpose to support the conditional existence of implicitInterRunnableVariable and explicit InterRunnableVariable or the variant existence of read LocalVariable (points) in the implementation.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=readLocalVariable.shortName, readLocalVariable.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
serverCallPoint	ServerCallPoint	*	aggr	<p>The RunnableEntity has a ServerCallPoint. The aggregation of ServerCallPoint is subject to variability with the purpose to support the conditional existence of client server PortPrototypes or the variant existence of server call points in the implementation.</p>





Class	RunnableEntity			
				<div>△</div> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=serverCallPoint.shortName, serverCallPoint.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
symbol	CIdentifier	0..1	attr	The symbol describing this RunnableEntity's entry point. This is considered the API of the RunnableEntity and is required during the RTE contract phase.
waitPoint	WaitPoint	*	aggr	The WaitPoint associated with the RunnableEntity.
writtenLocalVariable	VariableAccess	*	aggr	<p>The presence of a writtenLocalVariable implies that a RunnableEntity needs write access to a VariableData Prototype in the role of implicitInterRunnableVariable or explicitInterRunnableVariable.</p> <p>The aggregation of writtenLocalVariable is subject to variability with the purpose to support the conditional existence of implicitInterRunnableVariable and explicitInterRunnableVariable or the variant existence of writtenLocalVariable (points) in the implementation.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=writtenLocalVariable.shortName, writtenLocalVariable.variationPoint.shortLabel vh.latestBindingTime=preCompileTime

Table D.242: RunnableEntity

Class	RunnableEntityArgument			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RunnableEntity			
Note	This meta-class represents the ability to provide specific information regarding the arguments to a RunnableEntity.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
symbol	CIdentifier	0..1	attr	This represents the symbol to be generated into the actual signature on the level of the C programming language.

Table D.243: RunnableEntityArgument

Class	RunnableEntityGroup			
Package	M2::AUTOSARTemplates::SWComponentTemplate::ImplicitCommunicationBehavior			
Note	This meta-class represents the ability to define a collection of RunnableEntities. The collection can be nested.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
runnableEntity	RunnableEntity	*	iref	<p>This represents a collection of RunnableEntitys that belong to the enclosing RunnableEntityGroup.</p> Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime InstanceRef implemented by: RunnableEntityInCompositionInstanceRef





Class	RunnableEntityGroup			
runnableEntityGroup	RunnableEntityGroup	*	iref	<p>This represents the ability to define nested groups of RunnableEntitys.</p> <p>Stereotypes: atpVariation</p> <p>Tags: vh.latestBindingTime=preCompileTime</p> <p>InstanceRef implemented by: InnerRunnableEntityGroupInCompositionInstanceRef</p>

Table D.244: RunnableEntityGroup

Class	Sdg			
Package	M2::MSR::AsamHdo::SpecialData			
Note	<p>Sdg (SpecialDataGroup) is a generic model which can be used to keep arbitrary information which is not explicitly modeled in the meta-model.</p> <p>Sdg can have various contents as defined by sdgContentsType. Special Data should only be used moderately since all elements should be defined in the meta-model.</p> <p>Thereby SDG should be considered as a temporary solution when no explicit model is available. If an sdg Caption is available, it is possible to establish a reference to the sdg structure.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
gid	NameToken	1	attr	<p>This attributes specifies an identifier. Gid comes from the SGML/XML-Term "Generic Identifier" which is the element name in XML. The role of this attribute is the same as the name of an XML - element.</p> <p>Tags: xml.attribute=true</p>
sdgCaption	SdgCaption	0..1	aggr	<p>This aggregation allows to assign the properties of Identifiable to the sdg. By this, a shortName etc. can be assigned to the Sdg.</p> <p>Tags: xml.sequenceOffset=20</p>
sdgContentsType	SdgContents	0..1	aggr	<p>This is the content of the Sdg.</p> <p>Tags: xml.roleElement=false xml.roleWrapperElement=false xml.sequenceOffset=30 xml.typeElement=false xml.typeWrapperElement=false</p>

Table D.245: Sdg

Class	ScaleConstr			
Package	M2::MSR::AsamHdo::Constraints::GlobalConstraints			
Note	This meta-class represents the ability to specify constraints as a list of intervals (called scales).			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
desc	MultiLanguageOverviewParagraph	0..1	aggr	<p><desc> represents a general but brief description of the object in question.</p> <p>Tags: xml.sequenceOffset=30</p>
lowerLimit	Limit	0..1	attr	<p>This specifies the lower limit of the scale.</p> <p>Stereotypes: atpVariation</p> <p>Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=40</p>





Class	ScaleConstr			
shortLabel	Identifier	0..1	attr	This element specifies a short name for the scaleConstr. This can for example be used to create more specific messages of a constraint checker. The constraints cannot be associated in the meta-model, therefore shortLabel is somehow a substitute for shortName. Tags: xml.sequenceOffset=20
upperLimit	Limit	0..1	attr	This specifies the upper limit of a the scale. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=50
validity	ScaleConstrValidity Enum	0..1	attr	Specifies if the values defined by the scales are considered to be valid. If the attribute is missing then the default value is "VALID". Tags: xml.attribute=true

Table D.246: ScaleConstr

Class	SectionNamePrefix			
Package	M2::AUTOSARTemplates::CommonStructure::ResourceConsumption::MemorySectionUsage			
Note	A prefix to be used for generated code artifacts defining a memory section name in the source code of the using module or SWC.			
Base	ARObject, ImplementationProps , Referrable			
Attribute	Type	Mult.	Kind	Note
implementedIn	DependencyOnArtifact	0..1	ref	Optional reference that allows to Indicate the code artifact (header file) containing the preprocessor implementation of memory sections with this prefix. The usage of this link supersedes the usage of a memory mapping header with the default name (derived from the BswModuleDescription's shortName).

Table D.247: SectionNamePrefix

Enumeration	SendIndicationEnum
Package	M2::AUTOSARTemplates::SystemTemplate::SoftwareCluster
Note	This meta-class provides a way to specify in which way redundancy shall be applied on collection level. Tags: atp.Status=draft
Literal	Description
anySendOperation	This value represents the requirement that any send operation of the Software Cluster is indicated. Tags: atp.EnumerationLiteralIndex=2
none	This value represents the requirement that send operations of the Software Cluster are not indicated. Tags: atp.EnumerationLiteralIndex=1

Table D.248: SendIndicationEnum

Class	SenderComSpec (abstract)
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication
Note	Communication attributes for a sender port (PPortPrototype typed by SenderReceiverInterface).
Base	ARObject, PPortComSpec





Class	SenderComSpec (abstract)			
Subclasses	NonqueuedSenderComSpec, QueuedSenderComSpec			
Attribute	Type	Mult.	Kind	Note
composite Network Representation	CompositeNetworkRepresentation	*	aggr	This represents a CompositeNetworkRepresentation defined in the context of a SenderComSpec.
dataElement	AutosarDataPrototype	0..1	ref	Data element these quality of service attributes apply to.
handleOutOfRange	HandleOutOfRangeEnum	0..1	attr	This attribute controls how out-of-range values shall be dealt with.
network Representation	SwDataDefProps	0..1	aggr	A networkRepresentation is used to define how the data Element is mapped to a communication bus.
transmission Acknowledge	TransmissionAcknowledgementRequest	0..1	aggr	Requested transmission acknowledgement for data element.
transmission Props	TransmissionComSpecProps	0..1	aggr	This aggregation represents the definition transmission props in the context of the enclosing SenderComSpec.
usesEndToEndProtection	Boolean	0..1	attr	This indicates whether the corresponding dataElement shall be transmitted using end-to-end protection. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime

Table D.249: SenderComSpec

Class	SenderReceiverInterface			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	A sender/receiver interface declares a number of data elements to be sent and received. Tags: atp.recommendedPackage=PortInterfaces			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, DataInterface, Identifiable , MultilanguageReferrable, PackageableElement, PortInterface , Referrable			
Attribute	Type	Mult.	Kind	Note
dataElement	VariableDataPrototype	*	aggr	The data elements of this SenderReceiverInterface.
invalidation Policy	InvalidationPolicy	*	aggr	InvalidationPolicy for a particular dataElement
metaDataItem Set	MetaDataItemSet	*	aggr	This aggregation defines fixed sets of meta-data items associated with dataElements of the enclosing Sender ReceiverInterface

Table D.250: SenderReceiverInterface

Class	SenderReceiverToSignalGroupMapping			
Package	M2::AUTOSARTemplates::SystemTemplate::DataMapping			
Note	Mapping of a sender receiver communication data element with a composite datatype to a signal group.			
Base	ARObject, DataMapping			
Attribute	Type	Mult.	Kind	Note
dataElement	VariableDataPrototype	1	iref	Reference to a data element with a composite datatype which is mapped to a signal group. InstanceRef implemented by: VariableDataPrototypeIn SystemInstanceRef
signalGroup	SystemSignalGroup	1	ref	Reference to the signal group, which contain all primitive datatypes of the composite type





Class	SenderReceiverToSignalGroupMapping			
typeMapping	SenderRecCompositeTypeMapping	1	aggr	The CompositeTypeMapping maps the ApplicationArray Elements and ApplicationRecordElements to Signals of the SignalGroup.

Table D.251: SenderReceiverToSignalGroupMapping

Class	SenderReceiverToSignalMapping			
Package	M2::AUTOSARTemplates::SystemTemplate::DataMapping			
Note	Mapping of a sender receiver communication data element to a signal.			
Base	ARObject, DataMapping			
Attribute	Type	Mult.	Kind	Note
dataElement	VariableDataPrototype	1	iref	Reference to the data element. InstanceRef implemented by: VariableDataPrototypeInSystemInstanceRef
senderToSignal TextTable Mapping	TextTableMapping	0..1	aggr	This mapping allows for the text-table translation between the sending DataPrototype that is defined in the Port Prototype and the physicalProps defined for the System Signal.
signalTo ReceiverText TableMapping	TextTableMapping	0..1	aggr	This mapping allows for the text-table translation between the physicalProps defined for the SystemSignal and a receiving DataPrototype that is defined in the Port Prototype.
systemSignal	SystemSignal	1	ref	Reference to the system signal used to carry the data element.

Table D.252: SenderReceiverToSignalMapping

Class	SensorActuatorSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	The SensorActuatorSwComponentType introduces the possibility to link from the software representation of a sensor/actuator to its hardware description provided by the ECU Resource Template. Tags: atp.recommendedPackage=SwComponentTypes			
Base	ARElement, ARObject, AtomicSwComponentType , AtpBlueprint , AtpBlueprintable , AtpClassifier , AtpType , CollectableElement , Identifiable , MultilanguageReferrable , PackageableElement , Referrable , SwComponentType			
Attribute	Type	Mult.	Kind	Note
sensorActuator	HwDescriptionEntity	0..1	ref	Reference from the Sensor Actuator Software Component Type to the description of the actual hardware.

Table D.253: SensorActuatorSwComponentType

Enumeration	ServerArgumentImplPolicyEnum			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	This defines how the argument type of the servers RunnableEntity is implemented.			
Literal	Description			
useArgumentType	The argument type of the RunnableEntity is derived from the AutosarDataType of the Argument Prototype. Tags: atp.EnumerationLiteralIndex=0			
useVoid	The argument type of the RunnableEntity is void. Tags: atp.EnumerationLiteralIndex=2			

Table D.254: ServerArgumentImplPolicyEnum

Class	ServerCallPoint (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ServerCall			
Note	If a RunnableEntity owns a ServerCallPoint it is entitled to invoke a particular ClientServerOperation of a specific RPortPrototype of the corresponding AtomicSwComponentType			
Base	ARObject, AbstractAccessPoint , AtpClassifier , AtpFeature , AtpStructureElement , Identifiable , MultilanguageReferrable , Referrable			
Subclasses	AsynchronousServerCallPoint , SynchronousServerCallPoint			
Attribute	Type	Mult.	Kind	Note
operation	ClientServerOperation	0..1	iref	The operation that is called by this runnable. InstanceRef implemented by: ROperationInAtomicSwc InstanceRef
timeout	TimeValue	0..1	attr	Time in seconds before the server call times out and returns with an error message. It depends on the call type (synchronous or asynchronous) how this is reported.

Table D.255: ServerCallPoint

Class	ServerComSpec			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Communication attributes for a server port (PPortPrototype and ClientServerInterface).			
Base	ARObject, PPortComSpec			
Attribute	Type	Mult.	Kind	Note
operation	ClientServerOperation	0..1	ref	Operation these communication attributes apply to.
queueLength	PositiveInteger	0..1	attr	Length of call queue on the server side. The queue is implemented by the RTE. The value shall be greater or equal to 1. Setting the value of queueLength to 1 implies that incoming requests are rejected while another request that arrived earlier is being processed.
transformation ComSpecProps	TransformationCom SpecProps	*	aggr	This references the TransformationComSpecProps which define port-specific configuration for data transformation.

Table D.256: ServerComSpec

Class	ServiceProxySwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	<p>This class provides the ability to express a software-component which provides access to an internal service for remote ECUs. It acts as a proxy for the service providing access to the service.</p> <p>An important use case is the request of vehicle mode switches: Such requests can be communicated via sender-receiver interfaces across ECU boundaries, but the mode manager being responsible to perform the mode switches is an AUTOSAR Service which is located in the Basic Software and is not visible in the VFB view. To handle this situation, a ServiceProxySwComponentType will act as proxy for the mode manager. It will have R-Ports to be connected with the mode requestors on VFB level and Service-Ports to be connected with the local mode manager at ECU integration time.</p> <p>Apart from the semantics, a ServiceProxySwComponentType has these specific properties:</p> <ul style="list-style-type: none"> • A prototype of it can be mapped to more than one ECUs in the system description. • Exactly one additional instance of it will be created in the ECU-Extract per ECU to which the prototype has been mapped. • For remote communication, it can have only R-Ports with sender-receiver interfaces and 1:n semantics. • There shall be no connectors between two prototypes of any ServiceProxySwComponentType. <p>Tags:atp.recommendedPackage=SwComponentTypes</p>			





Class	ServiceProxySwComponentType			
Base	ARElement, ARObject, AtomicSwComponentType , AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable , SwComponentType			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.257: ServiceProxySwComponentType

Class	ServiceSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	ServiceSwComponentType is used for configuring services for a given ECU. Instances of this class are only to be created in ECU Configuration phase for the specific purpose of the service configuration. Tags: atp.recommendedPackage=SwComponentTypes			
Base	ARElement, ARObject, AtomicSwComponentType , AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable , SwComponentType			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.258: ServiceSwComponentType

Class	SubElementMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	This meta-class allows for the definition of mappings of elements of a composite data type.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
firstElement	SubElementRef	0..1	aggr	This represents the first element referenced in the scope of the mapping. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
secondElement	SubElementRef	0..1	aggr	This represents the second element referenced in the scope of the mapping. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
textTable Mapping	TextTableMapping	0..2	aggr	This allows for the text-table translation of individual elements of a composite data type.

Table D.259: SubElementMapping

Class	SwAddrMethod			
Package	M2::MSR::DataDictionary::AuxiliaryObjects			
Note	Used to assign a common addressing method, e.g. common memory section, to data or code objects. These objects could actually live in different modules or components. Tags: atp.recommendedPackage=SwAddrMethods			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
memory Allocation KeywordPolicy	MemoryAllocationKeywordPolicyType	0..1	attr	Enumeration to specify the name pattern of the Memory Allocation Keyword.





Class	SwAddrMethod			
option	Identifier	*	attr	<p>This attribute introduces the ability to specify further intended properties of the MemorySection in with the related objects shall be placed.</p> <p>These properties are handled as to be selected. The intended options are mentioned in the list.</p> <p>In the Memory Mapping configuration, this option list is used to determine an appropriate MemMapAddressing ModeSet.</p>
section Initialization Policy	SectionInitialization PolicyType	0..1	attr	<p>Specifies the expected initialization of the variables (inclusive those which are implementing VariableData Prototypes). Therefore this is an implementation constraint for initialization code of BSW modules (especially RTE) as well as the start-up code which initializes the memory segment to which the AutosarData Prototypes referring to the SwAddrMethod's are later on mapped.</p> <p>If the attribute is not defined it has the identical semantic as the attribute value "INIT"</p>
sectionType	MemorySectionType	0..1	attr	<p>Defines the type of memory sections which can be associated with this addressing method.</p>

Table D.260: SwAddrMethod

Class	SwBaseType			
Package	M2::MSR::AsamHdo::BaseTypes			
Note	<p>This meta-class represents a base type used within ECU software.</p> <p>Tags:atp.recommendedPackage=BaseTypes</p>			
Base	ARElement, ARObjct, AtpBlueprint, AtpBlueprintable, BaseType , CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
–	–	–	–	–

Table D.261: SwBaseType

Enumeration	SwCalibrationAccessEnum			
Package	M2::MSR::DataDictionary::DataDefProperties			
Note	Determines the access rights to a data object w.r.t. measurement and calibration.			
Literal	Description			
notAccessible	<p>The element will not be accessible via MCD tools, i.e. will not appear in the ASAP file.</p> <p>Tags:atp.EnumerationLiteralIndex=0</p>			
readOnly	<p>The element will only appear as read-only in an ASAP file.</p> <p>Tags:atp.EnumerationLiteralIndex=1</p>			
readWrite	<p>The element will appear in the ASAP file with both read and write access.</p> <p>Tags:atp.EnumerationLiteralIndex=2</p>			

Table D.262: SwCalibrationAccessEnum

Class	SwComponentPrototype			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	Role of a software component within a composition.			
Base	ARObject, AtpFeature, AtpPrototype, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
type	SwComponentType	0..1	tref	Type of the instance. Stereotypes: isOfType

Table D.263: SwComponentPrototype

Class	SwComponentType (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	Base class for AUTOSAR software components.			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Subclasses	AtomicSwComponentType , CompositionSwComponentType , ParameterSwComponentType			
Attribute	Type	Mult.	Kind	Note
consistency Needs	ConsistencyNeeds	*	aggr	This represents the collection of ConsistencyNeeds owned by the enclosing SwComponentType. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=consistencyNeeds.shortName, consistencyNeeds.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
port	PortPrototype	*	aggr	The PortPrototypes through which this SwComponent Type can communicate. The aggregation of PortPrototype is subject to variability with the purpose to support the conditional existence of PortPrototypes. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=port.shortName, port.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
portGroup	PortGroup	*	aggr	A port group being part of this component. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
swComponent Documentation	SwComponent Documentation	0..1	aggr	This adds a documentation to the SwComponentType. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=swComponentDocumentation, swComponentDocumentation.variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=-10
unitGroup	UnitGroup	*	ref	This allows for the specification of which UnitGroups are relevant in the context of referencing SwComponentType.

Table D.264: SwComponentType

Class	SwConnector (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	The base class for connectors between ports. Connectors have to be identifiable to allow references from the system constraint template.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable , Referrable			
Subclasses	AssemblySwConnector , DelegationSwConnector , PassThroughSwConnector			
Attribute	Type	Mult.	Kind	Note
mapping	PortInterfaceMapping	0..1	ref	Reference to a PortInterfaceMapping specifying the mapping of unequal named PortInterface elements of the two different PortInterfaces typing the two PortPrototypes which are referenced by the ConnectorPrototype.

Table D.265: SwConnector

Class	<<atpVariation>> SwDataDefProps			
Package	M2::MSR::DataDictionary::DataDefProperties			
Note	<p>This class is a collection of properties relevant for data objects under various aspects. One could consider this class as a "pattern of inheritance by aggregation". The properties can be applied to all objects of all classes in which SwDataDefProps is aggregated.</p> <p>Note that not all of the attributes or associated elements are useful all of the time. Hence, the process definition (e.g. expressed with an OCL or a Document Control Instance MSR-DCI) has the task of implementing limitations.</p> <p>SwDataDefProps covers various aspects:</p> <ul style="list-style-type: none"> • Structure of the data element for calibration use cases: is it a single value, a curve, or a map, but also the recordLayouts which specify how such elements are mapped/converted to the Data Types in the programming language (or in AUTOSAR). This is mainly expressed by properties like swRecordLayout and swCalprmAxisSet • Implementation aspects, mainly expressed by swImplPolicy, swVariableAccessImplPolicy, swAddrMethod, swPointerTargetProps, baseType, implementationDataType and additionalNativeTypeQualifier • Access policy for the MCD system, mainly expressed by swCalibrationAccess • Semantics of the data element, mainly expressed by compuMethod and/or unit, dataConstr, invalidValue • Code generation policy provided by swRecordLayout <p>Tags:vh.latestBindingTime=codeGenerationTime</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
additionalNativeTypeQualifier	NativeDeclarationString	0..1	attr	<p>This attribute is used to declare native qualifiers of the programming language which can neither be deduced from the baseType (e.g. because the data object describes a pointer) nor from other more abstract attributes. Examples are qualifiers like "volatile", "strict" or "enum" of the C-language. All such declarations have to be put into one string.</p> <p>Tags:xml.sequenceOffset=235</p>





Class	<<atpVariation>> SwDataDefProps			
annotation	Annotation	*	aggr	<p>This aggregation allows to add annotations (yellow pads ...) related to the current data object.</p> <p>Tags: xml.roleElement=true xml.roleWrapperElement=true xml.sequenceOffset=20 xml.typeElement=false xml.typeWrapperElement=false</p>
baseType	SwBaseType	0..1	ref	<p>Base type associated with the containing data object.</p> <p>Tags:xml.sequenceOffset=50</p>
compuMethod	CompuMethod	0..1	ref	<p>Computation method associated with the semantics of this data object.</p> <p>Tags:xml.sequenceOffset=180</p>
dataConstr	DataConstr	0..1	ref	<p>Data constraint for this data object.</p> <p>Tags:xml.sequenceOffset=190</p>
displayFormat	DisplayFormatString	0..1	attr	<p>This property describes how a number is to be rendered e.g. in documents or in a measurement and calibration system.</p> <p>Tags:xml.sequenceOffset=210</p>
displayPresentation	DisplayPresentationEnum	0..1	attr	<p>This attribute controls the presentation of the related data for measurement and calibration tools.</p>
implementationDataType	AbstractImplementationDataType	0..1	ref	<p>This association denotes the ImplementationDataType of a data declaration via its aggregated SwDataDefProps. It is used whenever a data declaration is not directly referring to a base type. Especially</p> <ul style="list-style-type: none"> • redefinition of an ImplementationDataType via a "typedef" to another ImplementationDatatype • the target type of a pointer (see SwPointerTarget Props), if it does not refer to a base type directly • the data type of an array or record element within an ImplementationDataType, if it does not refer to a base type directly • the data type of an SwServiceArg, if it does not refer to a base type directly <p>Tags:xml.sequenceOffset=215</p>
invalidValue	ValueSpecification	0..1	aggr	<p>Optional value to express invalidity of the actual data element.</p> <p>Tags:xml.sequenceOffset=255</p>
stepSize	Float	0..1	attr	<p>This attribute can be used to define a value which is added to or subtracted from the value of a DataPrototype when using up/down keys while calibrating.</p>
swAddrMethod	SwAddrMethod	0..1	ref	<p>Addressing method related to this data object. Via an association to the same SwAddrMethod it can be specified that several DataPrototypes shall be located in the same memory without already specifying the memory section itself.</p> <p>Tags:xml.sequenceOffset=30</p>





Class	<<atpVariation>> SwDataDefProps			
swAlignment	AlignmentType	0..1	attr	<p>The attribute describes the intended alignment of the DataPrototype. If the attribute is not defined the alignment is determined by the swBaseType size and the memory AllocationKeywordPolicy of the referenced SwAddr Method.</p> <p>Tags:xml.sequenceOffset=33</p>
swBit Representation	SwBitRepresentation	0..1	aggr	<p>Description of the binary representation in case of a bit variable.</p> <p>Tags:xml.sequenceOffset=60</p>
swCalibration Access	SwCalibrationAccess Enum	0..1	attr	<p>Specifies the read or write access by MCD tools for this data object.</p> <p>Tags:xml.sequenceOffset=70</p>
swCalprmAxis Set	SwCalprmAxisSet	0..1	aggr	<p>This specifies the properties of the axes in case of a curve or map etc. This is mainly applicable to calibration parameters.</p> <p>Tags:xml.sequenceOffset=90</p>
swComparison Variable	SwVariableRefProxy	*	aggr	<p>Variables used for comparison in an MCD process.</p> <p>Tags: xml.sequenceOffset=170 xml.typeElement=false</p>
swData Dependency	SwDataDependency	0..1	aggr	<p>Describes how the value of the data object has to be calculated from the value of another data object (by the MCD system).</p> <p>Tags:xml.sequenceOffset=200</p>
swHostVariable	SwVariableRefProxy	0..1	aggr	<p>Contains a reference to a variable which serves as a host-variable for a bit variable. Only applicable to bit objects.</p> <p>Tags: xml.sequenceOffset=220 xml.typeElement=false</p>
swImplPolicy	SwImplPolicyEnum	0..1	attr	<p>Implementation policy for this data object.</p> <p>Tags:xml.sequenceOffset=230</p>
swIntended Resolution	Numerical	0..1	attr	<p>The purpose of this element is to describe the requested quantization of data objects early on in the design process.</p> <p>The resolution ultimately occurs via the conversion formula present (compuMethod), which specifies the transition from the physical world to the standardized world (and vice-versa) (here, "the slope per bit" is present implicitly in the conversion formula).</p> <p>In the case of a development phase without a fixed conversion formula, a pre-specification can occur through swIntendedResolution.</p> <p>The resolution is specified in the physical domain according to the property "unit".</p> <p>Tags:xml.sequenceOffset=240</p>
swInterpolation Method	Identifier	0..1	attr	<p>This is a keyword identifying the mathematical method to be applied for interpolation. The keyword needs to be related to the interpolation routine which needs to be invoked.</p> <p>Tags:xml.sequenceOffset=250</p>





Class	<<atpVariation>> SwDataDefProps			
swIsVirtual	Boolean	0..1	attr	<p>This element distinguishes virtual objects. Virtual objects do not appear in the memory, their derivation is much more dependent on other objects and hence they shall have a swDataDependency .</p> <p>Tags:xml.sequenceOffset=260</p>
swPointerTarget Props	SwPointerTargetProps	0..1	aggr	<p>Specifies that the containing data object is a pointer to another data object.</p> <p>Tags:xml.sequenceOffset=280</p>
swRecord Layout	SwRecordLayout	0..1	ref	<p>Record layout for this data object.</p> <p>Tags:xml.sequenceOffset=290</p>
swRefresh Timing	MultidimensionalTime	0..1	aggr	<p>This element specifies the frequency in which the object involved shall be or is called or calculated. This timing can be collected from the task in which write access processes to the variable run. But this cannot be done by the MCD system.</p> <p>So this attribute can be used in an early phase to express the desired refresh timing and later on to specify the real refresh timing.</p> <p>Tags:xml.sequenceOffset=300</p>
swTextProps	SwTextProps	0..1	aggr	<p>the specific properties if the data object is a text object.</p> <p>Tags:xml.sequenceOffset=120</p>
swValueBlock Size	Numerical	0..1	attr	<p>This represents the size of a Value Block</p> <p>Stereotypes: atpVariation</p> <p>Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=80</p>
swValueBlock SizeMult (ordered)	Numerical	*	attr	<p>This attribute is used to specify the dimensions of a value block (VAL_BLK) for the case that that value block has more than one dimension.</p> <p>The dimensions given in this attribute are ordered such that the first entry represents the first dimension, the second entry represents the second dimension, and so on.</p> <p>For one-dimensional value blocks the attribute swValueBlockSize shall be used and this attribute shall not exist.</p> <p>Stereotypes: atpVariation</p> <p>Tags:vh.latestBindingTime=preCompileTime</p>
unit	Unit	0..1	ref	<p>Physical unit associated with the semantics of this data object. This attribute applies if no compuMethod is specified. If both units (this as well as via compuMethod) are specified the units shall be compatible.</p> <p>Tags:xml.sequenceOffset=350</p>
valueAxisData Type	ApplicationPrimitive DataType	0..1	ref	<p>The referenced ApplicationPrimitiveDataType represents the primitive data type of the value axis within a compound primitive (e.g. curve, map). It supersedes CompuMethod, Unit, and BaseType.</p> <p>Tags:xml.sequenceOffset=355</p>

Table D.266: SwDataDefProps

Enumeration	SwImplPolicyEnum
Package	M2::MSR::DataDictionary::DataDefProperties
Note	Specifies the implementation strategy with respect to consistency mechanisms of variables.
Literal	Description
const	forced implementation such that the running software within the ECU shall not modify it. For example implemented with the "const" modifier in C. This can be applied for parameters (not for those in NVRAM) as well as argument data prototypes. Tags: atp.EnumerationLiteralIndex=0
fixed	This data element is fixed. In particular this indicates, that it might also be implemented e.g. as in place data, (#DEFINE). Tags: atp.EnumerationLiteralIndex=1
measurementPoint	The data element is created for measurement purposes only. The data element is never read directly within the ECU software. In contrast to a "standard" data element in an unconnected provide port is, this unconnection is guaranteed for measurementPoint data elements. Tags: atp.EnumerationLiteralIndex=2
queued	The content of the data element is queued and the data element has 'event' semantics, i.e. data elements are stored in a queue and all data elements are processed in 'first in first out' order. The queuing is intended to be implemented by RTE Generator. This value is not applicable for parameters. Tags: atp.EnumerationLiteralIndex=3
standard	This is applicable for all kinds of data elements. For variable data prototypes the 'last is best' semantics applies. For parameter there is no specific implementation directive. Tags: atp.EnumerationLiteralIndex=4

Table D.267: SwImplPolicyEnum

Class	SwPointerTargetProps			
Package	M2::MSR::DataDictionary::DataDefProperties			
Note	<p>This element defines, that the data object (which is specified by the aggregating element) contains a reference to another data object or to a function in the CPU code. This corresponds to a pointer in the C-language.</p> <p>The attributes of this element describe the category and the detailed properties of the target which is either a data description or a function signature.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
functionPointerSignature	BswModuleEntry	0..1	ref	<p>The referenced BswModuleEntry serves as the signature of a function pointer definition. Primary use case: function pointer passed as argument to other function.</p> <p>Tags:xml.sequenceOffset=40</p>
swDataDefProps	SwDataDefProps	0..1	aggr	<p>The properties of the target data type.</p> <p>Tags:xml.sequenceOffset=30</p>
targetCategory	Identifier	0..1	attr	<p>This specifies the category of the target:</p> <ul style="list-style-type: none"> In case of a data pointer, it shall specify the category of the referenced data. In case of a function pointer, it could be used to denote the category of the referenced BswModuleEntry. Since currently no categories for BswModuleEntry are defined it will be empty. <p>Tags:xml.sequenceOffset=5</p>

Table D.268: SwPointerTargetProps

Class	SwRecordLayout			
Package	M2::MSR::DataDictionary::RecordLayout			
Note	<p>Defines how the data objects (variables, calibration parameters etc.) are to be stored in the ECU memory. As an example, this definition specifies the sequence of axis points in the ECU memory. Iterations through axis values are stored within the sub-elements swRecordLayoutGroup.</p> <p>Tags:atp.recommendedPackage=SwRecordLayouts</p>			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
swRecordLayoutGroup	SwRecordLayoutGroup	0..1	aggr	<p>This is the top level record layout group.</p> <p>Tags: xml.roleElement=true xml.roleWrapperElement=false xml.sequenceOffset=20 xml.typeElement=false xml.typeWrapperElement=false</p>

Table D.269: SwRecordLayout

Class	SwServiceArg			
Package	M2::MSR::DataDictionary::ServiceProcessTask			
Note	<p>Specifies the properties of a data object exchanged during the call of an SwService, e.g. an argument or a return value.</p> <p>The SwServiceArg can also be used in the argument list of a C-macro. For this purpose the category shall be set to "MACRO". A reference to implementationDataType can optional be added if the actual argument has an implementationDataType.</p>			
Base	ARObject, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
direction	ArgumentDirectionEnum	0..1	attr	<p>Specifies the direction of the data transfer. The direction shall indicate the direction of the actual information that is being consumed by the caller and/or the callee, not the direction of formal arguments in C.</p> <p>The attribute is optional for backwards compatibility reasons. For example, if a pointer is used to pass a memory address for the expected result, the direction shall be "out". If a pointer is used to pass a memory address with content to be read by the callee, its direction shall be "in".</p> <p>Tags:xml.sequenceOffset=10</p>
swArraysizes	ValueList	0..1	aggr	<p>This turns the argument of the service to an array.</p> <p>Tags:xml.sequenceOffset=20</p>
swDataDefProps	SwDataDefProps	0..1	aggr	<p>Data properties of this SwServiceArg.</p> <p>Tags:xml.sequenceOffset=30</p>

Table D.270: SwServiceArg

Class	SwSystemconst			
Package	M2::MSR::DataDictionary::SystemConstant			





Class	SwSystemconst			
Note	<p>This element defines a system constant which serves an input to select a particular variation point. In particular a system constant serves as an operand of the binding function (swSyscond) in a Variation point.</p> <p>Note that the binding process can only happen if a value was assigned to to the referenced system constants.</p> <p>Tags:atp.recommendedPackage=SwSystemconsts</p>			
Base	ARElement, ARObject, AtpDefinition, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
swDataDef Props	SwDataDefProps	0..1	aggr	<p>This denotes the data definition properties of the system constant. This supports to express the limits and optionally a conversion within the internal to physical values by a compu method.</p> <p>Tags:xml.sequenceOffset=40</p>

Table D.271: SwSystemconst

Class	<<atpMixedString>> SwSystemconstDependentFormula (abstract)			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class represents an expression depending on system constants.			
Base	ARObject, FormulaExpression			
Subclasses	AttributeValueVariationPoint , BlueprintFormula, ConditionByFormula , FMFormulaByFeaturesAndSwSystemconsts			
Attribute	Type	Mult.	Kind	Note
sysc	SwSystemconst	1	ref	<p>This refers to a system constant. The internal (coded) value of the system constant shall be used.</p> <p>Tags:xml.sequenceOffset=50</p>
syscString	SwSystemconst	1	ref	<p>syscString indicates that the referenced system constant shall be evaluated as a string according to [TPS_SWCT_01431].</p>

Table D.272: SwSystemconstDependentFormula

Class	SwSystemconstValue			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class assigns a particular value to a system constant.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
annotation	Annotation	*	aggr	<p>This provides the ability to add information why the value is set like it is.</p> <p>Tags:xml.sequenceOffset=30</p>
swSystemconst	SwSystemconst	1	ref	<p>This is the system constant to which the value applies.</p> <p>Tags:xml.sequenceOffset=10</p>
value	Numerical	1	attr	<p>This is the particular value of a system constant. It is specified as Numerical. Further restrictions may apply by the definition of the system constant.</p> <p>The value attribute defines the internal value of the Sw Systemconst as it is processed in the Formula Language.</p>





Class	SwSystemconstValue			
				<div>△</div> Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=20

Table D.273: SwSystemconstValue

Class	SwSystemconstantValueSet			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class represents the ability to specify a set of system constant values. Tags: atp.recommendedPackage=SwSystemconstantValueSets			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
sw Systemconstant Value	SwSystemconstValue	*	aggr	This is one particular value of a system constant.

Table D.274: SwSystemconstantValueSet

Class	<<atpMixed>> SwValues			
Package	M2::MSR::CalibrationData::CalibrationValue			
Note	This meta-class represents a list of values. These values can either be the input values of a curve (abscissa values) or the associated values (ordinate values). In case of multidimensional structures, the values are ordered such that the lowest index runs the fastest. In particular for maps and cuboids etc. the resulting long value list can be subsectioned using Value Group. But the processing needs to be done as if vg is not there. Note that numerical values and textual values should not be mixed.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
v	Numerical	0..1	attr	This is a non variant Value. It is provided for sake of Compatibility to ASAM CDF. Tags: xml.sequenceOffset=40
vf	Numerical	0..1	attr	This allows to specify the value as VariationPoint. It is distinguished to non variant for sake of compatibility to ASAM CDF 2.0. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=20
vg	ValueGroup	0..1	aggr	This allows to have intersections in the values in order to support specific rendering (eg. using stylesheets). For tools it is important that the v values are always processed in the same (flattened) order and the tool is able to interpret it without respecting vg. Tags: xml.sequenceOffset=50





Class	<<atpMixed>> SwValues			
vt	VerbatimString	0..1	attr	<p>This represents the values of textual data elements (Strings). Note that vt uses the to separate the values for the different bitfield masks in case that the semantics of the related DataPrototype is described by means of a BITFIELD_TEXTTABLE in the associated CompuMethod.</p> <p>Tags:xml.sequenceOffset=30</p>
vtf	NumericalOrText	0..1	aggr	<p>Thias aggregation represents the ability to provide a value that is either numerical or text which existence is subject to variability.</p> <p>From the formal point of view, the aggregation needs to have the multiplicity 1 because SwValues is modelled with stereotype <<atpMixed>>. Nevertheless, the existence of vtf is optional and subject to constraints.</p> <p>Stereotypes: atpVariation Tags:vh.latestBindingTime=preCompileTime</p>

Table D.275: SwValues

Class	SwcBswMapping			
Package	M2::AUTOSARTemplates::CommonStructure::SwcBswMapping			
Note	<p>Maps an SwcInternalBehavior to an BswInternalBehavior. This is required to coordinate the API generation and the scheduling for AUTOSAR Service Components, ECU Abstraction Components and Complex Driver Components by the RTE and the BSW scheduling mechanisms.</p> <p>Tags:atp.recommendedPackage=SwcBswMappings</p>			
Base	ARElement, ARObject, AtpClassifier, AtpFeature, AtpStructureElement, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
bswBehavior	BswInternalBehavior	0..1	ref	The mapped BswInternalBehavior
runnable Mapping	SwcBswRunnableMapping	*	aggr	<p>A mapping between a pair of SWC and BSW runnables.</p> <p>Stereotypes: atpVariation Tags:vh.latestBindingTime=preCompileTime</p>
swcBehavior	SwcInternalBehavior	0..1	ref	The mapped SwcInternalBehavior.
synchronized ModeGroup	SwcBswSynchronized ModeGroupPrototype	*	aggr	<p>A pair of SWC and BSW mode group prototypes to be synchronized by the scheduler.</p> <p>Stereotypes: atpVariation Tags:vh.latestBindingTime=preCompileTime</p>
synchronized Trigger	SwcBswSynchronized Trigger	*	aggr	<p>A pair of SWC and BSW Triggers to be synchronized by the scheduler.</p> <p>Stereotypes: atpVariation Tags:vh.latestBindingTime=preCompileTime</p>

Table D.276: SwcBswMapping

Class	SwcBswRunnableMapping			
Package	M2::AUTOSARTemplates::CommonStructure::SwcBswMapping			
Note	<p>Maps a BswModuleEntity to a RunnableEntity if it is implemented as part of a BSW module (in the case of an AUTOSAR Service, a Complex Driver or an ECU Abstraction). The mapping can be used by a tool to find relevant information on the behavior, e.g. whether the bswEntity shall be running in interrupt context.</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note





Class	SwcBswRunnableMapping			
bswEntity	BswModuleEntity	1	ref	The mapped BswModuleEntity
swcRunnable	RunnableEntity	1	ref	The mapped SWC runnable.

Table D.277: SwcBswRunnableMapping

Class	SwcBswSynchronizedTrigger			
Package	M2::AUTOSARTemplates::CommonStructure::SwcBswMapping			
Note	Synchronizes a Trigger provided by a component via a port with a Trigger provided by a BSW module or cluster.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
bswTrigger	Trigger	1	ref	The BSW Trigger.
swcTrigger	Trigger	1	iref	The SWC Trigger provided by a particular port. InstanceRef implemented by: PTriggerInAtomicSwcType InstanceRef

Table D.278: SwcBswSynchronizedTrigger

Class	SwcExclusiveAreaPolicy			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior			
Note	Options how to generate the ExclusiveArea related APIs. If no SwcExclusiveAreaPolicy is specified for an ExclusiveArea the default values apply.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
apiPrinciple	ApiPrincipleEnum	0..1	attr	Specifies for this ExclusiveArea if either one common set of Enter and Exit APIs for the whole software component is requested from the Rte or if the set of Enter and Exit APIs is expected per RunnableEntity. The default value is "common".
exclusiveArea	ExclusiveArea	0..1	ref	This reference represents the ExclusiveArea for which the policy applies.

Table D.279: SwcExclusiveAreaPolicy

Class	SwcImplementation			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcImplementation			
Note	This meta-class represents a specialization of the general Implementation meta-class with respect to the usage in application software. Tags: atp.recommendedPackage=SwcImplementations			
Base	ARElement, ARObject, CollectableElement, Identifiable , Implementation , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
behavior	SwcInternalBehavior	0..1	ref	The internal behavior implemented by this Implementation.
perInstanceMemorySize	PerInstanceMemorySize	*	aggr	Allows a definition of the size of the per-instance memory for this implementation. The aggregation of PerInstanceMemorySize is subject to variability with the purpose to support variability in the software components implementations. Typically different algorithms in the





Class	SwcImplementation			
				<p>implementation are requiring different number of memory objects, in this case PerInstanceMemory.</p> <p>Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime</p>
required RTEVendor	String	0..1	attr	<p>Identify a specific RTE vendor. This information is potentially important at the time of integrating (in particular: linking) the application code with the RTE. The semantics is that (if the association exists) the corresponding code has been created to fit to the vendor-mode RTE provided by this specific vendor. Attempting to integrate the code with another RTE generated in vendor mode is in general not possible.</p>

Table D.280: SwcImplementation

Class	SwcInternalBehavior			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior			
Note	The SwcInternalBehavior of an AtomicSwComponentType describes the relevant aspects of the software-component with respect to the RTE, i.e. the RunnableEntities and the RTEEvents they respond to.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , InternalBehavior , Multilanguage , Referrable , Referrable			
Attribute	Type	Mult.	Kind	Note
arTypedPer Instance Memory	VariableDataPrototype	*	aggr	<p>Defines an AUTOSAR typed memory-block that needs to be available for each instance of the SW-component.</p> <p>This is typically only useful if supportsMultipleInstantiation is set to "true" or if the component defines NVRAM access via permanent blocks.</p> <p>The aggregation of arTypedPerInstanceMemory is subject to variability with the purpose to support variability in the software component's implementations. Typically different algorithms in the implementation are requiring different number of memory objects.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=arTypedPerInstanceMemory.shortName, arTypedPerInstanceMemory.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
event	RTEEvent	*	aggr	<p>This is a RTEEvent specified for the particular Swc InternalBehavior.</p> <p>The aggregation of RTEEvent is subject to variability with the purpose to support the conditional existence of RTE events. Note: the number of RTE events might vary due to the conditional existence of PortPrototypes using Data ReceivedEvents or due to different scheduling needs of algorithms.</p> <p>Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=event.shortName, event.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>





Class	SwcInternalBehavior			
exclusiveArea Policy	SwcExclusiveArea Policy	*	aggr	Options how to generate the ExclusiveArea related APIs. When no SwcExclusiveAreaPolicy is specified for an ExclusiveArea the default values apply. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=exclusiveAreaPolicy, exclusiveAreaPolicy.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
explicitInter Runnable Variable	VariableDataPrototype	*	aggr	Implement state message semantics for establishing communication among runnables of the same component. The aggregation of explicitInterRunnableVariable is subject to variability with the purpose to support variability in the software components implementations. Typically different algorithms in the implementation are requiring different number of memory objects. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=explicitInterRunnableVariable.shortName, explicitInterRunnableVariable.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
handle TerminationAnd Restart	HandleTerminationAnd RestartEnum	0..1	attr	This attribute controls the behavior with respect to stopping and restarting. The corresponding AtomicSw ComponentType may either not support stop and restart, or support only stop, or support both stop and restart.
implicitInter Runnable Variable	VariableDataPrototype	*	aggr	Implement state message semantics for establishing communication among runnables of the same component. The aggregation of implicitInterRunnableVariable is subject to variability with the purpose to support variability in the software components implementations. Typically different algorithms in the implementation are requiring different number of memory objects. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=implicitInterRunnableVariable.shortName, implicitInterRunnableVariable.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
includedData TypeSet	IncludedDataTypeSet	*	aggr	The includedDataTypeSet is used by a software component for its implementation. Stereotypes: atpSplitable Tags: atp.Splitkey=includedDataTypeSet
includedMode Declaration GroupSet	IncludedMode DeclarationGroupSet	*	aggr	This aggregation represents the included Mode DeclarationGroups Stereotypes: atpSplitable Tags: atp.Splitkey=includedModeDeclarationGroupSet
instantiation DataDefProps	InstantiationDataDef Props	*	aggr	The purpose of this is that within the context of a given SwComponentType some data def properties of individual instantiations can be modified. The aggregation of InstantiationDataDefProps is subject to variability with the purpose to support the conditional existence of Port Prototypes and component local memories like "per InstanceParameter" or "arTypedPerInstanceMemory".





Class	SwcInternalBehavior			
				<div>△</div> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=instantiationDataDefProps, instantiationDataDefProps.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
perInstanceMemory	PerInstanceMemory	*	aggr	<p>Defines a per-instance memory object needed by this software component. The aggregation of PerInstanceMemory is subject to variability with the purpose to support variability in the software components implementations. Typically different algorithms in the implementation are requiring different number of memory objects.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=perInstanceMemory.shortName, perInstanceMemory.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
perInstanceParameter	ParameterDataPrototype	*	aggr	<p>Defines parameter(s) or characteristic value(s) that needs to be available for each instance of the software-component. This is typically only useful if supportsMultipleInstantiation is set to "true". The aggregation of perInstanceParameter is subject to variability with the purpose to support variability in the software components implementations. Typically different algorithms in the implementation are requiring different number of memory objects.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=perInstanceParameter.shortName, perInstanceParameter.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
portAPIOption	PortAPIOption	*	aggr	<p>Options for generating the signature of port-related calls from a runnable to the RTE and vice versa. The aggregation of PortPrototypes is subject to variability with the purpose to support the conditional existence of ports.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=portAPIOption, portAPIOption.variationPoint.shortLabel vh.latestBindingTime=preCompileTime
runnable	RunnableEntity	*	aggr	<p>This is a RunnableEntity specified for the particular SwcInternalBehavior.</p> <p>The aggregation of RunnableEntity is subject to variability with the purpose to support the conditional existence of RunnableEntities. Note: the number of RunnableEntities might vary due to the conditional existence of Port Prototypes using DataReceivedEvents or due to different scheduling needs of algorithms.</p> Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=runnable.shortName, runnable.variationPoint.shortLabel vh.latestBindingTime=preCompileTime





Class	SwcInternalBehavior			
service Dependency	SwcService Dependency	*	aggr	<p>Defines the requirements on AUTOSAR Services for a particular item.</p> <p>The aggregation of SwcServiceDependency is subject to variability with the purpose to support the conditional existence of ports as well as the conditional existence of ServiceNeeds.</p> <p>The SwcServiceDependency owned by an SwcInternal Behavior can be located in a different physical file in order to support that SwcServiceDependency might be provided in later development steps or even by different expert domain (e.g OBD expert for Obd related Service Needs) tools. Therefore the aggregation is <<atp Splitable>>.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=serviceDependency.shortName, service Dependency.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
shared Parameter	ParameterData Prototype	*	aggr	<p>Defines parameter(s) or characteristic value(s) shared between SwComponentPrototypes of the same Sw ComponentType The aggregation of sharedParameter is subject to variability with the purpose to support variability in the software components implementations. Typically different algorithms in the implementation are requiring different number of memory objects.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=sharedParameter.shortName, shared Parameter.variationPoint.shortLabel vh.latestBindingTime=preCompileTime</p>
supports Multiple Instantiation	Boolean	0..1	attr	<p>Indicate whether the corresponding software-component can be multiply instantiated on one ECU. In this case the attribute will result in an appropriate component API on programming language level (with or without instance handle).</p>
variationPoint Proxy	VariationPointProxy	*	aggr	<p>Proxy of a variation points in the C/C++ implementation.</p> <p>Stereotypes: atpSplitable</p> <p>Tags:atp.Splitkey=variationPointProxy.shortName</p>

Table D.281: SwcInternalBehavior

Class	SwcModeManagerErrorEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This represents the ability to react on errors occurring during mode handling.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable , RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
modeGroup	ModeDeclarationGroup Prototype	0..1	iref	<p>This represents the ModeDeclarationGroupPrototype for which the error behavior of the mode manager applies.</p> <p>InstanceRef implemented by:PModeGroupInAtomic SwcInstanceRef</p>

Table D.282: SwcModeManagerErrorEvent

Class	SwcModeSwitchEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This event is raised upon a received mode change.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , Multilanguage Referrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
activation	ModeActivationKind	0..1	attr	Specifies if the event is activated on entering or exiting the referenced Mode.
mode (ordered)	ModeDeclaration	0..2	iref	Reference to one or two Modes that initiate the SwcModeSwitchEvent. InstanceRef implemented by: RModelnAtomicSwc InstanceRef

Table D.283: SwcModeSwitchEvent

Class	SwcServiceDependency			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ServiceMapping			
Note	Specialization of ServiceDependency in the context of an SwcInternalBehavior. It allows to associate ports, port groups and (in special cases) data defined for an atomic software component to a given ServiceNeeds element.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable , ServiceDependency			
Attribute	Type	Mult.	Kind	Note
assignedData	RoleBasedData Assignment	*	aggr	Defines the role of an associated data object of the same component. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
assignedPort	RoleBasedPort Assignment	*	aggr	Defines the role of an associated port of the same component. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=assignedPort, assignedPort.variation Point.shortLabel vh.latestBindingTime=preCompileTime
representedPort Group	PortGroup	0..1	ref	This reference specifies an association between the ServiceNeeds and a PortGroup, for example to request a communication mode which applies for communication via these ports. The referred PortGroup shall be local to this atomic SWC, but via the links between the Port Groups, a tool can evaluate this information such that all the ports linked via this port group on the same ECU can be found.
serviceNeeds	ServiceNeeds	0..1	aggr	The associated ServiceNeeds.

Table D.284: SwcServiceDependency

Class	SymbolProps			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	This meta-class represents the ability to attach with the symbol attribute a symbolic name that is conform to C language requirements to another meta-class, e.g. AtomicSwComponentType, that is a potential subject to a name clash on the level of RTE source code.			
Base	ARObject, ImplementationProps , Referrable			
Attribute	Type	Mult.	Kind	Note





Class	SymbolProps			
–	–	–	–	–

Table D.285: SymbolProps

Class	SynchronousServerCallPoint			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::ServerCall			
Note	This means that the RunnableEntity is supposed to perform a blocking wait for a response from the server.			
Base	ARObject, AbstractAccessPoint , AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable , ServerCallPoint			
Attribute	Type	Mult.	Kind	Note
calledFrom WithinExclusive Area	ExclusiveAreaNesting Order	0..1	ref	This indicates that the call point is located at the deepest level inside one or more ExclusiveAreas that are nested in the given order.

Table D.286: SynchronousServerCallPoint

Class	System			
Package	M2::AUTOSARTemplates::SystemTemplate			
Note	<p>The top level element of the System Description. The System description defines five major elements: Topology, Software, Communication, Mapping and Mapping Constraints.</p> <p>The System element directly aggregates the elements describing the Software, Mapping and Mapping Constraints; it contains a reference to an ASAM FIBEX description specifying Communication and Topology.</p> <p>Tags:atp.recommendedPackage=Systems</p>			
Base	ARElement, ARObject, AtpClassifier, AtpFeature, AtpStructureElement, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
clientId DefinitionSet	ClientIdDefinitionSet	*	ref	Set of Client Identifiers that are used for inter-ECU client-server communication in the System.
containerIPdu HeaderByte Order	ByteOrderEnum	0..1	attr	Defines the byteOrder of the header in ContainerIPdus.
ecuExtract Version	RevisionLabelString	0..1	attr	Version number of the Ecu Extract.
fibexElement	FibexElement	*	ref	<p>Reference to ASAM FIBEX elements specifying Communication and Topology.</p> <p>All Fibex Elements used within a System Description shall be referenced from the System Element.</p> <p>atpVariation: In order to describe a product-line, all Fibex Elements can be optional.</p> <p>Stereotypes: atpVariation</p> <p>Tags:vh.latestBindingTime=postBuild</p>
interpolation Routine MappingSet	InterpolationRoutine MappingSet	*	ref	This reference identifies the InterpolationRoutineMapping Sets that are relevant in the context of the enclosing System.





Class	System			
j1939SharedAddressCluster	J1939SharedAddressCluster	*	aggr	<p>Collection of J1939Clusters that share a common address space for the routing of messages.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=j1939SharedAddressCluster.shortName, j1939SharedAddressCluster.variationPoint.shortLabel vh.latestBindingTime=postBuild</p>
mapping	SystemMapping	*	aggr	<p>Aggregation of all mapping aspects (mapping of SW components to ECUs, mapping of data elements to signals, and mapping constraints).</p> <p>In order to support OEM / Tier 1 interaction and shared development for one common System this aggregation is atpSplitable and atpVariation. The content of System Mapping can be provided by several parties using different names for the SystemMapping.</p> <p>This element is not required when the System description is used for a network-only use-case.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=mapping.shortName, mapping.variationPoint.shortLabel vh.latestBindingTime=postBuild</p>
pncVectorLength	PositiveInteger	0..1	attr	Length of the partial networking request release information vector (in bytes).
pncVectorOffset	PositiveInteger	0..1	attr	Absolute offset (with respect to the NM-PDU) of the partial networking request release information vector that is defined in bytes as an index starting with 0.
rootSoftwareComposition	RootSwCompositionPrototype	0..1	aggr	<p>Aggregation of the root software composition, containing all software components in the System in a hierarchical structure. This element is not required when the System description is used for a network-only use-case.</p> <p>atpVariation: The RootSwCompositionPrototype can vary.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=rootSoftwareComposition.shortName, rootSoftwareComposition.variationPoint.shortLabel vh.latestBindingTime=systemDesignTime</p>
swCluster	CpSoftwareCluster	*	ref	<p>CP Software Clusters of this System</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=swCluster.cpSoftwareCluster, swCluster.variationPoint.shortLabel atp.Status=draft vh.latestBindingTime=systemDesignTime</p>
systemDocumentation	Chapter	*	aggr	<p>Possibility to provide additional documentation while defining the System. The System documentation can be composed of several chapters.</p> <p>Stereotypes: atpSplitable; atpVariation</p> <p>Tags: atp.Splitkey=systemDocumentation.shortName, systemDocumentation.variationPoint.shortLabel vh.latestBindingTime=systemDesignTime xml.sequenceOffset=-10</p>
systemVersion	RevisionLabelString	1	attr	Version number of the System Description.

Table D.287: System

Class	SystemMapping			
Package	M2::AUTOSARTemplates::SystemTemplate			
Note	The system mapping aggregates all mapping aspects (mapping of SW components to ECUs, mapping of data elements to signals, and mapping constraints).			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
applicationPartitionToEcuPartitionMapping	ApplicationPartitionToEcuPartitionMapping	*	aggr	Mapping of ApplicationPartitions to EcuPartitions Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=applicationPartitionToEcuPartitionMapping.shortName, applicationPartitionToEcuPartitionMapping.variationPoint.shortLabel vh.latestBindingTime=postBuild
comManagementMapping	ComManagementMapping	*	aggr	Mappings between Mode Management PortGroups and communication channels. Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime
cryptoServiceMapping	CryptoServiceMapping	*	aggr	This aggregation represents the collection of crypto service mappings in the context of the enclosing System Mapping. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=cryptoServiceMapping.shortName, cryptoServiceMapping.variationPoint.shortLabel vh.latestBindingTime=postBuild
dataMapping	DataMapping	*	aggr	The data mappings defined. Stereotypes: atpVariation Tags: vh.latestBindingTime=postBuild
ecuResourceMapping	ECUMapping	*	aggr	Mapping of hardware related topology elements onto their counterpart definitions in the ECU Resource Template. atpVariation: The ECU Resource type might be variable. Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime
j1939ControllerApplicationToJ1939NmNodeMapping	J1939ControllerApplicationToJ1939NmNodeMapping	*	aggr	Mapping of a J1939ControllerApplication to a J1939NmNode.
mappingConstraint	MappingConstraint	*	aggr	Constraints that limit the mapping freedom for the mapping of SW components to ECUs. Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime
pncMapping	PncMapping	*	aggr	Mappings between Virtual Function Clusters and Partial Network Clusters. Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime
portElementToComResourceMapping	PortElementToCommunicationResourceMapping	*	aggr	maps a communication resource to CP Software Clusters Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=portElementToComResourceMapping.shortName, portElementToComResourceMapping.variationPoint.shortLabel atp.Status=draft vh.latestBindingTime=postBuild





Class	SystemMapping			
resource Estimation	EcuResourceEstimation	*	aggr	Resource estimations for this set of mappings, zero or one per ECU instance. atpVariation: Used ECUs are variable. Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime
resourceTo Application Partition Mapping	CpSoftwareCluster ResourceToApplication PartitionMapping	*	aggr	Maps a Software Cluster resource to an Application Partition to restrict the usage. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=resourceToApplicationPartition Mapping.shortName, resourceToApplicationPartition Mapping.variationPoint.shortLabel atp.Status=draft vh.latestBindingTime=systemDesignTime
signalPath Constraint	SignalPathConstraint	*	aggr	Constraints that limit the mapping freedom for the mapping of data elements to signals. Stereotypes: atpVariation Tags: vh.latestBindingTime=systemDesignTime
softwareCluster ToResource Mapping	CpSoftwareClusterTo ResourceMapping	*	aggr	maps a service resource to CP Software Clusters Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=softwareClusterToResourceMapping.short Name, softwareClusterToResourceMapping.variation Point.shortLabel atp.Status=draft vh.latestBindingTime=preCompileTime
swCluster Mapping	CpSoftwareClusterTo EcuInstanceMapping	*	aggr	The mappings of SW cluster to ECUs. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=swClusterMapping.shortName, swCluster Mapping.variationPoint.shortLabel atp.Status=draft vh.latestBindingTime=systemDesignTime
swcTo Application Partition Mapping	SwcToApplication PartitionMapping	*	aggr	Allows to map a given SwComponentPrototype to a formally defined partition at a point in time when the corresponding EcuInstance is not yet known or defined. Stereotypes: atpSplitable; atpVariation Tags: atp.Splitkey=swcToApplicationPartitionMapping.short Name, swcToApplicationPartitionMapping.variation Point.shortLabel vh.latestBindingTime=postBuild
swImplMapping	SwcToImplMapping	*	aggr	The mappings of AtomicSoftwareComponent Instances to Implementations. atpVariation: Derived, because SwcToEcuMapping is variable. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
swMapping	SwcToEcuMapping	*	aggr	The mappings of SW components to ECUs. atpVariation: SWC shall be mapped to other ECUs. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime

Table D.288: SystemMapping

Class	SystemSignal			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreCommunication			
Note	<p>The system signal represents the communication system's view of data exchanged between SW components which reside on different ECUs. The system signals allow to represent this communication in a flattened structure, with exactly one system signal defined for each data element prototype sent and received by connected SW component instances.</p> <p>Tags:atp.recommendedPackage=SystemSignals</p>			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
dynamicLength	Boolean	1	attr	The length of dynamic length signals is variable in run-time. Only a maximum length of such a signal is specified in the configuration (attribute length in ISignal element).
physicalProps	SwDataDefProps	0..1	aggr	Specification of the physical representation.

Table D.289: SystemSignal

Class	SystemSignalGroup			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreCommunication			
Note	<p>A signal group refers to a set of signals that shall always be kept together. A signal group is used to guarantee the atomic transfer of AUTOSAR composite data types.</p> <p>The SystemSignalGroup defines a signal grouping on VFB level. On cluster level the Signal grouping is described by the ISignalGroup element.</p> <p>Tags:atp.recommendedPackage=SystemSignalGroups</p>			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
systemSignal	SystemSignal	*	ref	Reference to a set of SystemSignals that shall always be kept together.
transforming SystemSignal	SystemSignal	0..1	ref	Optional reference to the SystemSignal which shall contain the transformed (linear) data.

Table D.290: SystemSignalGroup

Class	TextTableMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	Defines the mapping of two DataPrototypes typed by AutosarDataTypes that refer to CompuMethods of category TEXTTABLE, SCALE_LINEAR_AND_TEXTTABLE or BITFIELD_TEXTTABLE.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
bitfieldTextTableMaskFirst	PositiveInteger	0..1	attr	<p>This attribute can be used to support the mapping of bit field to bit field, boolean values to bit fields, and vice versa. The attribute defines the bit mask for the first element of the TextTableMapping.</p> <p>Stereotypes: atpVariation Tags:vh.latestBindingTime=preCompileTime</p>





Class	TextTableMapping			
bitfieldTextTableMaskSecond	PositiveInteger	0..1	attr	This attribute can be used to support the mapping of bit field to bit field, boolean values to bit fields, and vice versa. The attribute defines the bit mask for the second element of the TextTableMapping. Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime
identicalMapping	Boolean	0..1	attr	If identicalMapping is set == true the values of the two referenced DataPrototypes do not need any conversion of the values.
mappingDirection	MappingDirectionEnum	0..1	attr	Specifies the conversion direction for which the TextTableMapping is applicable.
valuePair	TextTableValuePair	*	aggr	Defines a pair of values which are translated into each other.

Table D.291: TextTableMapping

Class	TextValueSpecification			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	The purpose of TextValueSpecification is to define the labels that correspond to enumeration values.			
Base	ARObject, ValueSpecification			
Attribute	Type	Mult.	Kind	Note
value	VerbatimString	0..1	attr	This is the value itself. Note that vt uses the operator to separate the values for the different bitfield masks in case that the semantics of the related DataPrototype is described by means of a BITFIELD_TEXTTABLE in the associated CompuMethod.

Table D.292: TextValueSpecification

Class	TimingEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	TimingEvent references the RunnableEntity that need to be started in response to the TimingEvent			
Base	ARObject, AbstractEvent , AtpClassifier , AtpFeature , AtpStructureElement , Identifiable , MultilanguageReferrable , RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
offset	TimeValue	0..1	attr	The value makes an assumption about the time offset of the first activation of the RunnableEntity triggered by the mapped TimingEvent relative to the periodic activation of the time base of this TimingEvent. Unit: second.
period	TimeValue	0..1	attr	Period of timing event in seconds. The value of this attribute shall be greater than zero.

Table D.293: TimingEvent

Class	<<atpVariation>> TransformationSignalProps (abstract)			
Package	M2::AUTOSARTemplates::SystemTemplate::Transformer			
Note	TransformationSignalProps holds all the attributes for the different TransformationTechnologies that are ISignal specific. Tags: vh.latestBindingTime=postBuild			
Base	ARObject, Describable			





Class	<<atpVariation>> TransformationISignalProps (abstract)			
Subclasses	EndToEndTransformationISignalProps, SOMEIPTTransformationISignalProps, UserDefinedTransformationISignalProps			
Attribute	Type	Mult.	Kind	Note
csErrorReaction	CSTransformerErrorReactionEnum	0..1	attr	Defines whether the transformer chain of client/server communication coordinates an autonomous error reaction together with the RTE or whether any error reaction is the responsibility of the application.
dataPrototypeTransformationProps	DataPrototypeTransformationProps	*	aggr	Fine granular modeling of TransformationProps on the level of DataPrototypes.
transformer	TransformationTechnology	1	ref	Reference to the TransformationTechnology description that contains transformer specific and ISignal independent configuration properties.

Table D.294: TransformationISignalProps

Class	TransformationTechnology			
Package	M2::AUTOSARTemplates::SystemTemplate::Transformer			
Note	A TransformationTechnology is a transformer inside a transformer chain. Tags: xml.namePlural=TRANSFORMATION-TECHNOLOGIES			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
bufferProperties	BufferProperties	1	aggr	Aggregation of the mandatory BufferProperties.
hasInternalState	Boolean	0..1	attr	This attribute defines whether the Transformer has an internal state or not.
needsOriginalData	Boolean	0..1	attr	Specifies whether this transformer gets access to the SWC's original data.
protocol	String	1	attr	Specifies the protocol that is implemented by this transformer.
transformationDescription	TransformationDescription	0..1	aggr	A transformer can be configured with transformer specific parameters which are represented by the Transformer Description. Stereotypes: atpVariation Tags: vh.latestBindingTime=postBuild
transformerClass	TransformerClassEnum	1	attr	Specifies to which transformer class this transformer belongs.
version	String	1	attr	Version of the implemented protocol.

Table D.295: TransformationTechnology

Enumeration	TransformerClassEnum
Package	M2::AUTOSARTemplates::SystemTemplate::Transformer
Note	Specifies the transformer class of a transformer.
Literal	Description
custom	The transformer is a custom transformer. Tags: atp.EnumerationLiteralIndex=0
safety	The transformer is a safety transformer. Tags: atp.EnumerationLiteralIndex=1





Enumeration	TransformerClassEnum
security	The transformer is a security transformer. Tags: atp.EnumerationLiteralIndex=2
serializer	The transformer is a serializing transformer. Tags: atp.EnumerationLiteralIndex=3

Table D.296: TransformerClassEnum

Class	TransformerHardErrorEvent			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	The event is raised when data are received which should trigger a Client/Server operation or an external trigger but during transformation of the data a hard transformer error occurred.			
Base	ARObject, AbstractEvent, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, RTEEvent , Referrable			
Attribute	Type	Mult.	Kind	Note
operation	ClientServerOperation	0..1	iref	This represents the ClientServerOperation to which the TransformerHardErrorEvent refers to. InstanceRef implemented by: POperationInAtomicSwc InstanceRef
requiredTrigger	Trigger	0..1	iref	Trigger for which the transformer can trigger this TransformerHardErrorEvent InstanceRef implemented by: RTriggerInAtomicSwc InstanceRef

Table D.297: TransformerHardErrorEvent

Class	TransmissionAcknowledgementRequest			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Communication			
Note	Requests transmission acknowledgement that data has been sent successfully. Success/failure is reported via a SendPoint of a RunnableEntity.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
timeout	TimeValue	0..1	attr	Number of seconds before an error is reported or in case of allowed redundancy, the value is sent again.

Table D.298: TransmissionAcknowledgementRequest

Class	Trigger			
Package	M2::AUTOSARTemplates::CommonStructure::TriggerDeclaration			
Note	A trigger which is provided (i.e. released) or required (i.e. used to activate something) in the given context.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
swImplPolicy	SwImplPolicyEnum	0..1	attr	This attribute, when set to value queued, allows for a queued processing of Triggers.
triggerPeriod	MultidimensionalTime	0..1	aggr	Optional definition of a period in case of a periodically (time or angle) driven external trigger.

Table D.299: Trigger

Class	TriggerInterface			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	A trigger interface declares a number of triggers that can be sent by an trigger source. Tags: atp.recommendedPackage=PortInterfaces			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, PortInterface , Referrable			
Attribute	Type	Mult.	Kind	Note
trigger	Trigger	*	aggr	The Trigger of this trigger interface.

Table D.300: TriggerInterface

Class	TriggerInterfaceMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	Defines the mapping of unequal named Triggers in context of two different TriggerInterfaces.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, Identifiable , MultilanguageReferrable, PortInterfaceMapping , Referrable			
Attribute	Type	Mult.	Kind	Note
triggerMapping	TriggerMapping	*	aggr	Mapping of two Trigger in two different TriggerInterface

Table D.301: TriggerInterfaceMapping

Class	TriggerToSignalMapping			
Package	M2::AUTOSARTemplates::SystemTemplate::DataMapping			
Note	This meta-class represents the ability to map a trigger to a SystemSignal of size 0. The Trigger does not transport any other information than its existence, therefore the limitation in terms of signal length.			
Base	ARObject, DataMapping			
Attribute	Type	Mult.	Kind	Note
systemSignal	SystemSignal	1	ref	This is the SystemSignal taken to transport the Trigger over the network. Tags: xml.sequenceOffset=20
trigger	Trigger	1	iref	This represents the Trigger that shall be used to trigger RunnableEntities deployed to a remote ECU. Tags: xml.sequenceOffset=10 InstanceRef implemented by: TriggerInSystemInstanceRef

Table D.302: TriggerToSignalMapping

Class	Unit
Package	M2::MSR::AsamHdo::Units
Note	<p>This is a physical measurement unit. All units that might be defined should stem from SI units. In order to convert one unit into another factor and offset are defined.</p> <p>For the calculation from SI-unit to the defined unit the factor (factorSiToUnit) and the offset (offsetSiToUnit) are applied as follows:</p> $x \{unit\} := y * \{siUnit\} * factorSiToUnit \{unit\} / \{siUnit\} + offsetSiToUnit \{unit\}$ <p>For the calculation from a unit to SI-unit the reciprocal of the factor (factorSiToUnit) and the negation of the offset (offsetSiToUnit) are applied.</p> $y \{siUnit\} := (x * \{unit\} - offsetSiToUnit \{unit\}) / (factorSiToUnit \{unit\} / \{siUnit\})$ <p>Tags:atp.recommendedPackage=Units</p>





Class	Unit			
Base	ARElement, ARObject, CollectableElement, Identifiable , MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mult.	Kind	Note
displayName	SingleLanguageUnitNames	0..1	aggr	This specifies how the unit shall be displayed in documents or in user interfaces of tools. The displayName corresponds to the Unit.Display in an ASAM MCD-2MC file. Tags: xml.sequenceOffset=20
factorSiToUnit	Float	0..1	attr	This is the factor for the conversion from SI Units to units. The inverse is used for conversion from units to SI Units. Tags: xml.sequenceOffset=30
offsetSiToUnit	Float	0..1	attr	This is the offset for the conversion from and to siUnits. Tags: xml.sequenceOffset=40
physicalDimension	PhysicalDimension	0..1	ref	This association represents the physical dimension to which the unit belongs to. Note that only values with units of the same physical dimensions might be converted. Tags: xml.sequenceOffset=50

Table D.303: Unit

Class	<<atpMixed>> ValueList			
Package	M2::MSR::DataDictionary::DataDefProperties			
Note	This is a generic list of numerical values.			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note
v	Numerical	0..1	attr	This is a particular numerical value without variation. Tags: xml.sequenceOffset=30
vf (ordered)	Numerical	*	attr	This is one entry in the list of numerical values Stereotypes: atpVariation Tags: vh.latestBindingTime=preCompileTime xml.roleElement=true xml.roleWrapperElement=false xml.typeElement=false xml.typeWrapperElement=false

Table D.304: ValueList

Class	ValueSpecification (abstract)			
Package	M2::AUTOSARTemplates::CommonStructure::Constants			
Note	Base class for expressions leading to a value which can be used to initialize a data object.			
Base	ARObject			
Subclasses	AbstractRuleBasedValueSpecification , ApplicationValueSpecification , CompositeValueSpecification , ConstantReference , NotAvailableValueSpecification , NumericalValueSpecification , ReferenceValueSpecification , TextValueSpecification			
Attribute	Type	Mult.	Kind	Note
shortLabel	Identifier	0..1	attr	This can be used to identify particular value specifications for human readers, for example elements of a record type.

Table D.305: ValueSpecification

Class	VariableAccess			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::DataElements			
Note	<p>The presence of a VariableAccess implies that a RunnableEntity needs access to a VariableData Prototype.</p> <p>The kind of access is specified by the role in which the class is used.</p>			
Base	ARObject, AbstractAccessPoint , AtpClassifier, AtpFeature, AtpStructureElement, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
accessed Variable	AutosarVariableRef	0..1	aggr	This denotes the accessed variable.
scope	VariableAccessScope Enum	0..1	attr	This attribute allows for constraining the scope of the corresponding communication. For example, it possible to express whether the communication is intended to cross the boundary of an ECU or whether it is intended not to cross the boundary of a single partition.

Table D.306: VariableAccess

Class	VariableAndParameterInterfaceMapping			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	Defines the mapping of VariableDataPrototypes or ParameterDataPrototypes in context of two different SenderReceiverInterfaces, NvDataInterfaces or ParameterInterfaces.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, Identifiable , MultilanguageReferrable, PortInterfaceMapping , Referrable			
Attribute	Type	Mult.	Kind	Note
dataMapping	DataPrototypeMapping	*	aggr	Defines the mapping of two particular VariableData Prototypes or ParameterDataPrototypes with unequal names and/or unequal semantic (resolution or range) in context of two different SenderReceiverInterfaces, Nv DataInterfaces or ParameterInterfaces

Table D.307: VariableAndParameterInterfaceMapping

Class	VariableDataPrototype			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::DataPrototypes			
Note	<p>A VariableDataPrototype is used to contain values in an ECU application. This means that most likely a VariableDataPrototype allocates "static" memory on the ECU. In some cases optimization strategies might lead to a situation where the memory allocation can be avoided.</p> <p>In particular, the value of a VariableDataPrototype is likely to change as the ECU on which it is used executes.</p>			
Base	ARObject, AtpFeature, AtpPrototype, AutosarDataPrototype , DataPrototype , Identifiable , Multilanguage Referrable, Referrable			
Attribute	Type	Mult.	Kind	Note
initValue	ValueSpecification	0..1	aggr	Specifies initial value(s) of the VariableDataPrototype

Table D.308: VariableDataPrototype

Class	VariationPoint			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class represents the ability to express a "structural variation point". The container of the variation point is part of the selected variant if swSyscond evaluates to true and each postBuildVariant Criterion is fulfilled.			
Base	ARObject			





Class	VariationPoint			
Attribute	Type	Mult.	Kind	Note
blueprintCondition	DocumentationBlock	0..1	aggr	This represents a description that documents how the variation point shall be resolved when deriving objects from the blueprint. Note that variationPoints are not allowed within a blueprintCondition. Tags: xml.sequenceOffset=28
desc	MultiLanguageOverviewParagraph	0..1	aggr	This allows to describe shortly the purpose of the variation point. Tags: xml.sequenceOffset=20
formalBlueprintGenerator	BlueprintGenerator	0..1	aggr	This represents a description that documents how the variation point shall be resolved when deriving objects from the blueprint by using ARMQL. Note that variationPoints are not allowed within a formalBlueprintGenerator. Tags: atp.Status=draft xml.sequenceOffset=30
postBuildVariantCondition	PostBuildVariantCondition	*	aggr	This is the set of post build variant conditions which all shall be fulfilled in order to (postbuild) bind the variation point. Tags: xml.sequenceOffset=40
sdg	Sdg	0..1	aggr	An optional special data group is attached to every variation point. These data can be used by external software systems to attach application specific data. For example, a variant management system might add an identifier, an URL or a specific classifier. Tags: xml.sequenceOffset=50
shortLabel	Identifier	0..1	attr	This provides a name to the particular variation point to support the RTE generator. It is necessary for supporting splittable aggregations and if binding time is later than codeGenerationTime, as well as some RTE conditions. It needs to be unique with in the enclosing Identifiables with the same ShortName. Stereotypes: atpIdentityContributor Tags: xml.sequenceOffset=10
swSyscond	ConditionByFormula	0..1	aggr	This condition acts as Binding Function for the Variation Point. Note that the multiplicity is 0..1 in order to support pure postBuild variants. Tags: xml.sequenceOffset=30

Table D.309: VariationPoint

Class	VariationPointProxy			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::VariantHandling			
Note	The VariationPointProxy represents variation points of the C/C++ implementation. In case of bindingTime = compileTime the RTE provides defines which can be used for Pre Processor directives to implement compileTime variability.			
Base	ARObject, Identifiable , MultilanguageReferrable, Referrable			
Attribute	Type	Mult.	Kind	Note
conditionAccess	ConditionByFormula	0..1	aggr	This condition acts as Binding Function for the Variation Point.





Class	VariationPointProxy			
implementationDataType	ImplementationDataType	0..1	ref	This association to ImplementationDataType shall be taken as an implementation hint by the RTE generator.
postBuildValueAccess	PostBuildVariantCriterion	0..1	ref	This represents the applicable PostBuildVariantCriterion in the context of a VariationPointProxy. Note that the technical details how to access the particular postBuildValueAccess are still considered internal to the RTE and are consequently not standardized.
postBuildVariantCondition	PostBuildVariantCondition	*	aggr	This represents that applicable PostBuildVariantCondition in the context of aVariationPointProxy.
valueAccess	AttributeValueVariationPoint	0..1	aggr	This value acts as Binding Function for the VariationPoint.

Table D.310: VariationPointProxy

Class	WaitPoint			
Package	M2::AUTOSARTemplates::SWComponentTemplate::SwcInternalBehavior::RTEEvents			
Note	This defines a wait-point for which the RunnableEntity can wait.			
Base	ARObject, Identifiable , MultilanguageReferrable , Referrable			
Attribute	Type	Mult.	Kind	Note
timeout	TimeValue	0..1	attr	Time in seconds before the WaitPoint times out and the blocking wait call returns with an error indicating the timeout.
trigger	RTEEvent	0..1	ref	This is the RTEEvent this WaitPoint is waiting for.

Table D.311: WaitPoint

Class	<<atpVariation>> SwDataDefProps			
Package	M2::MSR::DataDictionary::DataDefProperties			
Note	<p>This class is a collection of properties relevant for data objects under various aspects. One could consider this class as a "pattern of inheritance by aggregation". The properties can be applied to all objects of all classes in which SwDataDefProps is aggregated.</p> <p>Note that not all of the attributes or associated elements are useful all of the time. Hence, the process definition (e.g. expressed with an OCL or a Document Control Instance MSR-DCI) has the task of implementing limitations.</p> <p>SwDataDefProps covers various aspects:</p> <ul style="list-style-type: none"> Structure of the data element for calibration use cases: is it a single value, a curve, or a map, but also the recordLayouts which specify how such elements are mapped/converted to the Data Types in the programming language (or in AUTOSAR). This is mainly expressed by properties like swRecordLayout and swCalprmAxisSet Implementation aspects, mainly expressed by swImplPolicy, swVariableAccessImplPolicy, swAddrMethod, swPointerTargetProps, baseType, implementationDataType and additionalNativeTypeQualifier Access policy for the MCD system, mainly expressed by swCalibrationAccess Semantics of the data element, mainly expressed by compuMethod and/or unit, dataConstr, invalidValue Code generation policy provided by swRecordLayout <p>Tags:vh.latestBindingTime=codeGenerationTime</p>			
Base	ARObject			
Attribute	Type	Mult.	Kind	Note





Class	<<atpVariation>> SwDataDefProps			
additionalNativeTypeQualifier	NativeDeclarationString	0..1	attr	<p>This attribute is used to declare native qualifiers of the programming language which can neither be deduced from the baseType (e.g. because the data object describes a pointer) nor from other more abstract attributes. Examples are qualifiers like "volatile", "strict" or "enum" of the C-language. All such declarations have to be put into one string.</p> <p>Tags:xml.sequenceOffset=235</p>
annotation	Annotation	*	aggr	<p>This aggregation allows to add annotations (yellow pads ...) related to the current data object.</p> <p>Tags: xml.roleElement=true xml.roleWrapperElement=true xml.sequenceOffset=20 xml.typeElement=false xml.typeWrapperElement=false</p>
baseType	SwBaseType	0..1	ref	<p>Base type associated with the containing data object.</p> <p>Tags:xml.sequenceOffset=50</p>
compuMethod	CompuMethod	0..1	ref	<p>Computation method associated with the semantics of this data object.</p> <p>Tags:xml.sequenceOffset=180</p>
dataConstr	DataConstr	0..1	ref	<p>Data constraint for this data object.</p> <p>Tags:xml.sequenceOffset=190</p>
displayFormat	DisplayFormatString	0..1	attr	<p>This property describes how a number is to be rendered e.g. in documents or in a measurement and calibration system.</p> <p>Tags:xml.sequenceOffset=210</p>
displayPresentation	DisplayPresentationEnum	0..1	attr	<p>This attribute controls the presentation of the related data for measurement and calibration tools.</p>
implementationDataType	AbstractImplementationDataType	0..1	ref	<p>This association denotes the ImplementationDataType of a data declaration via its aggregated SwDataDefProps. It is used whenever a data declaration is not directly referring to a base type. Especially</p> <ul style="list-style-type: none"> • redefinition of an ImplementationDataType via a "typedef" to another ImplementationDatatype • the target type of a pointer (see SwPointerTarget Props), if it does not refer to a base type directly • the data type of an array or record element within an ImplementationDataType, if it does not refer to a base type directly • the data type of an SwServiceArg, if it does not refer to a base type directly <p>Tags:xml.sequenceOffset=215</p>
invalidValue	ValueSpecification	0..1	aggr	<p>Optional value to express invalidity of the actual data element.</p> <p>Tags:xml.sequenceOffset=255</p>
stepSize	Float	0..1	attr	<p>This attribute can be used to define a value which is added to or subtracted from the value of a DataPrototype when using up/down keys while calibrating.</p>





Class	<<atpVariation>> SwDataDefProps			
swAddrMethod	SwAddrMethod	0..1	ref	Addressing method related to this data object. Via an association to the same SwAddrMethod it can be specified that several DataPrototypes shall be located in the same memory without already specifying the memory section itself. Tags: xml.sequenceOffset=30
swAlignment	AlignmentType	0..1	attr	The attribute describes the intended alignment of the DataPrototype. If the attribute is not defined the alignment is determined by the swBaseType size and the memory AllocationKeywordPolicy of the referenced SwAddr Method. Tags: xml.sequenceOffset=33
swBit Representation	SwBitRepresentation	0..1	aggr	Description of the binary representation in case of a bit variable. Tags: xml.sequenceOffset=60
swCalibration Access	SwCalibrationAccess Enum	0..1	attr	Specifies the read or write access by MCD tools for this data object. Tags: xml.sequenceOffset=70
swCalprmAxis Set	SwCalprmAxisSet	0..1	aggr	This specifies the properties of the axes in case of a curve or map etc. This is mainly applicable to calibration parameters. Tags: xml.sequenceOffset=90
swComparison Variable	SwVariableRefProxy	*	aggr	Variables used for comparison in an MCD process. Tags: xml.sequenceOffset=170 xml.typeElement=false
swData Dependency	SwDataDependency	0..1	aggr	Describes how the value of the data object has to be calculated from the value of another data object (by the MCD system). Tags: xml.sequenceOffset=200
swHostVariable	SwVariableRefProxy	0..1	aggr	Contains a reference to a variable which serves as a host-variable for a bit variable. Only applicable to bit objects. Tags: xml.sequenceOffset=220 xml.typeElement=false
swImplPolicy	SwImplPolicyEnum	0..1	attr	Implementation policy for this data object. Tags: xml.sequenceOffset=230
swIntended Resolution	Numerical	0..1	attr	The purpose of this element is to describe the requested quantization of data objects early on in the design process. The resolution ultimately occurs via the conversion formula present (compuMethod), which specifies the transition from the physical world to the standardized world (and vice-versa) (here, "the slope per bit" is present implicitly in the conversion formula). In the case of a development phase without a fixed conversion formula, a pre-specification can occur through swIntendedResolution. The resolution is specified in the physical domain according to the property "unit". Tags: xml.sequenceOffset=240





Class	<<atpVariation>> SwDataDefProps			
swInterpolationMethod	Identifier	0..1	attr	<p>This is a keyword identifying the mathematical method to be applied for interpolation. The keyword needs to be related to the interpolation routine which needs to be invoked.</p> <p>Tags:xml.sequenceOffset=250</p>
swIsVirtual	Boolean	0..1	attr	<p>This element distinguishes virtual objects. Virtual objects do not appear in the memory, their derivation is much more dependent on other objects and hence they shall have a swDataDependency .</p> <p>Tags:xml.sequenceOffset=260</p>
swPointerTargetProps	SwPointerTargetProps	0..1	aggr	<p>Specifies that the containing data object is a pointer to another data object.</p> <p>Tags:xml.sequenceOffset=280</p>
swRecordLayout	SwRecordLayout	0..1	ref	<p>Record layout for this data object.</p> <p>Tags:xml.sequenceOffset=290</p>
swRefreshTiming	MultidimensionalTime	0..1	aggr	<p>This element specifies the frequency in which the object involved shall be or is called or calculated. This timing can be collected from the task in which write access processes to the variable run. But this cannot be done by the MCD system.</p> <p>So this attribute can be used in an early phase to express the desired refresh timing and later on to specify the real refresh timing.</p> <p>Tags:xml.sequenceOffset=300</p>
swTextProps	SwTextProps	0..1	aggr	<p>the specific properties if the data object is a text object.</p> <p>Tags:xml.sequenceOffset=120</p>
swValueBlockSize	Numerical	0..1	attr	<p>This represents the size of a Value Block</p> <p>Stereotypes: atpVariation</p> <p>Tags: vh.latestBindingTime=preCompileTime xml.sequenceOffset=80</p>
swValueBlockSizeMult (ordered)	Numerical	*	attr	<p>This attribute is used to specify the dimensions of a value block (VAL_BLK) for the case that that value block has more than one dimension.</p> <p>The dimensions given in this attribute are ordered such that the first entry represents the first dimension, the second entry represents the second dimension, and so on.</p> <p>For one-dimensional value blocks the attribute swValueBlockSize shall be used and this attribute shall not exist.</p> <p>Stereotypes: atpVariation</p> <p>Tags:vh.latestBindingTime=preCompileTime</p>
unit	Unit	0..1	ref	<p>Physical unit associated with the semantics of this data object. This attribute applies if no compuMethod is specified. If both units (this as well as via compuMethod) are specified the units shall be compatible.</p> <p>Tags:xml.sequenceOffset=350</p>





Class	<<atpVariation>> SwDataDefProps			
valueAxisDataType	ApplicationPrimitiveDataType	0..1	ref	<p>The referenced ApplicationPrimitiveDataType represents the primitive data type of the value axis within a compound primitive (e.g. curve, map). It supersedes CompuMethod, Unit, and BaseType.</p> <p>Tags:xml.sequenceOffset=355</p>

Table D.312: SwDataDefProps

E Referenced ECUC Configuration Parameters

E.1 Com

E.1.1 ComMainFunctionTx

SWS Item	[ECUC_Com_10014]		
Container Name	ComMainFunctionTx		
Parent Container	ComConfig		
Description	Each element of this container defines one instance of Com_MainFunctionTx.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	ComMainTxTimeBase [ECUC_Com_10010]		
Parent Container	ComMainFunctionTx		
Description	<p>The period between successive calls to according instance of Com_MainFunctionTx in seconds. This parameter may be used by the COM generator to transform the values of the reception related timing configuration parameters of the COM module to internal implementation specific counter or tick values. The COM module's internal timing handling is implementation specific.</p> <p>The COM module (generator) may rely on the fact that Com_MainFunctionTx is scheduled according to the value configured here.</p>		
Multiplicity	1		
Type	EcucFloatParamDef		
Range]0 .. INF[
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComPreparationNotification [ECUC_Com_10020]		
Parent Container	ComMainFunctionTx		
Description	<p>This callback function indicates that the signals/signal groups to be sent via a dedicated Com_MainFunctionTx instance will now be prepared for transmission.</p> <p>If this parameter is omitted no notification shall take place.</p>		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComMainTxPartitionRef [ECUC_Com_10019]		
Parent Container	ComMainFunctionTx		
Description	Reference to EcucPartition, where the according Com_MainFunction instance is assigned to.		
Multiplicity	1		
Type	Reference to EcucPartition		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

E.1.2 ComMainFunctionRx

SWS Item	[ECUC_Com_10011]
Container Name	ComMainFunctionRx
Parent Container	ComConfig

Description	Each element of this container defines one instance of Com_MainFunctionRx.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	ComMainRxTimeBase [ECUC_Com_10018]		
Parent Container	ComMainFunctionRx		
Description	<p>The period between successive calls to according instance of Com_MainFunctionRx in seconds. This parameter may be used by the COM generator to transform the values of the reception related timing configuration parameters of the COM module to internal implementation specific counter or tick values. The COM module's internal timing handling is implementation specific.</p> <p>The COM module (generator) may rely on the fact that Com_MainFunctionRx is scheduled according to the value configured here.</p>		
Multiplicity	1		
Type	EcucFloatParamDef		
Range]0 .. INF[
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComMainRxPartitionRef [ECUC_Com_10017]		
Parent Container	ComMainFunctionRx		
Description	Reference to EcucPartition, where the according Com_MainFunction instance is assigned to.		
Multiplicity	1		
Type	Reference to EcucPartition		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

E.1.3 ComGroupSignal

SWS Item	[ECUC_Com_00520]		
Container Name	ComGroupSignal		
Parent Container	ComSignalGroup		
Description	This container contains the configuration parameters of group signals. I.e. signals that are included within a signal group.		
Post-Build Variant Multiplicity	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Configuration Parameters			

Name	ComBitPosition [ECUC_Com_00259]		
Parent Container	ComGroupSignal		
Description	Starting position within the I-PDU. This parameter refers to the position in the I-PDU and not in the shadow buffer. If the endianness conversion is configured to Opaque the parameter ComBitPosition shall define the bit0 of the first byte like in little endian byte order		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value			
Post-Build Variant Value	true		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComBitSize [ECUC_Com_00158]		
Parent Container	ComGroupSignal		
Description	Size in bits, for integer signal types. For ComSignalType UINT8_N and UINT8_DYN the size shall be configured by ComSignalLength. For ComSignalTypes FLOAT32 and FLOAT64 the size is already defined by the signal type and therefore may be omitted.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 64		
Default Value			
Post-Build Variant Multiplicity	true		

Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComHandleId [ECUC_Com_00165]		
Parent Container	ComGroupSignal		
Description	<p>The numerical value used as the ID.</p> <p>This ID identifies signals and signal groups in the COM APIs using Com_SignalIdType or Com_SignalGroupIdType parameter respectively.</p>		
Multiplicity	0..1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65535		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	ComSignalDataInvalidValue [ECUC_Com_00391]		
Parent Container	ComGroupSignal		
Description	<p>Defines the data invalid value of the signal.</p> <p>In case the ComSignalType is UINT8, UINT16, UINT32, UINT64, SINT8, SINT16, SINT32, SINT64 the string shall be interpreted as defined in the chapter Integer Type in the AUTOSAR EcuC specification. In case the ComSignalType is FLOAT32, FLOAT64 the string shall be interpreted as defined in the chapter Float Type in the AUTOSAR EcuC specification. In case the ComSignalType is BOOLEAN the string shall be interpreted as defined in the chapter Boolean Type in the AUTOSAR EcuC specification. In case the ComSignal is a UINT8_N, UINT8_DYN the string shall be interpreted as a decimal representation of the characters separated by blanks, e.g. "97 98 100" means a string "abd", where the char "a" is in byte 0(lowest address), "b" is in byte 1, and "d" is in byte 2 and (highest address). For the ComSignalType UINT8_DYN the dynamic length shall be set to the number of configured characters. An empty string "" shall be interpreted as 0-sized dynamic signal.</p>		
Multiplicity	0..1		
Type	EcucStringParamDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local dependency: In case of UINT8_N the length of ComSignalDataInvalidValue has to be the same as ComSignalLength.		

Name	ComSignalEndianness [ECUC_Com_00157]	
Parent Container	ComGroupSignal	
Description	Defines the endianness of the signal's network representation.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	BIG_ENDIAN	
	LITTLE_ENDIAN	
	OPAQUE	
Post-Build Variant Value	true	

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComSignalInitValue [ECUC_Com_00170]		
Parent Container	ComGroupSignal		
Description	<p>Initial value for this signal. In case of UINT8_N the default value is a string of length ComSignalLength with all bytes set to 0x00. In case of UINT8_DYN the initial size shall be 0.</p> <p>In case the ComSignalType is UINT8, UINT16, UINT32, UINT64, SINT8, SINT16, SINT32, SINT64 the string shall be interpreted as defined in the chapter Integer Type in the AUTOSAR EcuC specification. In case the ComSignalType is FLOAT32, FLOAT64 the string shall be interpreted as defined in the chapter Float Type in the AUTOSAR EcuC specification. In case the ComSignalType is BOOLEAN the string shall be interpreted as defined in the chapter Boolean Type in the AUTOSAR EcuC specification. In case the ComSignal is a UINT8_N, UINT8_DYN the string shall be interpreted as a decimal representation of the characters separated by blanks, e.g. "97 98 100" means a string "abd", where the char "a" is in byte 0(lowest address), "b" is in byte 1, and "d" is in byte 2 and (highest address). For the ComSignalType UINT8_DYN the dynamic length shall be set to the number of configured characters. An empty string "" shall be interpreted as 0-sized dynamic signal.</p>		
Multiplicity	0..1		
Type	EcucStringParamDef		
Default Value	0		
Regular Expression			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local dependency: In case of UINT8_N the length of ComSignalInitValue has to be the same as ComSignalLength.		

Name	ComSignalLength [ECUC_Com_00437]		
Parent Container	ComGroupSignal		
Description	<p>Description: For ComSignalType UINT8_N this parameter specifies the length n in bytes. For ComSignalType UINT8_DYN it specifies the maximum length in bytes. For all other types this parameter shall be ignored.</p> <p>The supported maximum length is restricted by the used transportation system. For non TP-PDUs the maximum size of a PDU, and therefore also of any included signal, is limited by the concrete bus characteristic. For example, the limit is 8 bytes for CAN and LIN, 64 bytes for CAN FD and 254 for FlexRay.</p>		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComSignalType [ECUC_Com_00127]		
Parent Container	ComGroupSignal		
Description	<p>The AUTOSAR type of the signal. Whether or not the signal is signed or unsigned can be found by examining the value of this attribute. This type could also be used to reserved appropriate storage in AUTOSAR COM.</p>		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	BOOLEAN		
	FLOAT32		
	FLOAT64		
	SINT16		
	SINT32		
	SINT64		
	SINT8		
	UINT16		
	UINT32		
	UINT64		
	UINT8		

Post-Build Variant Value	UINT8_DYN	
	UINT8_N false	
Value Configuration Class	Pre-compile time	X VARIANT-PRE-COMPILE
	Link time	X VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–
Scope / Dependency	scope: local	

Name	ComTimeoutSubstitutionValue [ECUC_Com_10006]		
Parent Container	ComGroupSignal		
Description	<p>The signal substitution value will be used in case of a timeout and ComRxDataTimeoutAction is set to SUBSTITUTE. In case of UINT8_N the default value is a string of length ComSignalLength with all bytes set to 0x00.</p> <p>In case of UINT8_DYN the initial size shall be 0.</p> <p>In case the ComSignalType is UINT8, UINT16, UINT32, UINT64, SINT8, SINT16, SINT32, SINT64 the string shall be interpreted as defined in the chapter Integer Type in the AUTOSAR EcuC specification.</p> <p>In case the ComSignalType is FLOAT32, FLOAT64 the string shall be interpreted as defined in the chapter Float Type in the AUTOSAR EcuC specification.</p> <p>In case the ComSignalType is BOOLEAN the string shall be interpreted as defined in the chapter Boolean Type in the AUTOSAR EcuC specification.</p> <p>In case the ComSignal is a UINT8_N, UINT8_DYN the string shall be interpreted as a decimal representation of the characters separated by blanks, e.g. "97 98 100" means a string "abd", where the char "a" is in byte 0 (lowest address), "b" is in byte 1, and "d" is in byte 2 and (highest address). For the ComSignalType UINT8_DYN the dynamic length shall be set to the number of configured characters. An empty string "" shall be interpreted as 0-sized dynamic signal.</p>		
Multiplicity	0..1		
Type	EcucStringParamDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComTransferProperty [ECUC_Com_00560]		
Parent Container	ComGroupSignal		
Description	Optionally defines whether this group signal shall contribute to the TRIGGERED_ON_CHANGE transfer property of the signal group. If at least one group signal of a signal group has the "ComTransferProperty" configured all other group signals of that signal group shall have the attribute configured as well.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	PENDING	A change of the value of this group signal shall not be considered in the evaluation of the signal groups ComTransferProperty.	
	TRIGGERED_ON_CHANGE	A change of the value of this group signal shall be considered in the evaluation of the signal groups ComTransferProperty.	
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComSystemTemplateSystemSignalRef [ECUC_Com_00002]		
Parent Container	ComGroupSignal		
Description	Reference to the ISignalToIPduMapping that contains a reference to the ISignal (System Template) which this ComSignal (or ComGroupSignal) represents.		
Multiplicity	0..1		
Type	Foreign reference to I-SIGNAL-TO-I-PDU-MAPPING		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		

Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: ECU		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
ComFilter	0..1	<p>This container contains the configuration parameters of the AUTOSAR COM module's Filters.</p> <p>Note: On sender side the container is used to specify the transmission mode conditions.</p>

E.1.4 ComIPdu

SWS Item	[ECUC_Com_00340]		
Container Name	ComIPdu		
Parent Container	ComConfig		
Description	Contains the configuration parameters of the AUTOSAR COM module's I-PDUs.		
Post-Build Variant Multiplicity	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Configuration Parameters			

Name	ComIPduCallout [ECUC_Com_00387]
Parent Container	ComIPdu
Description	This parameter defines the existence and the name of a callout function for the corresponding I-PDU. If this parameter is omitted no I-PDU callout shall take place for the corresponding I-PDU.
Multiplicity	0..1
Type	EcucFunctionNameDef
Default Value	
Regular Expression	
Post-Build Variant Multiplicity	false
Post-Build Variant Value	false

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComIPduCancellationSupport [ECUC_Com_00709]		
Parent Container	ComIPdu		
Description	<p>Defines for I-PDUs with ComIPduType NORMAL: If the underlying IF-modul supports cancellation of transmit requests.</p> <p>Defines for I-PDUs with ComIPduType TP: If the underlying TP-module supports RX and TX cancellation of ongoing requests.</p>		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: ECU dependency: This parameter shall not be set to true if ComCancellationSupport is set to false		

Name	ComIPduDirection [ECUC_Com_00493]	
Parent Container	ComIPdu	
Description	The direction defines if this I-PDU, and therefore the contributing signals and signal groups, shall be sent or received.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	RECEIVE	
	SEND	
Post-Build Variant Value	false	

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local dependency: If configured to Sent also a ComTxIpdu container shall be included, see ECUC_Com_00496		

Name	ComIPduHandleId [ECUC_Com_00175]		
Parent Container	ComIPdu		
Description	The numerical value used as the ID of this I-PDU. The ComIPduHandleId is required by the API calls Com_RxIndication, Com_TpRxIndication, Com_StartOfReception and Com_CopyRxData to receive I-PDUs from the PduR (ComIP-duDirection: Receive), as well as the PduId passed to an Rx-I-PDU-callout. For Tx-I-PDUs (ComIPduDirection: Send), this handle Id is used for the APIs calls Com_TxConfirmation, Com_TriggerTransmit, Com_TriggerIPDUSend or Com_TriggerIPDUSendWithMetaData, Com_CopyTxData and Com_TpTxConfirmation to transmit respectively confirm transmissions of I-PDUs, as well as the PduId passed to the Tx-I-PDU-callout configured with ComIPduCallout and/or ComIPduTriggerTransmitCallout.		
Multiplicity	0..1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65535		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	ComIPduSignalProcessing [ECUC_Com_00119]	
Parent Container	ComIPdu	
Description	For the definition of the two modes Immediate and Deferred.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	DEFERRED	signal indication / confirmations are deferred for example to a cyclic task
	IMMEDIATE	the signal indications / confirmations are performed in Com_RxIndication/ Com_TxConfirmation

Post-Build Variant Value	true		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComIPduTriggerTransmitCallout [ECUC_Com_00765]		
Parent Container	ComIPdu		
Description	If there is a trigger transmit callout defined for this I-PDU this parameter contains the name of the callout function.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComIPduType [ECUC_Com_00761]		
Parent Container	ComIPdu		
Description	Defines if this I-PDU is a normal I-PDU that can be sent unfragmented or if this is a large I-PDU that shall be sent via the Transport Protocol of the underlying bus.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	NORMAL	sent or received via normal L-PDU	
	TP	sent or received via TP	
Post-Build Variant Value	true		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComIPduGroupRef [ECUC_Com_00206]		
Parent Container	ComIPdu		
Description	Reference to the I-PDU groups this I-PDU belongs to.		
Multiplicity	0..*		
Type	Reference to ComIPduGroup		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComIPduMainFunctionRef [ECUC_Com_10012]		
Parent Container	ComIPdu		
Description	Reference to the Com_MainFunctionRx/Com_MainFunctionTx this I-PDU belongs to. Mandatory, if multiple main functions of the relevant type are defined.		
Multiplicity	0..1		
Type	Choice reference to [ComMainFunctionRx,ComMainFunctionTx]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComIPduSignalGroupRef [ECUC_Com_00519]		
Parent Container	ComIPdu		
Description	References to all signal groups contained in this I-Pdu		
Multiplicity	0..*		
Type	Reference to ComSignalGroup		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		

Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComIPduSignalRef [ECUC_Com_00518]		
Parent Container	ComIPdu		
Description	References to all signals contained in this I-PDU.		
Multiplicity	0..*		
Type	Reference to ComSignal		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComPduldRef [ECUC_Com_00711]		
Parent Container	ComIPdu		
Description	Reference to the "global" Pdu structure to allow harmonization of handle IDs in the COM-Stack.		
Multiplicity	1		
Type	Reference to Pdu		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency			

Included Containers		
Container Name	Multiplicity	Scope / Dependency
ComIPduCounter	0..1	This optional container contains the configuration parameters of PDU Counter.

ComIPduReplication	0..1	This optional container contains the information needed for each I-PDU replicated.
ComTxIPdu	0..1	This container contains additional transmission related configuration parameters of the AUTOSAR COM module's I-PDUs.

E.1.5 ComSignal

SWS Item	[ECUC_Com_00344]		
Container Name	ComSignal		
Parent Container	ComConfig		
Description	Contains the configuration parameters of the AUTOSAR COM module's signals.		
Post-Build Variant Multiplicity	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Configuration Parameters			

Name	ComBitPosition [ECUC_Com_00259]		
Parent Container	ComSignal		
Description	Starting position within the I-PDU. This parameter refers to the position in the I-PDU and not in the shadow buffer. If the endianness conversion is configured to Opaque the parameter ComBitPosition shall define the bit0 of the first byte like in little endian byte order		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value			
Post-Build Variant Value	true		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComBitSize [ECUC_Com_00158]		
Parent Container	ComSignal		
Description	Size in bits, for integer signal types. For ComSignalType UINT8_N and UINT8_DYN the size shall be configured by ComSignalLength. For ComSignalTypes FLOAT32 and FLOAT64 the size is already defined by the signal type and therefore may be omitted.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 64		

Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComDataInvalidAction [ECUC_Com_00314]		
Parent Container	ComSignal		
Description	This parameter defines the action performed upon reception of an invalid signal. Relating to signal groups the action in case if one of the included signals is an invalid signal. If Replace is used the ComSignalInitValue will be used for the replacement.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	NOTIFY		
	REPLACE	Literal for DataInvalidAction	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	—	
Scope / Dependency	scope: local		

Name	ComErrorNotification [ECUC_Com_00499]		
Parent Container	ComSignal		
Description	Only valid on sender side: Name of Com_CbkTxErr callback function to be called. If this parameter is omitted no error notification shall take place.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			

Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComFirstTimeout [ECUC_Com_00183]		
Parent Container	ComSignal		
Description	Defines the length of the first deadline monitoring timeout period in seconds. This timeout is used immediately after start (or restart) of the deadline monitoring service. The timeout period of the successive periods is configured by ECUC_Com_00263.		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. 3600]		
Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComHandleId [ECUC_Com_00165]		
Parent Container	ComSignal		
Description	<p>The numerical value used as the ID.</p> <p>This ID identifies signals and signal groups in the COM APIs using Com_SignalIdType or Com_SignalGroupIdType parameter respectively.</p>		
Multiplicity	0..1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65535		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	ComInitialValueOnly [ECUC_Com_00811]		
Parent Container	ComSignal		
Description	<p>This parameter defines that the respective signal's initial value shall be put into the respective PDU but there will not be any update of the value through the RTE. Thus the Com implementation does not need to expect any API calls for this signal (group).</p>		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComInvalidNotification [ECUC_Com_00315]		
Parent Container	ComSignal		
Description	Only valid on receiver side: Name of Com_CbkInv callback function to be called. Name of the function which notifies the RTE about the reception of an invalidated signal/ signal group. Only applicable if ComDataInvalidAction is configured to NOTIFY.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComNotification [ECUC_Com_00498]		
Parent Container	ComSignal		
Description	On sender side: Name of Com_CbkTxAck callback function to be called. On receiver side: Name of Com_CbkRxAck callback function to be called. If this parameter is omitted no notification shall take place.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	

Scope / Dependency	scope: local
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Name	ComRxDataTimeoutAction [ECUC_Com_00412]		
Parent Container	ComSignal		
Description	This parameter defines the action performed upon expiration of the reception deadline monitoring timer.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	NONE	no replacement shall take place	
	REPLACE	signals shall be replaced by their ComSignalInitValue	
	SUBSTITUTE	signals shall be replaced by their ComTimeoutSubstitutionValue	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	—	
Scope / Dependency	scope: local		

Name	ComSignalDataInvalidValue [ECUC_Com_00391]		
Parent Container	ComSignal		
Description	<p>Defines the data invalid value of the signal.</p> <p>In case the ComSignalType is UINT8, UINT16, UINT32, UINT64, SINT8, SINT16, SINT32, SINT64 the string shall be interpreted as defined in the chapter Integer Type in the AUTOSAR EcuC specification. In case the ComSignalType is FLOAT32, FLOAT64 the string shall be interpreted as defined in the chapter Float Type in the AUTOSAR EcuC specification. In case the ComSignalType is BOOLEAN the string shall be interpreted as defined in the chapter Boolean Type in the AUTOSAR EcuC specification. In case the ComSignal is a UINT8_N, UINT8_DYN the string shall be interpreted as a decimal representation of the characters separated by blanks, e.g. "97 98 100" means a string "abd", where the char "a" is in byte 0(lowest address), "b" is in byte 1, and "d" is in byte 2 and (highest address). For the ComSignalType UINT8_DYN the dynamic length shall be set to the number of configured characters. An empty string "" shall be interpreted as 0-sized dynamic signal.</p>		
Multiplicity	0..1		
Type	EcucStringParamDef		
Default Value			

Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local dependency: In case of UINT8_N the length of ComSignalDataInvalidValue has to be the same as ComSignalLength.		

Name	ComSignalEndianness [ECUC_Com_00157]		
Parent Container	ComSignal		
Description	Defines the endianness of the signal's network representation.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	BIG_ENDIAN		
	LITTLE_ENDIAN		
	OPAQUE		
Post-Build Variant Value	true		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComSignalInitValue [ECUC_Com_00170]		
Parent Container	ComSignal		
Description	<p>Initial value for this signal. In case of UINT8_N the default value is a string of length ComSignalLength with all bytes set to 0x00. In case of UINT8_DYN the initial size shall be 0.</p> <p>In case the ComSignalType is UINT8, UINT16, UINT32, UINT64, SINT8, SINT16, SINT32, SINT64 the string shall be interpreted as defined in the chapter Integer Type in the AUTOSAR EcuC specification. In case the ComSignalType is FLOAT32, FLOAT64 the string shall be interpreted as defined in the chapter Float Type in the AUTOSAR EcuC specification. In case the ComSignalType is BOOLEAN the string shall be interpreted as defined in the chapter Boolean Type in the AUTOSAR EcuC specification. In case the ComSignal is a UINT8_N, UINT8_DYN the string shall be interpreted as a decimal representation of the characters separated by blanks, e.g. "97 98 100" means a string "abd", where the char "a" is in byte 0(lowest address), "b" is in byte 1, and "d" is in byte 2 and (highest address). For the ComSignalType UINT8_DYN the dynamic length shall be set to the number of configured characters. An empty string "" shall be interpreted as 0-sized dynamic signal.</p>		
Multiplicity	0..1		
Type	EcucStringParamDef		
Default Value	0		
Regular Expression			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local dependency: In case of UINT8_N the length of ComSignalInitValue has to be the same as ComSignalLength.		

Name	ComSignalLength [ECUC_Com_00437]		
Parent Container	ComSignal		
Description	<p>Description: For ComSignalType UINT8_N this parameter specifies the length n in bytes. For ComSignalType UINT8_DYN it specifies the maximum length in bytes. For all other types this parameter shall be ignored.</p> <p>The supported maximum length is restricted by the used transportation system. For non TP-PDUs the maximum size of a PDU, and therefore also of any included signal, is limited by the concrete bus characteristic. For example, the limit is 8 bytes for CAN and LIN, 64 bytes for CAN FD and 254 for FlexRay.</p>		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComSignalType [ECUC_Com_00127]	
Parent Container	ComSignal	
Description	<p>The AUTOSAR type of the signal. Whether or not the signal is signed or unsigned can be found by examining the value of this attribute. This type could also be used to reserved appropriate storage in AUTOSAR COM.</p>	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	BOOLEAN	
	FLOAT32	
	FLOAT64	
	SINT16	
	SINT32	
	SINT64	
	SINT8	
	UINT16	
	UINT32	
	UINT64	
	UINT8	

Post-Build Variant Value	UINT8_DYN		
	UINT8_N false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComTimeout [ECUC_Com_00263]		
Parent Container	ComSignal		
Description	Defines the length of the deadline monitoring timeout period in seconds. The period for the first timeout period can be configured separately by ECUC_Com_00183.		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. 3600]		
Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComTimeoutNotification [ECUC_Com_00552]		
Parent Container	ComSignal		
Description	On sender side: Name of Com_CbkTxTOut callback function to be called. On receiver side: Name of Com_CbkRxTOut callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComTimeoutSubstitutionValue [ECUC_Com_10006]
Parent Container	ComSignal
Description	<p>The signal substitution value will be used in case of a timeout and ComRxDataTimeoutAction is set to SUBSTITUTE. In case of UINT8_N the default value is a string of length ComSignalLength with all bytes set to 0x00.</p> <p>In case of UINT8_DYN the initial size shall be 0.</p> <p>In case the ComSignalType is UINT8, UINT16, UINT32, UINT64, SINT8, SINT16, SINT32, SINT64 the string shall be interpreted as defined in the chapter Integer Type in the AUTOSAR EcuC specification.</p> <p>In case the ComSignalType is FLOAT32, FLOAT64 the string shall be interpreted as defined in the chapter Float Type in the AUTOSAR EcuC specification.</p> <p>In case the ComSignalType is BOOLEAN the string shall be interpreted as defined in the chapter Boolean Type in the AUTOSAR EcuC specification.</p> <p>In case the ComSignal is a UINT8_N, UINT8_DYN the string shall be interpreted as a decimal representation of the characters separated by blanks, e.g. "97 98 100" means a string "abd", where the char "a" is in byte 0(lowest address), "b" is in byte 1, and "d" is in byte 2 and (highest address). For the ComSignalType UINT8_DYN the dynamic length shall be set to the number of configured characters. An empty string "" shall be interpreted as 0-sized dynamic signal.</p>
Multiplicity	0..1
Type	EcucStringParamDef
Default Value	
Regular Expression	
Post-Build Variant Multiplicity	true
Post-Build Variant Value	true

Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComTransferProperty [ECUC_Com_00232]		
Parent Container	ComSignal		
Description	Defines if a write access to this signal can trigger the transmission of the corresponding I-PDU. If the I-PDU is triggered, depends also on the transmission mode of the corresponding I-PDU.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	PENDING	A write access to this signal never triggers the transmission of the corresponding I-PDU.	
	TRIGGERED	Depending on the transmission mode, a write access to this signal can trigger the transmission of the corresponding I-PDU.	
	TRIGGERED_ON_CHANNEL	Depending on the transmission mode, a write access to this signal can trigger the transmission of the corresponding I-PDU, but only in case the written value is different to the locally stored (last sent or initial value) in length or value.	
	TRIGGERED_ON_CHANNEL_WITHOUT_REPETITION	Depending on the transmission mode, a write access to this signal can trigger the transmission of the corresponding I-PDU just once without a repetition, but only in case the written value is different to the locally stored (last sent or initial value) in length or value.	
	TRIGGERED_WITHOUT_REPETITION	Depending on the transmission mode, a write access to this signal can trigger the transmission of the corresponding I-PDU just once without a repetition.	
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComUpdateBitPosition [ECUC_Com_00257]		
Parent Container	ComSignal		
Description	<p>Bit position of update-bit inside I-PDU. If this attribute is omitted then there is no update-bit. This setting must be consistently on sender and on receiver side.</p> <p>Range: 0..63 for CAN and LIN, 0..511 for CAN FD, 0..2031 for FlexRay, 0..4294967295 for TP.</p>		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComSystemTemplateSystemSignalRef [ECUC_Com_00002]		
Parent Container	ComSignal		
Description	Reference to the ISignalToIPduMapping that contains a reference to the ISignal (System Template) which this ComSignal (or ComGroupSignal) represents.		
Multiplicity	0..1		
Type	Foreign reference to I-SIGNAL-TO-I-PDU-MAPPING		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: ECU		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
ComFilter	0..1	<p>This container contains the configuration parameters of the AUTOSAR COM module's Filters.</p> <p>Note: On sender side the container is used to specify the transmission mode conditions.</p>

E.1.6 ComSignalGroup

SWS Item	[ECUC_Com_00345]		
Container Name	ComSignalGroup		
Parent Container	ComConfig		
Description	Contains the configuration parameters of the AUTOSAR COM module's signal groups.		
Post-Build Variant Multiplicity	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Configuration Parameters			

Name	ComDataInvalidAction [ECUC_Com_00314]		
Parent Container	ComSignalGroup		
Description	This parameter defines the action performed upon reception of an invalid signal. Relating to signal groups the action in case if one of the included signals is an invalid signal. If Replace is used the ComSignalInitValue will be used for the replacement.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	NOTIFY		
	REPLACE	Literal for DataInvalidAction	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	—	

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComErrorNotification [ECUC_Com_00499]		
Parent Container	ComSignalGroup		
Description	Only valid on sender side: Name of Com_CbkTxErr callback function to be called. If this parameter is omitted no error notification shall take place.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComFirstTimeout [ECUC_Com_00183]		
Parent Container	ComSignalGroup		
Description	Defines the length of the first deadline monitoring timeout period in seconds. This timeout is used immediately after start (or restart) of the deadline monitoring service. The timeout period of the successive periods is configured by ECUC_Com_00263.		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. 3600]		
Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComHandleId [ECUC_Com_00165]		
Parent Container	ComSignalGroup		
Description	<p>The numerical value used as the ID.</p> <p>This ID identifies signals and signal groups in the COM APIs using Com_SignalIdType or Com_SignalGroupIdType parameter respectively.</p>		
Multiplicity	0..1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65535		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	ComInitialValueOnly [ECUC_Com_00811]		
Parent Container	ComSignalGroup		
Description	<p>This parameter defines that the respective signal's initial value shall be put into the respective PDU but there will not be any update of the value through the RTE. Thus the Com implementation does not need to expect any API calls for this signal (group).</p>		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency		scope: local	

Name	ComInvalidNotification [ECUC_Com_00315]		
Parent Container	ComSignalGroup		
Description	Only valid on receiver side: Name of Com_CbkInv callback function to be called. Name of the function which notifies the RTE about the reception of an invalidated signal/ signal group. Only applicable if ComDataInvalidAction is configured to NOTIFY.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency		scope: local	

Name	ComNotification [ECUC_Com_00498]		
Parent Container	ComSignalGroup		
Description	On sender side: Name of Com_CbkTxAck callback function to be called. On receiver side: Name of Com_CbkRxAck callback function to be called. If this parameter is omitted no notification shall take place.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComRxDataTimeoutAction [ECUC_Com_00412]		
Parent Container	ComSignalGroup		
Description	This parameter defines the action performed upon expiration of the reception deadline monitoring timer.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	NONE	no replacement shall take place	
	REPLACE	signals shall be replaced by their ComSignalInitValue	
	SUBSTITUTE	signals shall be replaced by their ComTimeoutSubstitutionValue	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComSignalGroupArrayAccess [ECUC_Com_10003]		
Parent Container	ComSignalGroup		
Description	Defines whether the uint8-array based access shall be used for this ComSignalGroup.		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	ComTimeout [ECUC_Com_00263]		
Parent Container	ComSignalGroup		
Description	Defines the length of the deadline monitoring timeout period in seconds. The period for the first timeout period can be configured separately by ECUC_Com_00183.		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. 3600]		
Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			
scope: local			

Name	ComTimeoutNotification [ECUC_Com_00552]		
Parent Container	ComSignalGroup		
Description	On sender side: Name of Com_CbkTxTOut callback function to be called. On receiver side: Name of Com_CbkRxTOut callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: local		

Name	ComTransferProperty [ECUC_Com_00232]		
Parent Container	ComSignalGroup		
Description	Defines if a write access to this signal can trigger the transmission of the corresponding I-PDU. If the I-PDU is triggered, depends also on the transmission mode of the corresponding I-PDU.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	PENDING	A write access to this signal never triggers the transmission of the corresponding I-PDU.	
	TRIGGERED	Depending on the transmission mode, a write access to this signal can trigger the transmission of the corresponding I-PDU.	
	TRIGGERED_ON_CHANNEL	Depending on the transmission mode, a write access to this signal can trigger the transmission of the corresponding I-PDU, but only in case the written value is different to the locally stored (last sent or initial value) in length or value.	
	TRIGGERED_ON_CHANNEL_WITHOUT_REPETITION	Depending on the transmission mode, a write access to this signal can trigger the transmission of the corresponding I-PDU just once without a repetition, but only in case the written value is different to the locally stored (last sent or initial value) in length or value.	
	TRIGGERED_WITHOUT_REPETITION	Depending on the transmission mode, a write access to this signal can trigger the transmission of the corresponding I-PDU just once without a repetition.	
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComUpdateBitPosition [ECUC_Com_00257]		
Parent Container	ComSignalGroup		
Description	<p>Bit position of update-bit inside I-PDU. If this attribute is omitted then there is no update-bit. This setting must be consistently on sender and on receiver side.</p> <p>Range: 0..63 for CAN and LIN, 0..511 for CAN FD, 0..2031 for FlexRay, 0..4294967295 for TP.</p>		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: local		

Name	ComSystemTemplateSignalGroupRef [ECUC_Com_00001]		
Parent Container	ComSignalGroup		
Description	<p>Reference to the ISignalToIPduMapping that contains a reference to the ISignalGroup (SystemTemplate) which this ComSignalGroup represents.</p>		
Multiplicity	0..1		
Type	Foreign reference to I-SIGNAL-TO-I-PDU-MAPPING		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: ECU		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
ComGroupSignal	0..*	This container contains the configuration parameters of group signals. I.e. signals that are included within a signal group.

E.2 LdCom

Module SWS Item	ECUC_LdCom_00001		
Module Name	LdCom		
Module Description	Configuration of the AUTOSAR LdCom module.		
Post-Build Variant Support	true		
Supported Config Variants	VARIANT-LINK-TIME, VARIANT-POST-BUILD, VARIANT-PRE-COMPILE		
Included Containers			
Container Name	Multiplicity	Scope / Dependency	
LdComConfig	1	This container contains the configuration parameters and sub containers of the AUTOSAR LdCom module.	
LdComGeneral	1	Contains the general configuration parameters of the LdCom module.	

E.2.1 LdComConfig

SWS Item	[ECUC_LdCom_00003]
Container Name	LdComConfig
Parent Container	LdCom
Description	This container contains the configuration parameters and sub containers of the AUTOSAR LdCom module.
Configuration Parameters	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
LdComIPdu	0..*	Contains the configuration parameters of the IPdu inside LdCom.

E.2.2 LdComIPdu

SWS Item	[ECUC_LdCom_00006]
Container Name	LdComIPdu
Parent Container	LdComConfig

Description	Contains the configuration parameters of the IPdu inside LdCom.		
Post-Build Variant Multiplicity	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Configuration Parameters			

Name	LdComApiType [ECUC_LdCom_00002]		
Parent Container	LdComIPdu		
Description	<p>Defines if this I-PDU is a normal I-PDU that shall be sent unfragmented or if this is a large I-PDU that shall be sent via the Transport Protocol of the underlying bus.</p> <p>This setting is used by RTE to invoke the proper API.</p>		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	LDCOM_IF	sent or received via interface API.	
	LDCOM_TP	sent or received via transport protocol API.	
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	—	
Scope / Dependency	scope: ECU		

Name	LdComHandleId [ECUC_LdCom_00005]		
Parent Container	LdComIPdu		
Description	This is the ID used by RTE to invoke LdCom. A corresponding shortName is created, which is used for the invocations of the RTE. The same ID is used for invocations by PduR.		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65535		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: ECU		

Name	LdComIPduDirection [ECUC_LdCom_00007]		
Parent Container	LdComIPdu		
Description	The direction defines if this IPdu, and therefore the contributing signal, shall be sent or received.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	LDCOM_RECEIVE		
	LDCOM_SEND		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	—	
Scope / Dependency	scope: local		

Name	LdComRxCopyRxData [ECUC_LdCom_00013]		
Parent Container	LdComIPdu		
Description	Only on receiver side: Name of Rte_LdComCbKCopyRxData callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComRxIndication [ECUC_LdCom_00014]		
Parent Container	LdComIPdu		
Description	Only on receiver side: Name of Rte_LdComCbKRxIndication callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			

Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComRxStartOfReception [ECUC_LdCom_00015]		
Parent Container	LdComIPdu		
Description	Only on receiver side: Name of Rte_LdComCbKStartOfReception callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComTpRxIndication [ECUC_LdCom_00016]		
Parent Container	LdComIPdu		
Description	Only on receiver side: Name of Rte_LdComCbKTpRxIndication callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			

Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComTpTxConfirmation [ECUC_LdCom_00017]		
Parent Container	LdComIPdu		
Description	Only on sender side: Name of Rte_LdComCbKtpTxConfirmation callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComTxConfirmation [ECUC_LdCom_00021]		
Parent Container	LdComIPdu		
Description	Only on sender side: Name of Rte_LdComCbKtxConfirmation callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			

Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComTxCopyTxData [ECUC_LdCom_00018]		
Parent Container	LdComIPdu		
Description	Only on sender side: Name of Rte_LdComCbkJCopyTxData callback function to be called.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComTxTriggerTransmit [ECUC_LdCom_00019]		
Parent Container	LdComIPdu		
Description	Only on sender side: Name of Rte_LdComCbkJTriggerTransmit callback function to be called. If defined TriggerTransmit has to be supported for this signal.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			

Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComPduRef [ECUC_LdCom_00010]		
Parent Container	LdComIPdu		
Description	Reference to the global Pdu.		
Multiplicity	1		
Type	Reference to Pdu		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	LdComSystemTemplateSignalRef [ECUC_LdCom_00011]		
Parent Container	LdComIPdu		
Description	Reference to the ISignalToIPduMapping that contains a reference to the ISignal (System Template).		
Multiplicity	0..1		
Type	Foreign reference to I-SIGNAL-TO-I-PDU-MAPPING		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD

Scope / Dependency	scope: ECU
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No Included Containers

E.3 EcuC

Module SWS Item	ECUC_EcuC_00008	
Module Name	EcuC	
Module Description	Virtual module to collect ECU Configuration specific / global configuration information.	
Post-Build Variant Support	true	
Supported Config Variants	VARIANT-POST-BUILD, VARIANT-PRE-COMPILE	
Included Containers		
Container Name	Multiplicity	Scope / Dependency
EcucConfigSet	0..1	This container contains the configuration parameters and sub containers of the global PduCollection.
EcucHardware	0..1	Hardware definition of this Ecu.
EcucPartitionCollection	0..1	Collection of Partitions defined for this ECU.
EcucPostBuildVariants	0..1	Collection of toplevel PostBuildSelectable variants. The PredefinedVariants linked inside this container will determine how many PostBuildSelectableVariants exist. If this container exist the name pattern for initialization of BSW modules will be <Mip>_Config_<PredefinedVariant.shortName>. If this container does not exist the name pattern for initialization of BSW modlues will be <Mip>_Config.
EcucUnitGroupAssignment	0..1	Collection of UnitGroup references to support the generation of ASAM MCD file.
EcucVariationResolver	0..1	Collection of PredefinedVariant elements containing definition of values for SwSystemconst which shall be applied when resolving the variability during ECU Configuration.

E.3.1 EcucPartition

SWS Item	[ECUC_EcuC_00005]		
Container Name	EcucPartition		
Parent Container	EcucPartitionCollection		
Description	Definition of one Partition on this ECU. One Partition will be implemented using one Os-Application.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE, VARIANT-POST-BUILD
	Link time	–	
	Post-build time	–	

Configuration Parameters

Name	EcucDefaultBswPartition [ECUC_EcuC_00037]		
Parent Container	EcucPartition		
Description	<p>Denotes the default BSW partition. This partition will host all BSW Modules, which are not explicitly mapped to a different partition.</p> <p>For partitions other than the default BSW partition this parameter can be omitted.</p>		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	PartitionCanBeRestarted [ECUC_EcuC_00006]		
Parent Container	EcucPartition		
Description	<p>Specifies the requirement whether the Partition can be restarted. If set to true all software executing in this partition shall be capable of handling a restart.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	EcucEcuPartitionRef [ECUC_EcuC_00083]		
Parent Container	EcucPartition		
Description	<p>Reference to the EcuPartition to define the link to the partition described in the System description.</p> <p>Tags: atp.Status=draft</p>		

Multiplicity	0..1		
Type	Foreign reference to ECU-PARTITION		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	EcucPartitionBswModuleDistinguishedPartition [ECUC_EcuC_00068]		
Parent Container	EcucPartition		
Description	This maps the abstract partition of the Bsw Module to a concrete Partition existing in the ECU.		
Multiplicity	0..*		
Type	Foreign reference to BSW-DISTINGUISHED-PARTITION		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	EcucPartitionSoftwareComponentInstanceRef [ECUC_EcuC_00036]		
Parent Container	EcucPartition		
Description	References the SW Component instances from the Ecu Extract that shall be executed in this partition.		
Multiplicity	0..*		
Type	Instance reference to SW-COMPONENT-PROTOTYPE context: ROOT-SW-COMPOSITION-PROTOTYPE		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

No Included Containers

E.3.2 EcucPdu

SWS Item	[ECUC_EcuC_00001]		
Container Name	Pdu		
Parent Container	EcucPduCollection		
Description	One Pdu flowing through the COM-Stack. This Pdu is used by all Com-Stack modules to agree on referencing the same Pdu.		
Post-Build Variant Multiplicity	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Configuration Parameters			

Name	DynamicLength [ECUC_EcuC_00078]		
Parent Container	Pdu		
Description	This parameter defines whether the Pdu has dynamic length (true) or not (false). Please note that the usage of this attribute is restricted by [constr_3448].		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

Name	J1939Requestable [ECUC_EcuC_00072]		
Parent Container	Pdu		
Description	Pdu can be triggered by the J1939 request message.		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

Name	PduLength [ECUC_EcuC_00003]		
Parent Container	Pdu		
Description	Length of the Pdu in bytes. It should be noted that in former AUTOSAR releases (Rel 2.1, Rel 3.0, Rel 3.1, Rel 4.0 Rev. 1) this parameter was defined in bits.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value			
Post-Build Variant Value	true		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

Name	EcucPduDefaultPartitionRef [ECUC_EcuC_00082]		
Parent Container	Pdu		
Description	Reference to EcucPartition, where the according Pdu is assigned to.		
Multiplicity	0..1		
Type	Reference to EcucPartition		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	MetaDataTypeRef [ECUC_EcuC_00077]		
Parent Container	Pdu		
Description	Reference to meta data that is transported in the Pdu through the AUTOSAR layers.		
Multiplicity	0..1		
Type	Reference to MetaDataType		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	SysTPduToFrameTriggeringRef [ECUC_EcuC_00052]		
Parent Container	Pdu		
Description	<p>Reference to the FrameTriggering from the SystemTemplate which this Pdu belongs to.</p> <p>SysTPduToFrameTriggeringRef shall be used for UserDefinedPdus, NmPdus and NPdus which are not going through the Pdu Router. This reference shall not be used if SysTPduToPduTriggeringRef exists.</p>		
Multiplicity	0..1		
Type	Foreign reference to FRAME-TRIGGERING		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	<p>dependency: SysTPduToFrameTriggeringRef shall be used for UserDefinedPdus, NmPdus and NPdus which are not going through the Pdu Router. This reference shall not be used if SysTPduToPduTriggeringRef exists.</p>		

Name	SysTPduToPduTriggeringRef [ECUC_EcuC_00054]		
Parent Container	Pdu		
Description	<p>Reference to the PduTriggering from the SystemTemplate which this Pdu represents.</p> <p>SysTPduToPduTriggeringRef shall be used for all Pdus except UserDefinedPdus, NmPdus and NPdus which are not going through the Pdu Router. For these Pdus, SysTPduToFrameTriggeringRef shall be used.</p>		
Multiplicity	0..1		
Type	Foreign reference to PDU-TRIGGERING		
Post-Build Variant Multiplicity	true		
Post-Build Variant Value	true		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	–	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	<p>dependency: SysTPduToPduTriggeringRef shall be used for all Pdus except UserDefinedPdus, NmPdus and NPdus which are not going through the Pdu Router. This reference shall not be used if SysTPduToFrameTriggeringRef exists.</p>		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
EcucPduDedicatedPartition	0..*	Module specific container for Pdu to partition assignment.

E.3.3 EcucPduDedicatedPartition

SWS Item	[ECUC_EcuC_00079]		
Container Name	EcucPduDedicatedPartition		
Parent Container	Pdu		
Description	Module specific container for Pdu to partition assignment.		
Post-Build Variant Multiplicity	true		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

Name	EcucPduDedicatedPartitionBswModuleRef [ECUC_EcuC_00080]		
Parent Container	EcucPduDedicatedPartition		
Description	Reference to BSW module, for which the according dedicated Pdu assignment is valid.		
Multiplicity	1		
Type	Foreign reference to ECUC-MODULE-CONFIGURATION-VALUES		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	EcucPduDedicatedPartitionRef [ECUC_EcuC_00081]		
Parent Container	EcucPduDedicatedPartition		
Description	Module specific reference to EcucPartition, where the according Pdu is assigned to. The dedicated partition reference shall overrule the default partition reference for the respective module.		
Multiplicity	0..1		
Type	Reference to EcucPartition		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

E.4 NvM

E.4.1 NvMBlockDescriptor

SWS Item	[ECUC_NvM_00061]
Container Name	NvMBlockDescriptor
Parent Container	NvM
Description	Container for a management structure to configure the composition of a given NVRAM Block Management Type. Its multiplicity describes the number of configured NVRAM blocks, one block is required to be configured. The NVRAM block descriptors are condensed in the NVRAM block descriptor table.
Configuration Parameters	

Name	NvMBlockCrcType [ECUC_NvM_00476]		
Parent Container	NvMBlockDescriptor		
Description	Defines CRC data width for the NVRAM block. Default: NVM_CRC16, i.e. CRC16 will be used if NVM_BLOCK_USE_CRC==true		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	NVM_CRC16	(Default) CRC16 will be used if NVM_BLOCK_USE_CRC==true.	
	NVM_CRC32	CRC32 is selected for this NVRAM block if NVM_BLOCK_USE_CRC==true.	
	NVM_CRC8	CRC8 is selected for this NVRAM block if NVM_BLOCK_USE_CRC==true.	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	—	
Scope / Dependency	scope: local dependency: NVM_BLOCK_USE_CRC, NVM_CALC_RAM_BLOCK_CRC		

Name	NvMBlockHeaderInclude [ECUC_NvM_00554]
Parent Container	NvMBlockDescriptor
Description	Defines the header file where the owner of the NVRAM block has the declarations of the permanent RAM data block, ROM data block (if configured) and the callback function prototype for each configured callback. If no permanent RAM block, ROM block or callback functions are configured then this configuration parameter shall be ignored.
Multiplicity	0..1
Type	EcucStringParamDef
Default Value	
Regular Expression	

Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMBlockJobPriority [ECUC_NvM_00477]		
Parent Container	NvMBlockDescriptor		
Description	Defines the job priority for a NVRAM block (0 = Immediate priority).		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMBlockManagementType [ECUC_NvM_00062]		
Parent Container	NvMBlockDescriptor		
Description	Defines the block management type for the NVRAM block.[SWS_NvM_00137]		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	NVM_BLOCK_DATASET	NVRAM block is configured to be of dataset type.	
	NVM_BLOCK_NATIVE	NVRAM block is configured to be of native type.	
	NVM_BLOCK_REDUNDANT	NVRAM block is configured to be of redundant type.	
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	—	
Scope / Dependency	scope: local		

Name	NvMBlockUseAutoValidation [ECUC_NvM_00557]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines whether the RAM Block shall be auto validated during shutdown phase.</p> <p>true: if auto validation mechanism is used, false: otherwise</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMBlockUseCompression [ECUC_NvM_00563]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines whether the data is compressed before written. true: data compression activated (takes more time to read and write) false: no compression</p> <p>Tags: atp.Status=draft</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMBlockUseCrc [ECUC_NvM_00036]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines CRC usage for the NVRAM block, i.e. memory space for CRC is reserved in RAM and NV memory.</p> <p>true: CRC will be used for this NVRAM block. false: CRC will not be used for this NVRAM block.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Value	false		

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMBlockUseCRCCompMechanism [ECUC_NvM_00556]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines whether the CRC of the RAM Block shall be compared during a write job with the CRC which was calculated during the last successful read or write job.</p> <p>true: if compare mechanism is used, false: otherwise</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local dependency: False if NvMBlockUseCrc = False		

Name	NvMBlockUsePort [ECUC_NvM_00559]		
Parent Container	NvMBlockDescriptor		
Description	<p>If this parameter is true it defines whether:</p> <ul style="list-style-type: none"> the port with interface 'NvMMirror' for synchronization mechanism callbacks are generated if the parameter NvMBlockUseSyncMechanism is configured TRUE; the port with interface 'NvMNotifyInitBlock' for initialization block callback is generated if NvMInitBlockCallback parameter is configured (independent of the content); the port with interface 'NvMNotifyJobFinished' for single block callback is generated if NvMSingleBlockCallback parameter is configured (independent of the content); the port with interface 'NvMAdmin' for SetBlockProtection operation is generated. 		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency		scope: local	

Name	NvMBlockUseSetRamBlockStatus [ECUC_NvM_00552]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines if NvMSetRamBlockStatusApi shall be used for this block or not.</p> <p>Note: If NvMSetRamBlockStatusApi is disabled this configuration parameter shall be ignored.</p> <p>true: calling of NvMSetRamBlockStatus for this RAM block shall set the status of the RAM block.</p> <p>false: calling of NvMSetRamBlockStatus for this RAM block shall be ignored.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency		scope: local	

Name	NvMBlockUseSyncMechanism [ECUC_NvM_00519]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines whether an explicit synchronization mechanism with a RAM mirror and callback routines for transferring data to and from NvM module's RAM mirror is used for NV block. true if synchronization mechanism is used, false otherwise.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency		scope: local	

Name	NvMBlockWriteProt [ECUC_NvM_00033]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines an initial write protection of the NV block</p> <p>true: Initial block write protection is enabled. false: Initial block write protection is disabled.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMBswMBlockStatusInformation [ECUC_NvM_00551]		
Parent Container	NvMBlockDescriptor		
Description	<p>This parameter specifies whether BswM is informed about the current status of the specified block.</p> <p>True: Call BswM_NvM_CurrentBlockMode on changes False: Don't inform BswM at all</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMCalcRamBlockCrc [ECUC_NvM_00119]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines CRC (re)calculation for the permanent RAM block or NVRAM blocks which are configured to use explicit synchronization mechanism.</p> <p>true: CRC will be (re)calculated for this permanent RAM block. false: CRC will not be (re)calculated for this permanent RAM block.</p>		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local dependency: NVM_BLOCK_USE_CRC		

Name	NvMMaxNumOfReadRetries [ECUC_NvM_00533]		
Parent Container	NvMBlockDescriptor		
Description	Defines the maximum number of read retries.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 7		
Default Value	0		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMMaxNumOfWriteRetries [ECUC_NvM_00499]		
Parent Container	NvMBlockDescriptor		
Description	Defines the maximum number of write retries for a NVRAM block with [ECUC_NvM_00061]. Regardless of configuration a consistency check (and maybe write retries) are always forced for each block which is processed by the request NvM_WriteAll and NvM_WriteBlock.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 7		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMNvBlockBaseNumber [ECUC_NvM_00478]		
Parent Container	NvMBlockDescriptor		
Description	<p>Configuration parameter to perform the link between the NVM_NVRAM_BLOCK_IDENTIFIER used by the SW-Cs and the FEE_BLOCK_NUMBER expected by the memory abstraction modules. The parameter value equals the FEE_BLOCK_NUMBER or EA_BLOCK_NUMBER shifted to the right by NvMDatasetSelectionBits bits. (ref. to chapter 7.1.2.1).</p> <p>Calculation Formula: value = TargetBlockReference.[Ea/Fee]BlockConfiguration.[Ea/Fee]BlockNumber » NvMDatasetSelectionBits</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 65534		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local dependency: FEE_BLOCK_NUMBER, EA_BLOCK_NUMBER		

Name	NvMNvBlockLength [ECUC_NvM_00479]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines the NV block data length in bytes.</p> <p>Note: The implementer can add the attribute 'withAuto' to the parameter definition which indicates that the length can be calculated by the generator automatically (e.g. by using a parser that searches and analyzes the data structure corresponding to the block). When 'withAuto' is set to 'true' for this parameter definition the 'isAutoValue' can be set to 'true'. If 'isAutoValue' is set to 'true' the actual value will not be considered during ECU Configuration but will be (re-)calculated by the code generator and stored in the value attribute afterwards.</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 65535		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMNvBlockNum [ECUC_NvM_00480]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines the number of multiple NV blocks in a contiguous area according to the given block management type.</p> <p>1-255 For NVRAM blocks to be configured of block management type NVM_BLOCK_DATASET. The actual range is limited according to SWS_NvM_00444.</p> <p>1 For NVRAM blocks to be configured of block management type NVM_BLOCK_NATIVE</p> <p>2 For NVRAM blocks to be configured of block management type NVM_BLOCK_REDUNDANT</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 255		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local dependency: NVM_BLOCK_MANAGEMENT_TYPE		

Name	NvMNvramBlockIdentifier [ECUC_NvM_00481]		
Parent Container	NvMBlockDescriptor		
Description	<p>Identification of a NVRAM block via a unique block identifier.</p> <p>Implementation Type: NvM_BlockIdType.</p> <p>min = 2 max = 2¹⁶ - NVM_DATASET_SELECTION_BITS - 1</p> <p>Reserved NVRAM block IDs: 0 -> to derive multi block request results via NvM_GetErrorStatus 1 -> redundant NVRAM block which holds the configuration ID (generation tool should check that this block is correctly configured from type, CRC and size point of view)</p>		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	2 .. 65535		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local dependency: NVM_DATASET_SELECTION_BITS		

Name	NvMNvramDeviceId [ECUC_NvM_00035]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines the NVRAM device ID where the NVRAM block is located.</p> <p>Calculation Formula: value = TargetBlockReference.[Ea/Fee]BlockConfiguration.[Ea/Fee]DeviceIndex</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 1		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local dependency: EA_DEVICE_INDEX, FEE_DEVICE_INDEX		

Name	NvMRamBlockDataAddress [ECUC_NvM_00482]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines the start address of the RAM block data.</p> <p>If this is not configured, no permanent RAM data block is available for the selected block management type.</p>		
Multiplicity	0..1		
Type	EcucStringParamDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMReadRamBlockFromNvCallback [ECUC_NvM_00521]		
Parent Container	NvMBlockDescriptor		
Description	<p>Entry address of a block specific callback routine which shall be called in order to let the application copy data from the NvM module's mirror to RAM block. Implementation type: Std_ReturnType</p> <p>E_OK: copy was successful E_NOT_OK: copy was not successful, callback routine to be called again</p>		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMResistantToChangedSw [ECUC_NvM_00483]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines whether a NVRAM block shall be treated resistant to configuration changes or not. If there is no default data available at configuration time then the application shall be responsible for providing the default initialization data. In this case the application has to use NvM_GetErrorStatus() to be able to distinguish between first initialization and corrupted data.</p> <p>true: NVRAM block is resistant to changed software. false: NVRAM block is not resistant to changed software.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMRomBlockDataAddress [ECUC_NvM_00484]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines the start address of the ROM block data.</p> <p>If not configured, no ROM block is available for the selected block management type.</p>		
Multiplicity	0..1		
Type	EcucStringParamDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMRomBlockNum [ECUC_NvM_00485]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines the number of multiple ROM blocks in a contiguous area according to the given block management type.</p> <p>0-254 For NVRAM blocks to be configured of block management type NVM_BLOCK_DATASET. The actual range is limited according to SWS_NvM_00444.</p> <p>0-1 For NVRAM blocks to be configured of block management type NVM_BLOCK_NATIVE</p> <p>0-1 For NVRAM blocks to be configured of block management type NVM_BLOCK_REDUNDANT</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 254		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	—	
Scope / Dependency	scope: local dependency: NVM_BLOCK_MANAGEMENT_TYPE, NVM_NV_BLOCK_NUM		

Name	NvMSelectBlockForFirstInitAll {NVM_SELECT_BLOCK_FOR_FIRST_INIT_ALL} [ECUC_NvM_00558]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines whether a block will be processed or not by NvM_FirstInitAll. A block can be configured to be processed even if it doesn't have permanent RAM and/or explicit synchronization.</p> <p>TRUE: block will be processed by NvM_FirstInitAll</p> <p>FALSE: block will not be processed by NvM_FirstInitAll</p>		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMSelectBlockForReadAll [ECUC_NvM_00117]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines whether a NVRAM block shall be processed during NvM_ReadAll or not. This configuration parameter has only influence on those NVRAM blocks which are configured to have a permanent RAM block or which are configured to use explicit synchronization mechanism.</p> <p>true: NVRAM block shall be processed by NvM_ReadAll false: NVRAM block shall not be processed by NvM_ReadAll</p>		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	

Scope / Dependency	scope: local dependency: NVM_RAM_BLOCK_DATA_ADDRESS
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Name	NvMSelectBlockForWriteAll [ECUC_NvM_00549]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines whether a NVRAM block shall be processed during NvM_WriteAll or not. This configuration parameter has only influence on those NVRAM blocks which are configured to have a permanent RAM block or which are configured to use explicit synchronization mechanism.</p> <p>true: NVRAM block shall be processed by NvM_WriteAll false: NVRAM block shall not be processed by NvM_WriteAll</p>		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local dependency: NVM_RAM_BLOCK_DATA_ADDRESS		

Name	NvMStaticBlockIDCheck [ECUC_NvM_00532]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines if the Static Block ID check is enabled.</p> <p>false: Static Block ID check is disabled. true: Static Block ID check is enabled.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMWriteBlockOnce [ECUC_NvM_00072]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines write protection after first write. The NVRAM manager sets the write protection bit either after the NV block was written the first time or if the block was already written and it is detected as valid and consistent during a read for it.</p> <p>true: Defines write protection after first write is enabled.</p> <p>false: Defines write protection after first write is disabled.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMWriteRamBlockToNvCallback [ECUC_NvM_00520]		
Parent Container	NvMBlockDescriptor		
Description	<p>Entry address of a block specific callback routine which shall be called in order to let the application copy data from RAM block to NvM module's mirror. Implementation type: Std_ReturnType</p> <p>E_OK: copy was successful E_NOT_OK: copy was not successful, callback routine to be called again</p>		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default Value			
Regular Expression			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMWriteVerification [ECUC_NvM_00534]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines if Write Verification is enabled.</p> <p>false: Write verification is disabled. true: Write Verification is enabled.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMWriteVerificationDataSize [ECUC_NvM_00538]		
Parent Container	NvMBlockDescriptor		
Description	<p>Defines the number of bytes to compare in each step when comparing the content of a RAM Block and a block read back.</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 65535		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	–	
Scope / Dependency	scope: local		

Name	NvMBlockCipherringRef [ECUC_NvM_00567]		
Parent Container	NvMBlockDescriptor		
Description	<p>Reference to cipherring container.</p> <p>If configured, NvM encrypt the data before storage and decrypt the data after restoring. If empty, the NvM stores and restore the original user data.</p> <p>Tags: atp.Status=draft</p>		
Multiplicity	0..1		
Type	Reference to NvMBlockCipherring		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local dependency: Key will be located in RAM if this configuration item is not present.		

Name	NvMBlockEcucPartitionRef [ECUC_NvM_00564]		
Parent Container	NvMBlockDescriptor		
Description	Maps the NV block to zero or one ECUC partition to limit the access to this NV block. The ECUC partition referenced is within the subset of the ECUC partitions where the NvM is mapped to.		
Multiplicity	0..1		
Type	Reference to EcucPartition		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
NvMInitBlockCallback	0..1	<p>The presence of this container indicates, that a block specific callback routine is called if no ROM data is available for initialization of the NVRAM block. If the container is not present, no callback routine is called for initialization of the NVRAM block with default data.</p> <p>In case the container has a NvMInitBlockCallbackFnc, the NvM will call this function.</p> <p>In case there is no NvMInitBlockCallbackFnc, the NvM will have an port PNIB_{Block}.</p>
NvMSingleBlockCallback	0..1	<p>The presence of this container indicates, that the block specific callback routine which shall be invoked on termination of each asynchronous single block request [SWS_NvM_00113] If the container is not present, no callback routine is called..</p> <p>In case the container has a NvMSingleBlockCallbackFnc, the NvM will call this function.</p> <p>In case there is no NvMSingleBlockCallbackFnc, the NvM will have an port PNJF_{Block}.</p>

NvMTargetBlock Reference	1	This parameter is just a container for the parameters for EA and FEE
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E.5 Os

E.5.1 OsAlarm

SWS Item	[ECUC_Os_00003]
Container Name	OsAlarm
Parent Container	Os
Description	An OsAlarm may be used to asynchronously inform or activate a specific task. It is possible to start alarms automatically at system start-up depending on the application mode.
Configuration Parameters	

Name	OsAlarmAccessingApplication [ECUC_Os_00004]		
Parent Container	OsAlarm		
Description	Reference to applications which have an access to this object.		
Multiplicity	0..*		
Type	Reference to OsApplication		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	OsAlarmCounterRef [ECUC_Os_00005]		
Parent Container	OsAlarm		
Description	Reference to the assigned counter for that alarm		
Multiplicity	1		
Type	Reference to OsCounter		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
OsAlarmAction	1	This container defines which type of notification is used when the alarm expires.
OsAlarmAutostart	0..1	If present this container defines if an alarm is started automatically at system start-up depending on the application mode.

E.5.2 OsApplication

SWS Item	[ECUC_Os_00114]
Container Name	OsApplication
Parent Container	Os
Description	<p>An AUTOSAR OS must be capable of supporting a collection of OS objects (tasks, interrupts, alarms, hooks etc.) that form a cohesive functional unit. This collection of objects is termed an OS-Application.</p> <p>All objects which belong to the same OS-Application have access to each other. Access means to allow to use these objects within API services.</p> <p>Access by other applications can be granted separately.</p>
Configuration Parameters	

Name	OsTrusted [ECUC_Os_00115]		
Parent Container	OsApplication		
Description	<p>Parameter to specify if an OS-Application is trusted or not.</p> <p>true: OS-Application is trusted false: OS-Application is not trusted (default)</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	<p>scope: ECU</p> <p>dependency: Required for scalability class 3 and 4.</p>		

Name	OsTrustedApplicationDelayTimingViolationCall [ECUC_Os_00395]		
Parent Container	OsApplication		
Description	Parameter to specify if a timing violation which occurs within an trusted OS-Application is raised immediately or if it is delayed until the current task returns to the calling OS-Application (return of CallTrustedFunction) true: violation / call to ProtectionHook() is delayed false: timing violation cause an immediate call to the ProtectionHook().		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	true		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsTrustedApplicationWithProtection [ECUC_Os_00394]		
Parent Container	OsApplication		
Description	Parameter to specify if a trusted OS-Application is executed with memory protection or not. true: OS-Application runs within a protected environment. This means that write access is limited. false: OS-Application has full write access (default)		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value	false		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsAppAlarmRef [ECUC_Os_00231]		
Parent Container	OsApplication		
Description	Specifies the OsAlarms that belong to the OsApplication.		
Multiplicity	0..*		
Type	Reference to OsAlarm		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsAppCounterRef [ECUC_Os_00234]		
Parent Container	OsApplication		
Description	References the OsCounters that belong to the OsApplication.		
Multiplicity	0..*		
Type	Reference to OsCounter		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsAppEcucPartitionRef [ECUC_Os_00392]		
Parent Container	OsApplication		
Description	Denotes which "EcucPartition" is implemented by this "OSApplication".		
Multiplicity	0..1		
Type	Reference to EcucPartition		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Name	OsApplsRef [ECUC_Os_00221]		
Parent Container	OsApplication		
Description	references which Oslrs belong to the OsApplication		
Multiplicity	0..*		
Type	Reference to Oslr		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsApplicationCoreRef [ECUC_Os_00393]		
Parent Container	OsApplication		
Description	Reference to the Core Definition in the Ecuc Module where the CoreId is defined. This reference is used to describe to which Core the OsApplication is bound.		
Multiplicity	0..1		
Type	Reference to EcucCoreDefinition		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsAppScheduleTableRef [ECUC_Os_00230]		
Parent Container	OsApplication		
Description	References the OsScheduleTables that belong to the OsApplication.		
Multiplicity	0..*		
Type	Reference to OsScheduleTable		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsAppTaskRef [ECUC_Os_00116]		
Parent Container	OsApplication		
Description	references which OsTasks belong to the OsApplication		
Multiplicity	0..*		
Type	Reference to OsTask		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsRestartTask [ECUC_Os_00120]		
Parent Container	OsApplication		
Description	<p>Optionally one task of an OS-Application may be defined as Restart Task.</p> <p>Multiplicity = 1: Restart Task is activated by the Operating System if the protection hook requests it.</p> <p>Multiplicity = 0: No task is automatically started after a protection error happened.</p>		
Multiplicity	0..1		
Type	Reference to OsTask		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU dependency: Required for scalability class 3 and 4.		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
OsApplicationHooks	1	Container to structure the OS-Application-specific hooks
OsApplicationTrusted Function	0..*	Container to structure the configuration parameters of trusted functions

E.5.3 OsCounter

SWS Item	[ECUC_Os_00026]
Container Name	OsCounter
Parent Container	Os
Description	Configuration information for the counters that belong to the OsApplication.
Configuration Parameters	

Name	OsCounterMaxAllowedValue [ECUC_Os_00027]		
Parent Container	OsCounter		
Description	Maximum possible allowed value of the system counter in ticks.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 18446744073709551615		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	OsCounterMinCycle [ECUC_Os_00028]	
Parent Container	OsCounter	
Description	The MINCYCLE attribute specifies the minimum allowed number of counter ticks for a cyclic alarm linked to the counter.	
Multiplicity	1	
Type	EcucIntegerParamDef	
Range	1 .. 18446744073709551615	
Default Value		

Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsCounterTicksPerBase [ECUC_Os_00029]		
Parent Container	OsCounter		
Description	The TICKSPERBASE attribute specifies the number of ticks required to reach a counterspecific unit. The interpretation is implementation-specific.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 4294967295		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsCounterType [ECUC_Os_00255]		
Parent Container	OsCounter		
Description	This parameter contains the natural type or unit of the counter.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	HARDWARE	This counter is driven by some hardware e.g. a hardware timer unit.	
	SOFTWARE	The counter is driven by some software which calls the IncrementCounter service.	
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsSecondsPerTick [ECUC_Os_00030]		
Parent Container	OsCounter		
Description	Time of one counter tick in seconds.		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. INF]		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsCounterAccessingApplication [ECUC_Os_00031]		
Parent Container	OsCounter		
Description	Reference to applications which have an access to this object.		
Multiplicity	0..*		
Type	Reference to OsApplication		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
OsDriver	0..1	<p>This Container contains the information who will drive the counter. This configuration is only valid if the counter has OsCounterType set to HARDWARE.</p> <p>If the container does not exist (multiplicity=0) the timer is managed by the OS internally (OSINTERNAL).</p> <p>If the container exists the OS can use the GPT interface to manage the timer. The user have to supply the GPT channel.</p> <p>If the counter is driven by some other (external to the OS) source (like a TPU for example) this must be described as a vendor specific extension.</p>
OsTimeConstant	0..*	<p>Allows the user to define constants which can be e.g. used to compare time values with timer tick values.</p> <p>A time value will be converted to a timer tick value during generation and can later on accessed via the OsConstName. The conversation is done by rounding time values to the nearest fitting tick value.</p>

E.5.4 OsEvent

SWS Item	[ECUC_Os_00033]
Container Name	OsEvent
Parent Container	Os
Description	Representation of OS events in the configuration context. Adopted from the ISO 17356-6 specification.
Configuration Parameters	

Name	OsEventMask [ECUC_Os_00034]		
Parent Container	OsEvent		
Description	If event mask would be set to AUTO in OIL, this parameter should be omitted here.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 18446744073709551615		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

E.5.5 OsScheduleTable

SWS Item	[ECUC_Os_00141]
Container Name	OsScheduleTable
Parent Container	Os
Description	An OsScheduleTable addresses the synchronization issue by providing an encapsulation of a statically defined set of alarms that cannot be modified at runtime.
Configuration Parameters	

Name	OsScheduleTableDuration [ECUC_Os_00053]		
Parent Container	OsScheduleTable		
Description	This parameter defines the modulus of the schedule table (in ticks).		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 18446744073709551615		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	OsScheduleTableRepeating [ECUC_Os_00144]		
Parent Container	OsScheduleTable		
Description	<p>true: first expiry point on the schedule table shall be processed at final expiry point delay ticks after the final expiry point is processed.</p> <p>false: the schedule table processing stops when the final expiry point is processed.</p>		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default Value			
Post-Build Variant Value	false		

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsScheduleTableCounterRef [ECUC_Os_00145]		
Parent Container	OsScheduleTable		
Description	This parameter contains a reference to the counter which drives the schedule table.		
Multiplicity	1		
Type	Reference to OsCounter		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsSchTblAccessingApplication [ECUC_Os_00054]		
Parent Container	OsScheduleTable		
Description	Reference to applications which have an access to this object.		
Multiplicity	0..*		
Type	Reference to OsApplication		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
OsScheduleTable Autostart	0..1	This container specifies if and how the schedule table is started on startup of the Operating System. The options to start a schedule table correspond to the API calls to start schedule tables during runtime.
OsScheduleTableExpiry Point	1..*	The point on a Schedule Table at which the OS activates tasks and/or sets events

OsScheduleTableSync	0..1	This container specifies the synchronization parameters of the schedule table.
---------------------	------	--

E.5.6 OsScheduleTableExpiryPoint

SWS Item	[ECUC_Os_00143]
Container Name	OsScheduleTableExpiryPoint
Parent Container	OsScheduleTable
Description	The point on a Schedule Table at which the OS activates tasks and/or sets events
Configuration Parameters	

Name	OsScheduleTblExpPointOffset [ECUC_Os_00062]		
Parent Container	OsScheduleTableExpiryPoint		
Description	The offset from zero (in ticks) at which the expiry point is to be processed.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 18446744073709551615		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency			

Included Containers		
Container Name	Multiplicity	Scope / Dependency
OsScheduleTableEvent Setting	0..*	Event that is triggered by that schedule table.
OsScheduleTableTask Activation	0..*	Task that is triggered by that schedule table.
OsScheduleTbl AdjustableExpPoint	0..1	Adjustable expiry point

E.5.7 OsTask

SWS Item	[ECUC_Os_00073]
Container Name	OsTask
Parent Container	Os
Description	This container represents an ISO 17356 task.
Configuration Parameters	

Name	OsTaskActivation [ECUC_Os_00074]		
Parent Container	OsTask		
Description	This attribute defines the maximum number of queued activation requests for the task. A value equal to "1" means that at any time only a single activation is permitted for this task. Note that the value must be a natural number starting at 1.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 4294967295		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsTaskPeriod [ECUC_Os_00404]		
Parent Container	OsTask		
Description	<p>This parameter specifies the period in seconds of this task in case of a cyclically activated task.</p> <p>If this parameter is not given the task can be activated sporadically or cyclically with a unknown period value.</p> <p>This value is information, e.g. for time base calculations in the RTE in case TimingEvents are mapped onto this OsTask. Be aware, that this parameter is not supposed to be relevant for the OS! This information is given as part of the OS configuration to support configuration work flows using a fixed set of OsTasks.</p>		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[-INF .. INF]		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsTaskPriority [ECUC_Os_00075]		
Parent Container	OsTask		
Description	<p>The priority of a task is defined by the value of this attribute. This value has to be understood as a relative value, i.e. the values show only the relative ordering of the tasks.</p> <p>ISO 17356-3 defines the lowest priority as zero (0); larger values correspond to higher priorities.</p>		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default Value			
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsTaskSchedule [ECUC_Os_00076]		
Parent Container	OsTask		
Description	<p>The OsTaskSchedule attribute defines the preemptability of the task.</p> <p>If this attribute is set to NON, no internal resources may be assigned to this task.</p>		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	FULL		Task is preemptable.
	NON		Task is not preemptable.
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsMemoryMappingCodeLocationRef [ECUC_Os_00402]		
Parent Container	OsTask		
Description	Reference to the memory mapping containing details about the section where the code is placed.		
Multiplicity	0..1		
Type	Foreign reference to SW-ADDR-METHOD		
Post-Build Variant Value	false		

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OsTaskAccessingApplication [ECUC_Os_00077]		
Parent Container	OsTask		
Description	Reference to applications which have an access to this object.		
Multiplicity	0..*		
Type	Reference to OsApplication		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsTaskEventRef [ECUC_Os_00078]		
Parent Container	OsTask		
Description	This reference defines the list of events the extended task may react on.		
Multiplicity	0..*		
Type	Reference to OsEvent		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsTaskResourceRef [ECUC_Os_00079]		
Parent Container	OsTask		
Description	This reference defines a list of resources accessed by this task.		
Multiplicity	0..*		
Type	Reference to OsResource		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
OsTaskAutostart	0..1	<p>This container determines whether the task is activated during the system start-up procedure or not for some specific application modes.</p> <p>If the task shall be activated during the system start-up, this container is present and holds the references to the application modes in which the task is auto-started.</p>
OsTaskTimingProtection	0..1	This container contains all parameters regarding timing protection of the task.

E.5.8 Oslr

SWS Item	[ECUC_Os_00041]
Container Name	Oslr
Parent Container	Os
Description	The Oslr container represents an ISO 17356 interrupt service routine.
Configuration Parameters	

Name	OslrCategory [ECUC_Os_00042]	
Parent Container	Oslr	
Description	This attribute specifies the category of this ISR.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	CATEGORY_1	Interrupt is of category 1
	CATEGORY_2	Interrupt is of category 2
Post-Build Variant Value	false	

Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OslrPeriod [ECUC_Os_00403]		
Parent Container	Oslr		
Description	<p>This parameter specifies the period in seconds of this ISR in case of a cyclically triggered interrupt.</p> <p>If this parameter is not given the interrupt can be activated sporadically or cyclically with a unknown period value.</p> <p>This value is information, e.g. for time base calculations in the RTE in case TimingEvents are mapped onto this Oslr. Be aware, that this parameter is not supposed to be relevant for the OS! It's the responsibility of the integrator to ensure the activation of the ISR according the configured period. This information is given as part of the OS configuration to support configuration work flows using a fixed set of Oslrs.</p>		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[-INF .. INF]		
Default Value			
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Name	OslrResourceRef [ECUC_Os_00043]		
Parent Container	Oslr		
Description	This reference defines the resources accessed by this ISR.		
Multiplicity	0..*		
Type	Reference to OsResource		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	OsMemoryMappingCodeLocationRef [ECUC_Os_00402]		
Parent Container	Oslsr		
Description	Reference to the memory mapping containing details about the section where the code is placed.		
Multiplicity	0..1		
Type	Foreign reference to SW-ADDR-METHOD		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: ECU		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
OsLsrTimingProtection	0..1	<p>This container contains all parameters which are related to timing protection</p> <p>If the container exists, the timing protection is used for this interrupt. If the container does not exist, the interrupt is not supervised regarding timing violations.</p>

E.6 Xfrm

E.6.1 XfrmImplementationMapping

SWS Item	[ECUC_Xfrm_00001]
Container Name	XfrmImplementationMapping
Parent Container	Xfrm
Description	For each transformer (TransformationTechnology) in a transformer chain (DataTransformation) which is applied to an ISignal it is necessary to specify the BswModuleEntry which implements it. This is the container to hold these mappings.
Configuration Parameters	

Name	XfrmTransformerClassExtractProtocolHeaderFields [ECUC_Xfrm_00022]		
Parent Container	XfrmImplementationMapping		
Description	Defines the transformerClass of the TransformationTechnology containing information in its protocol header that is required to distinguish between requests vs. responses and normal vs. error responses in C/S communication. Usually this shall be the TransformationTechnology with transformerClass equal to "serializer". Setting this parameter basically instructs the RTE to pass a pointer to the Mip_ExtractProtocolHeaderFields() function of the respective transformer as an additional argument to the called transformer function. E.g., if the serializing transformer in the transformer chain is SomelpXf and this parameter is set to SERIALIZER, then SomelpXf_ExtractProtocolHeaderFields() will be passed as additional argument.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	SAFETY	The Mip_ExtractProtocolHeaderFields function of the safety transformer in the chain shall be called.	
	SECURITY	The Mip_ExtractProtocolHeaderFields function of the security transformer in the chain shall be called.	
	SERIALIZER	The Mip_ExtractProtocolHeaderFields function of the serializing transformer in the chain shall be called	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	—	
	Post-build time	—	
Scope / Dependency	scope: local		

Name	XfrmCSTansactionHandleImplementationDataTypeRef [ECUC_Xfrm_00021]		
Parent Container	XfrmImplementationMapping		
Description	Reference to the ImplementationDataType with category STRUCTURE which defines the type of the C/S transaction handle. Setting this parameter basically instructs the RTE to pass a reference to a variable of exactly this ImplementationDataType as an additional argument to the called transformer function.		
Multiplicity	0..1		
Type	Foreign reference to IMPLEMENTATION-DATA-TYPE		
Post-Build Variant Multiplicity	false		

Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	XfrmInvTransformerBswModuleEntryRef [ECUC_Xfrm_00005]		
Parent Container	XfrmImplementationMapping		
Description	Reference to the BswModuleEntry which implements the referenced inverse transformer on the receiving/called side.		
Multiplicity	0..1		
Type	Foreign reference to BSW-MODULE-ENTRY		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	XfrmTransformationTechnologyRef [ECUC_Xfrm_00003]		
Parent Container	XfrmImplementationMapping		
Description	Reference to the TransformationTechnology in the DataTransformation of the system description for which the implementation (BswModuleEntry) shall be mapped.		
Multiplicity	1		
Type	Foreign reference to TRANSFORMATION-TECHNOLOGY		
Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	XfrmTransformerBswModuleEntryRef [ECUC_Xfrm_00018]		
Parent Container	XfrmImplementationMapping		
Description	Reference to the BswModuleEntry which implements the referenced transformer on the sending/calling side.		
Multiplicity	0..1		
Type	Foreign reference to BSW-MODULE-ENTRY		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Name	XfrmVariableDataPrototypeInstanceRef [ECUC_Xfrm_00011]		
Parent Container	XfrmImplementationMapping		
Description	Instance Reference to a VariableDataPrototype in case a dedicated transformer BswModuleEntry is required per VariableDataPrototype access.		
Multiplicity	0..1		
Type	Instance reference to VARIABLE-DATA-PROTOTYPE context: SW-COMPONENT-PROTOTYPE PORT-PROTOTYPE		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

Included Containers		
Container Name	Multiplicity	Scope / Dependency
XfrmDemEventParameterRefs	0..1	Container for the references to DemEventParameter elements which shall be invoked using the API Dem_SetEventStatus in case the corresponding error occurs. The EventId is taken from the referenced DemEventParameter's DemEventId symbolic value. The standardized errors are provided in this container and can be extended by vendor-specific error references.

XfrmSignal	0..1	Reference to the signal in the system description that transports the transformed data.
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F Examples

This chapter contains more detailed information for examples which were shown inside the preceding chapters of the specification.

F.1 ModeDeclarationGroupMapping

The example for **Mapping of ModeDeclarations** in chapter 4.4.10 is based on the following ARXML:

```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="
  http://autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.
  org/schema/r4.0_AUTOSAR_4-2-1.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Demo</SHORT-NAME>
      <DESC>
        <L-2 L="EN">Example about Connection of Mode Managers and Mode
          Users with different number of ModeDeclarations</L-2>
      </DESC>
      <CATEGORY>EXAMPLE</CATEGORY>
    </AR-PACKAGE>
    <AR-PACKAGE>
      <SHORT-NAME>SwComponentTypes</SHORT-NAME>
      <ELEMENTS>
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>ModeManager</SHORT-NAME>
          <PORTS>
            <P-PORT-PROTOTYPE>
              <SHORT-NAME>EcuState</SHORT-NAME>
              <PROVIDED-COM-SPECS>
                <MODE-SWITCH-SENDER-COM-SPEC>
                  <ENHANCED-MODE-API>true</ENHANCED-MODE-API>
                  <MODE-GROUP-REF DEST="MODE-DECLARATION-GROUP-
                    PROTOTYPE">/Demo/PortInterfaces/
                    EcuStatesExtended/EcuStatesExtended</MODE-
                    GROUP-REF>
                  <QUEUE-LENGTH>1</QUEUE-LENGTH>
                </MODE-SWITCH-SENDER-COM-SPEC>
              </PROVIDED-COM-SPECS>
              <PROVIDED-INTERFACE-TREF DEST="MODE-SWITCH-INTERFACE"
                >/Demo/PortInterfaces/EcuStatesExtended</PROVIDED-
                INTERFACE-TREF>
            </P-PORT-PROTOTYPE>
          </PORTS>
        </APPLICATION-SW-COMPONENT-TYPE>
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>ModeUser</SHORT-NAME>
          <PORTS>
            <R-PORT-PROTOTYPE>
              <SHORT-NAME>EcuState</SHORT-NAME>
              <REQUIRED-COM-SPECS>
```

```

        <MODE-SWITCH-RECEIVER-COM-SPEC>
        <ENHANCED-MODE-API>1</ENHANCED-MODE-API>
        <SUPPORTS-ASYNCHRONOUS-MODE-SWITCH>>false</
        SUPPORTS-ASYNCHRONOUS-MODE-SWITCH>
        </MODE-SWITCH-RECEIVER-COM-SPEC>
    </REQUIRED-COM-SPECS>
    <REQUIRED-INTERFACE-TREF DEST="MODE-SWITCH-INTERFACE"
        >/Demo/PortInterfaces/EcuStatesBasic</REQUIRED-
        INTERFACE-TREF>
    </R-PORT-PROTOTYPE>
</PORTS>
</APPLICATION-SW-COMPONENT-TYPE>
<COMPOSITION-SW-COMPONENT-TYPE>
    <SHORT-NAME>DemoEcu</SHORT-NAME>
    <COMPONENTS>
        <SW-COMPONENT-PROTOTYPE>
            <SHORT-NAME>ModeManager</SHORT-NAME>
            <TYPE-TREF DEST="APPLICATION-SW-COMPONENT-TYPE">/Demo/
            /SwComponentTypes/ModeManager</TYPE-TREF>
        </SW-COMPONENT-PROTOTYPE>
        <SW-COMPONENT-PROTOTYPE>
            <SHORT-NAME>ModeUser</SHORT-NAME>
            <TYPE-TREF DEST="APPLICATION-SW-COMPONENT-TYPE">/Demo/
            /SwComponentTypes/ModeUser</TYPE-TREF>
        </SW-COMPONENT-PROTOTYPE>
    </COMPONENTS>
    <CONNECTORS>
        <ASSEMBLY-SW-CONNECTOR>
            <SHORT-NAME>ModeManager_EcuState_ModeUser_EcuState</
            SHORT-NAME>
            <MAPPING-REF DEST="MODE-INTERFACE-MAPPING">/Demo/
            PortInterfaceMappingSets/
            ModeSwitchInterfaceMapping/
            EcuStatesExtended_2_EcuStatesBasic</MAPPING-REF>
            <PROVIDER-IREF>
                <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PROTOTYPE
                ">/Demo/SwComponentTypes/DemoEcu/ModeManager</
                CONTEXT-COMPONENT-REF>
                <TARGET-P-PORT-REF DEST="P-PORT-PROTOTYPE">/Demo/
                SwComponentTypes/ModeManager/EcuState</TARGET-P-
                -PORT-REF>
            </PROVIDER-IREF>
            <REQUESTER-IREF>
                <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PROTOTYPE
                ">/Demo/SwComponentTypes/DemoEcu/ModeUser</
                CONTEXT-COMPONENT-REF>
                <TARGET-R-PORT-REF DEST="R-PORT-PROTOTYPE">/Demo/
                SwComponentTypes/ModeUser/EcuState</TARGET-R-
                PORT-REF>
            </REQUESTER-IREF>
        </ASSEMBLY-SW-CONNECTOR>
    </CONNECTORS>
</COMPOSITION-SW-COMPONENT-TYPE>
</ELEMENTS>
</AR-PACKAGE>
<AR-PACKAGE>

```

```

<SHORT-NAME>PortInterfaces</SHORT-NAME>
<ELEMENTS>
  <MODE-SWITCH-INTERFACE>
    <SHORT-NAME>EcuStatesBasic</SHORT-NAME>
    <MODE-GROUP>
      <SHORT-NAME>EcuStatesBasic</SHORT-NAME>
      <SW-CALIBRATION-ACCESS>READ-ONLY</SW-CALIBRATION-ACCESS>
      >
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        ModeDeclarationGroups/EcuStatesBasic</TYPE-TREF>
    </MODE-GROUP>
  </MODE-SWITCH-INTERFACE>
  <MODE-SWITCH-INTERFACE>
    <SHORT-NAME>EcuStatesExtended</SHORT-NAME>
    <MODE-GROUP>
      <SHORT-NAME>EcuStatesExtended</SHORT-NAME>
      <SW-CALIBRATION-ACCESS>READ-ONLY</SW-CALIBRATION-ACCESS>
      >
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        ModeDeclarationGroups/EcuStatesExtended</TYPE-TREF>
    </MODE-GROUP>
  </MODE-SWITCH-INTERFACE>
</ELEMENTS>
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<AR-PACKAGE>
  <SHORT-NAME>ModeDeclarationGroups</SHORT-NAME>
  <ELEMENTS>
    <MODE-DECLARATION-GROUP>
      <SHORT-NAME>EcuStatesBasic</SHORT-NAME>
      <CATEGORY>EXPLICIT_ORDER</CATEGORY>
      <INITIAL-MODE-REF DEST="MODE-DECLARATION">/Demo/
        ModeDeclarationGroups/EcuStatesBasic/STARTUP</INITIAL
        -MODE-REF>

    <MODE-DECLARATIONS>
      <MODE-DECLARATION>
        <SHORT-NAME>STARTUP</SHORT-NAME>
        <DESC>
          <L-2 L="EN">Startup phase of the Ecu</L-2>
        </DESC>
        <VALUE>1</VALUE>
      </MODE-DECLARATION>
      <MODE-DECLARATION>
        <SHORT-NAME>RUN</SHORT-NAME>
        <DESC>
          <L-2 L="EN">Run phase of the Ecu</L-2>
        </DESC>
        <VALUE>2</VALUE>
      </MODE-DECLARATION>
      <MODE-DECLARATION>
        <SHORT-NAME>POST_RUN</SHORT-NAME>
        <DESC>
          <L-2 L="EN">post run phase of the Ecu</L-2>
        </DESC>
        <VALUE>3</VALUE>
      </MODE-DECLARATION>

```

```

<MODE-DECLARATION>
  <SHORT-NAME>SHUTDOWN</SHORT-NAME>
  <DESC>
    <L-2 L="EN">shutdown phase of the Ecu</L-2>
  </DESC>
  <VALUE>4</VALUE>
</MODE-DECLARATION>
</MODE-DECLARATIONS>
<MODE-TRANSITIONS>
<MODE-TRANSITION>
  <SHORT-NAME>STARTUP_RUN</SHORT-NAME>
  <ENTERED-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/RUN</ENTERED-
    MODE-REF>
  <EXITED-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/STARTUP</
    EXITED-MODE-REF>
</MODE-TRANSITION>
<MODE-TRANSITION>
  <SHORT-NAME>STARTUP_POST_RUN</SHORT-NAME>
  <ENTERED-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/POST_RUN</
    ENTERED-MODE-REF>
  <EXITED-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/STARTUP</
    EXITED-MODE-REF>
</MODE-TRANSITION>
<MODE-TRANSITION>
  <SHORT-NAME>RUN_POST_RUN</SHORT-NAME>
  <ENTERED-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/POST_RUN</
    ENTERED-MODE-REF>
  <EXITED-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/RUN</EXITED-
    MODE-REF>
</MODE-TRANSITION>
<MODE-TRANSITION>
  <SHORT-NAME>POST_RUN_SHUTDOWN</SHORT-NAME>
  <ENTERED-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/SHUTDOWN</
    ENTERED-MODE-REF>
  <EXITED-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/POST_RUN</
    EXITED-MODE-REF>
</MODE-TRANSITION>
</MODE-TRANSITIONS>
<ON-TRANSITION-VALUE>0</ON-TRANSITION-VALUE>
</MODE-DECLARATION-GROUP>
<MODE-DECLARATION-GROUP>
  <SHORT-NAME>EcuStatesExtended</SHORT-NAME>
  <CATEGORY>ALPHABETIC_ORDER</CATEGORY>
  <INITIAL-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesExtended/StartUp</
    INITIAL-MODE-REF>
</MODE-DECLARATIONS>
<MODE-DECLARATION>

```

```

        <SHORT-NAME>StartUp</SHORT-NAME>
        <DESC>
            <L-2 L="EN">Start up phase of the Ecu</L-2>
        </DESC>
    </MODE-DECLARATION>
    <MODE-DECLARATION>
        <SHORT-NAME>Run</SHORT-NAME>
        <DESC>
            <L-2 L="EN">Run phase of the Ecu</L-2>
        </DESC>
    </MODE-DECLARATION>
    <MODE-DECLARATION>
        <SHORT-NAME>PostRun1</SHORT-NAME>
        <DESC>
            <L-2 L="EN">First post run phase of the Ecu</L-2>
        </DESC>
    </MODE-DECLARATION>
    <MODE-DECLARATION>
        <SHORT-NAME>PostRun2</SHORT-NAME>
        <DESC>
            <L-2 L="EN">Second post run phase of the Ecu</L-2>
        </DESC>
    </MODE-DECLARATION>
    <MODE-DECLARATION>
        <SHORT-NAME>ShutDown</SHORT-NAME>
        <DESC>
            <L-2 L="EN">Shut down phase of the Ecu</L-2>
        </DESC>
    </MODE-DECLARATION>
    <MODE-DECLARATION>
        <SHORT-NAME>Sleep</SHORT-NAME>
        <DESC>
            <L-2 L="EN">Sleep mode of the Ecu with reduced
                functionality</L-2>
        </DESC>
    </MODE-DECLARATION>
    <MODE-DECLARATION>
        <SHORT-NAME>Hibernate</SHORT-NAME>
        <DESC>
            <L-2 L="EN">Hibernate mode of the Ecu with extreme
                reduced functionality</L-2>
        </DESC>
    </MODE-DECLARATION>
    </MODE-DECLARATIONS>
    </MODE-DECLARATION-GROUP>
</ELEMENTS>
</AR-PACKAGE>
<AR-PACKAGE>
    <SHORT-NAME>PortInterfaceMappingSets</SHORT-NAME>
    <ELEMENTS>
        <MODE-DECLARATION-MAPPING-SET>
            <SHORT-NAME>EcuStateMapping</SHORT-NAME>
            <MODE-DECLARATION-MAPPINGS>
                <MODE-DECLARATION-MAPPING>
                    <SHORT-NAME>StartUp_2_STARTUP_</SHORT-NAME>
                    <FIRST-MODE-REFS>

```

```

    <FIRST-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesExtended/StartUp
    </FIRST-MODE-REF>
  </FIRST-MODE-REFS>
  <SECOND-MODE-REF DEST="MODE-DECLARATION">/Demo/
    ModeDeclarationGroups/EcuStatesBasic/STARTUP</
    SECOND-MODE-REF>
</MODE-DECLARATION-MAPPING>
<MODE-DECLARATION-MAPPING>
  <SHORT-NAME>Run_2_RUN</SHORT-NAME>
  <FIRST-MODE-REFS>
    <FIRST-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesExtended/Run</
      FIRST-MODE-REF>
    </FIRST-MODE-REFS>
    <SECOND-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesBasic/RUN</SECOND-
      MODE-REF>
  </MODE-DECLARATION-MAPPING>
<MODE-DECLARATION-MAPPING>
  <SHORT-NAME>PostRunX_2_POST_RUN</SHORT-NAME>
  <FIRST-MODE-REFS>
    <FIRST-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesExtended/
      PostRun1</FIRST-MODE-REF>
    <FIRST-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesExtended/
      PostRun2</FIRST-MODE-REF>
    </FIRST-MODE-REFS>
    <SECOND-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesBasic/POST_RUN</
      SECOND-MODE-REF>
  </MODE-DECLARATION-MAPPING>
<MODE-DECLARATION-MAPPING>
  <SHORT-NAME>ShutDown_2_SHUTDOWN</SHORT-NAME>
  <FIRST-MODE-REFS>
    <FIRST-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesExtended/
      ShutDown</FIRST-MODE-REF>
    </FIRST-MODE-REFS>
    <SECOND-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesBasic/SHUTDOWN</
      SECOND-MODE-REF>
  </MODE-DECLARATION-MAPPING>
<MODE-DECLARATION-MAPPING>
  <SHORT-NAME>Sleep_Hibernate_2_SHUTDOWN</SHORT-NAME>
  <FIRST-MODE-REFS>
    <FIRST-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesExtended/Sleep</
      FIRST-MODE-REF>
    <FIRST-MODE-REF DEST="MODE-DECLARATION">/Demo/
      ModeDeclarationGroups/EcuStatesExtended/
      Hibernate</FIRST-MODE-REF>
    </FIRST-MODE-REFS>

```



```

        <SECOND-MODE-REF DEST="MODE-DECLARATION">/Demo/
            ModeDeclarationGroups/EcuStatesBasic/SHUTDOWN</
                SECOND-MODE-REF>
    </MODE-DECLARATION-MAPPING>
</MODE-DECLARATION-MAPPINGS>
</MODE-DECLARATION-MAPPING-SET>
<PORT-INTERFACE-MAPPING-SET>
    <SHORT-NAME>ModeSwitchInterfaceMapping</SHORT-NAME>
    <PORT-INTERFACE-MAPPINGS>
        <MODE-INTERFACE-MAPPING>
            <SHORT-NAME>EcuStatesExtended_2_EcuStatesBasic</SHORT-
                NAME>
        <MODE-MAPPING>
            <FIRST-MODE-GROUP-REF DEST="MODE-DECLARATION-GROUP-
                PROTOTYPE">/Demo/PortInterfaces/
                    EcuStatesExtended/EcuStatesExtended</FIRST-MODE-
                        GROUP-REF>
            <MODE-DECLARATION-MAPPING-SET-REF DEST="MODE-
                DECLARATION-MAPPING-SET">/Demo/
                    PortInterfaceMappingSets/EcuStateMapping</MODE-
                        DECLARATION-MAPPING-SET-REF>
            <SECOND-MODE-GROUP-REF DEST="MODE-DECLARATION-GROUP-
                PROTOTYPE">/Demo/PortInterfaces/EcuStatesBasic
                    /EcuStatesBasic</SECOND-MODE-GROUP-REF>
        </MODE-MAPPING>
    </MODE-INTERFACE-MAPPING>
</PORT-INTERFACE-MAPPINGS>
</PORT-INTERFACE-MAPPING-SET>
</ELEMENTS>
</AR-PACKAGE>
</AR-PACKAGES>
</AR-PACKAGE>
</AR-PACKAGES>
</AUTOSAR>

```

F.2 Stability need for received data

The example for **Stability need for received data** in example 4.7 is based on the following ARXML:

```

<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="
    http://autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.
    org/schema/r4.0_AUTOSAR_4-2-1.xsd">
    <AR-PACKAGES>
        <AR-PACKAGE>
            <SHORT-NAME>Demo</SHORT-NAME>
            <CATEGORY>EXAMPLE</CATEGORY>
            <AR-PACKAGES>
                <AR-PACKAGE>
                    <SHORT-NAME>SwComponentTypes</SHORT-NAME>
                <ELEMENTS>
                    <COMPOSITION-SW-COMPONENT-TYPE>

```

```

<SHORT-NAME>COMP_1</SHORT-NAME>
<DESC><L-2 L="EN">Stability need for received data (see
    SWS RTE) </L-2></DESC>
<CONSISTENCY-NEEDSS>
<CONSISTENCY-NEEDS>
    <SHORT-NAME>CN_BC</SHORT-NAME>
    <DPG-DOES-NOT-REQUIRE-COHERENCYS>
    <DATA-PROTOTYPE-GROUP>
        <SHORT-NAME>CN_BC_DG1</SHORT-NAME>
        <IMPLICIT-DATA-ACCESS-IREFS>
        <IMPLICIT-DATA-ACCESS-IREF>
        <CONTEXT-SW-COMPONENT-PROTOTYPE-REF DEST="SW-
            COMPONENT-PROTOTYPE">/Demo/SwComponentTypes/
            COMP_1/ASWC_B</CONTEXT-SW-COMPONENT-PROTOTYPE-REF
        >
        <CONTEXT-PORT-PROTOTYPE-REF DEST="R-PORT-PROTOTYPE">/
            Demo/SwComponentTypes/ASWC_B/A</CONTEXT-PORT-
            PROTOTYPE-REF>
        <TARGET-VARIABLE-DATA-PROTOTYPE-REF DEST="VARIABLE-
            DATA-PROTOTYPE">/Demo/PortInterfaces/A/A</TARGET-
            VARIABLE-DATA-PROTOTYPE-REF>
        </IMPLICIT-DATA-ACCESS-IREF>

        <IMPLICIT-DATA-ACCESS-IREF>
        <CONTEXT-SW-COMPONENT-PROTOTYPE-REF DEST="SW-
            COMPONENT-PROTOTYPE">/Demo/SwComponentTypes/
            COMP_1/ASWC_C</CONTEXT-SW-COMPONENT-PROTOTYPE-REF
        >
        <CONTEXT-PORT-PROTOTYPE-REF DEST="R-PORT-PROTOTYPE">/
            Demo/SwComponentTypes/ASWC_C/A</CONTEXT-PORT-
            PROTOTYPE-REF>
        <TARGET-VARIABLE-DATA-PROTOTYPE-REF DEST="VARIABLE-
            DATA-PROTOTYPE">/Demo/PortInterfaces/A/A</TARGET-
            VARIABLE-DATA-PROTOTYPE-REF>
        </IMPLICIT-DATA-ACCESS-IREF>

        <IMPLICIT-DATA-ACCESS-IREF>
        <CONTEXT-SW-COMPONENT-PROTOTYPE-REF DEST="SW-
            COMPONENT-PROTOTYPE">/Demo/SwComponentTypes/
            COMP_1/ASWC_B</CONTEXT-SW-COMPONENT-PROTOTYPE-REF
        >
        <CONTEXT-PORT-PROTOTYPE-REF DEST="R-PORT-PROTOTYPE">/
            Demo/SwComponentTypes/ASWC_B/B</CONTEXT-PORT-
            PROTOTYPE-REF>
        <TARGET-VARIABLE-DATA-PROTOTYPE-REF DEST="VARIABLE-
            DATA-PROTOTYPE">/Demo/PortInterfaces/B/B</TARGET-
            VARIABLE-DATA-PROTOTYPE-REF>
        </IMPLICIT-DATA-ACCESS-IREF>

        <IMPLICIT-DATA-ACCESS-IREF>
        <CONTEXT-SW-COMPONENT-PROTOTYPE-REF DEST="SW-
            COMPONENT-PROTOTYPE">/Demo/SwComponentTypes/
            COMP_1/ASWC_C</CONTEXT-SW-COMPONENT-PROTOTYPE-REF
        >

```

```

<CONTEXT-PORT-PROTOTYPE-REF DEST="R-PORT-PROTOTYPE">/
  Demo/SwComponentTypes/ASWC_C/B</CONTEXT-PORT-
  PROTOTYPE-REF>
<TARGET-VARIABLE-DATA-PROTOTYPE-REF DEST="VARIABLE-
  DATA-PROTOTYPE">/Demo/PortInterfaces/B/B</TARGET-
  VARIABLE-DATA-PROTOTYPE-REF>
</IMPLICIT-DATA-ACCESS-IREF>

</IMPLICIT-DATA-ACCESS-IREFS>
</DATA-PROTOTYPE-GROUP>
</DPG-DOES-NOT-REQUIRE-COHERENCYS>
<REG-REQUIRES-STABILITYS>
<RUNNABLE-ENTITY-GROUP>
  <SHORT-NAME>CN_BC_RG1</SHORT-NAME>
  <RUNNABLE-ENTITY-IREFS>
  <RUNNABLE-ENTITY-IREF>
    <CONTEXT-SW-COMPONENT-PROTOTYPE-REF DEST="SW-
      COMPONENT-PROTOTYPE">/Demo/SwComponentTypes/
      COMP_1/ASWC_B</CONTEXT-SW-COMPONENT-PROTOTYPE-REF
      >
    <TARGET-RUNNABLE-ENTITY-REF DEST="RUNNABLE-ENTITY">/
      Demo/SwComponentTypes/ASWC_B/IB_ASWC_B/
      ASWC_B_RUN1</TARGET-RUNNABLE-ENTITY-REF>
    </RUNNABLE-ENTITY-IREF>
    <RUNNABLE-ENTITY-IREF>
      <CONTEXT-SW-COMPONENT-PROTOTYPE-REF DEST="SW-
        COMPONENT-PROTOTYPE">/Demo/SwComponentTypes/
        COMP_1/ASWC_C</CONTEXT-SW-COMPONENT-PROTOTYPE-REF
        >
      <TARGET-RUNNABLE-ENTITY-REF DEST="RUNNABLE-ENTITY">/
        Demo/SwComponentTypes/ASWC_C/IB_ASWC_C/
        ASWC_C_RUN1</TARGET-RUNNABLE-ENTITY-REF>
      </RUNNABLE-ENTITY-IREF>
    </RUNNABLE-ENTITY-IREFS>
  </RUNNABLE-ENTITY-GROUP>
  </REG-REQUIRES-STABILITYS>
</CONSISTENCY-NEEDS>
</CONSISTENCY-NEEDSS>
<COMPONENTS>
  <SW-COMPONENT-PROTOTYPE>
    <SHORT-NAME>ASWC_A</SHORT-NAME>
    <TYPE-TREF DEST="APPLICATION-SW-COMPONENT-TYPE">/Demo
      /SwComponentTypes/ASWC_A</TYPE-TREF>
  </SW-COMPONENT-PROTOTYPE>
  <SW-COMPONENT-PROTOTYPE>
    <SHORT-NAME>ASWC_B</SHORT-NAME>
    <TYPE-TREF DEST="APPLICATION-SW-COMPONENT-TYPE">/Demo
      /SwComponentTypes/ASWC_B</TYPE-TREF>
  </SW-COMPONENT-PROTOTYPE>
  <SW-COMPONENT-PROTOTYPE>
    <SHORT-NAME>ASWC_C</SHORT-NAME>
    <TYPE-TREF DEST="APPLICATION-SW-COMPONENT-TYPE">/Demo
      /SwComponentTypes/ASWC_C</TYPE-TREF>
  </SW-COMPONENT-PROTOTYPE>
</COMPONENTS>
</COMPOSITION-SW-COMPONENT-TYPE>

```

```

<APPLICATION-SW-COMPONENT-TYPE>
  <SHORT-NAME>ASWC_A</SHORT-NAME>
  <PORTS>
    <P-PORT-PROTOTYPE>
      <SHORT-NAME>A</SHORT-NAME>
      <PROVIDED-INTERFACE-TREF DEST="SENDER-RECEIVER-
        INTERFACE">/Demo/PortInterfaces/A</PROVIDED-
        INTERFACE-TREF>
    </P-PORT-PROTOTYPE>
    <P-PORT-PROTOTYPE>
      <SHORT-NAME>B</SHORT-NAME>
      <PROVIDED-INTERFACE-TREF DEST="SENDER-RECEIVER-
        INTERFACE">/Demo/PortInterfaces/B</PROVIDED-
        INTERFACE-TREF>
    </P-PORT-PROTOTYPE>
  </PORTS>
  <INTERNAL-BEHAVIORS>
    <SWC-INTERNAL-BEHAVIOR>
      <SHORT-NAME>IB_ASWC_A</SHORT-NAME>
      <RUNNABLES>
        <RUNNABLE-ENTITY>
          <SHORT-NAME>ASWC_A_RUN1</SHORT-NAME>
          <DATA-WRITE-ACCESS>
            <VARIABLE-ACCESS>
              <SHORT-NAME>DWP_ASWC_A_RUN1_A_A</SHORT-NAME>
              <ACCESSED-VARIABLE>
                <AUTOSAR-VARIABLE-IREF>
                  <PORT-PROTOTYPE-REF DEST="P-PORT-
                    PROTOTYPE">/Demo/SwComponentTypes/
                    ASWC_A/A</PORT-PROTOTYPE-REF>
                  <TARGET-DATA-PROTOTYPE-REF DEST="VARIABLE
                    -DATA-PROTOTYPE">/Demo/PortInterfaces
                    /A/A</TARGET-DATA-PROTOTYPE-REF>
                </AUTOSAR-VARIABLE-IREF>
              </ACCESSED-VARIABLE>
            </VARIABLE-ACCESS>
            <VARIABLE-ACCESS>
              <SHORT-NAME>DWP_ASWC_A_RUN1_B_B</SHORT-NAME>
              <ACCESSED-VARIABLE>
                <AUTOSAR-VARIABLE-IREF>
                  <PORT-PROTOTYPE-REF DEST="P-PORT-
                    PROTOTYPE">/Demo/SwComponentTypes/
                    ASWC_A/B</PORT-PROTOTYPE-REF>
                  <TARGET-DATA-PROTOTYPE-REF DEST="VARIABLE
                    -DATA-PROTOTYPE">/Demo/PortInterfaces
                    /B/B</TARGET-DATA-PROTOTYPE-REF>
                </AUTOSAR-VARIABLE-IREF>
              </ACCESSED-VARIABLE>
            </VARIABLE-ACCESS>
          </DATA-WRITE-ACCESS>
        </RUNNABLE-ENTITY>
      </RUNNABLES>
    </SWC-INTERNAL-BEHAVIOR>
  </INTERNAL-BEHAVIORS>
</APPLICATION-SW-COMPONENT-TYPE>
<APPLICATION-SW-COMPONENT-TYPE>

```

```

<SHORT-NAME>ASWC_B</SHORT-NAME>
<PORTS>
  <R-PORT-PROTOTYPE>
    <SHORT-NAME>A</SHORT-NAME>
    <REQUIRED-INTERFACE-TREF DEST="SENDER-RECEIVER-
      INTERFACE"/>/Demo/PortInterfaces/A</REQUIRED-
      INTERFACE-TREF>
  </R-PORT-PROTOTYPE>
  <R-PORT-PROTOTYPE>
    <SHORT-NAME>B</SHORT-NAME>
    <REQUIRED-INTERFACE-TREF DEST="SENDER-RECEIVER-
      INTERFACE"/>/Demo/PortInterfaces/B</REQUIRED-
      INTERFACE-TREF>
  </R-PORT-PROTOTYPE>
</PORTS>
<INTERNAL-BEHAVIORS>
  <SWC-INTERNAL-BEHAVIOR>
    <SHORT-NAME>IB_ASWC_B</SHORT-NAME>
    <RUNNABLES>
      <RUNNABLE-ENTITY>
        <SHORT-NAME>ASWC_B_RUN1</SHORT-NAME>
        <DATA-READ-ACCESS>
          <VARIABLE-ACCESS>
            <SHORT-NAME>DWP_ASWC_B_RUN1_A_A</SHORT-NAME>
            <ACCESSED-VARIABLE>
              <AUTOSAR-VARIABLE-IREF>
                <PORT-PROTOTYPE-REF DEST="R-PORT-
                  PROTOTYPE"/>/Demo/SwComponentTypes/
                  ASWC_B/A</PORT-PROTOTYPE-REF>
                <TARGET-DATA-PROTOTYPE-REF DEST="VARIABLE-
                  -DATA-PROTOTYPE"/>/Demo/PortInterfaces
                  /A/A</TARGET-DATA-PROTOTYPE-REF>
              </AUTOSAR-VARIABLE-IREF>
            </ACCESSED-VARIABLE>
          </VARIABLE-ACCESS>
          <VARIABLE-ACCESS>
            <SHORT-NAME>DWP_ASWC_B_RUN1_B_B</SHORT-NAME>
            <ACCESSED-VARIABLE>
              <AUTOSAR-VARIABLE-IREF>
                <PORT-PROTOTYPE-REF DEST="R-PORT-
                  PROTOTYPE"/>/Demo/SwComponentTypes/
                  ASWC_B/B</PORT-PROTOTYPE-REF>
                <TARGET-DATA-PROTOTYPE-REF DEST="VARIABLE-
                  -DATA-PROTOTYPE"/>/Demo/PortInterfaces
                  /B/B</TARGET-DATA-PROTOTYPE-REF>
              </AUTOSAR-VARIABLE-IREF>
            </ACCESSED-VARIABLE>
          </VARIABLE-ACCESS>
        </DATA-READ-ACCESS>
      </RUNNABLE-ENTITY>
    </RUNNABLES>
  </SWC-INTERNAL-BEHAVIOR>
</INTERNAL-BEHAVIORS>
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<APPLICATION-SW-COMPONENT-TYPE>
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```

```

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    <SHORT-NAME>A</SHORT-NAME>
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      INTERFACE"/>/Demo/PortInterfaces/A</REQUIRED-
      INTERFACE-TREF>
  </R-PORT-PROTOTYPE>
  <R-PORT-PROTOTYPE>
    <SHORT-NAME>B</SHORT-NAME>
    <REQUIRED-INTERFACE-TREF DEST="SENDER-RECEIVER-
      INTERFACE"/>/Demo/PortInterfaces/B</REQUIRED-
      INTERFACE-TREF>
  </R-PORT-PROTOTYPE>
</PORTS>
<INTERNAL-BEHAVIORS>
  <SWC-INTERNAL-BEHAVIOR>
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    <RUNNABLES>
      <RUNNABLE-ENTITY>
        <SHORT-NAME>ASWC_C_RUN1</SHORT-NAME>
        <DATA-READ-ACCESS>
          <VARIABLE-ACCESS>
            <SHORT-NAME>DWP_ASWC_C_RUN1_A_A</SHORT-NAME>
            <ACCESSED-VARIABLE>
              <AUTOSAR-VARIABLE-IREF>
                <PORT-PROTOTYPE-REF DEST="R-PORT-
                  PROTOTYPE"/>/Demo/SwComponentTypes/
                  ASWC_C/A</PORT-PROTOTYPE-REF>
                <TARGET-DATA-PROTOTYPE-REF DEST="VARIABLE
                  -DATA-PROTOTYPE"/>/Demo/PortInterfaces
                  /A/A</TARGET-DATA-PROTOTYPE-REF>
              </AUTOSAR-VARIABLE-IREF>
            </ACCESSED-VARIABLE>
          </VARIABLE-ACCESS>
          <VARIABLE-ACCESS>
            <SHORT-NAME>DWP_ASWC_C_RUN1_B_B</SHORT-NAME>
            <ACCESSED-VARIABLE>
              <AUTOSAR-VARIABLE-IREF>
                <PORT-PROTOTYPE-REF DEST="R-PORT-
                  PROTOTYPE"/>/Demo/SwComponentTypes/
                  ASWC_C/B</PORT-PROTOTYPE-REF>
                <TARGET-DATA-PROTOTYPE-REF DEST="VARIABLE
                  -DATA-PROTOTYPE"/>/Demo/PortInterfaces
                  /B/B</TARGET-DATA-PROTOTYPE-REF>
              </AUTOSAR-VARIABLE-IREF>
            </ACCESSED-VARIABLE>
          </VARIABLE-ACCESS>
        </DATA-READ-ACCESS>
      </RUNNABLE-ENTITY>
    </RUNNABLES>
  </SWC-INTERNAL-BEHAVIOR>
</INTERNAL-BEHAVIORS>
</APPLICATION-SW-COMPONENT-TYPE>
</ELEMENTS>
</AR-PACKAGE>
<AR-PACKAGE>

```

```

<SHORT-NAME>PortInterfaces</SHORT-NAME>
<ELEMENTS>
  <SENDER-RECEIVER-INTERFACE>
    <SHORT-NAME>A</SHORT-NAME>
    <DATA-ELEMENTS>
      <VARIABLE-DATA-PROTOTYPE>
        <SHORT-NAME>A</SHORT-NAME>
      </VARIABLE-DATA-PROTOTYPE>
    </DATA-ELEMENTS>
  </SENDER-RECEIVER-INTERFACE>
  <SENDER-RECEIVER-INTERFACE>
    <SHORT-NAME>B</SHORT-NAME>
    <DATA-ELEMENTS>
      <VARIABLE-DATA-PROTOTYPE>
        <SHORT-NAME>B</SHORT-NAME>
      </VARIABLE-DATA-PROTOTYPE>
    </DATA-ELEMENTS>
  </SENDER-RECEIVER-INTERFACE>
</ELEMENTS>
</AR-PACKAGE>
</AR-PACKAGES>
</AR-PACKAGE>
</AR-PACKAGES>
</AUTOSAR>

```

F.3 CompuMethod with bitfield texttable conversion

The following [CompuMethod](#) of [category](#) BITFIELD_TEXTTABLE

Listing F.1: example for bit field text table [CompuMethod](#)

```

1 <COMPU-METHOD>
2   <SHORT-NAME>Texttable</SHORT-NAME>
3   <CATEGORY>BITFIELD_TEXTTABLE</CATEGORY>
4   <COMPU-INTERNAL-TO-PHYS>
5     <COMPU-SCALES>
6       <!-- problem -->
7       <COMPU-SCALE>
8         <SHORT-LABEL>problem</SHORT-LABEL>
9         <SYMBOL>problem_flat_tire</SYMBOL>
10        <MASK>0b11110000</MASK>
11        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</LOWER-LIMIT>
12        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</UPPER-LIMIT>
13        <COMPU-CONST>
14          <VT>flat tire</VT>
15        </COMPU-CONST>
16      </COMPU-SCALE>
17      <COMPU-SCALE>
18        <SHORT-LABEL>problem</SHORT-LABEL>
19        <SYMBOL>problem_low_pressure</SYMBOL>
20        <MASK>0b11110000</MASK>
21        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00010000</LOWER-LIMIT>
22        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00010000</UPPER-LIMIT>
23        <COMPU-CONST>

```

```

24         <VT>low pressure</VT>
25     </COMPU-CONST>
26 </COMPU-SCALE>
27 <COMPU-SCALE>
28     <SHORT-LABEL>problem</SHORT-LABEL>
29     <SYMBOL>problem_unbalanced</SYMBOL>
30     <MASK>0b11110000</MASK>
31     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00100000</LOWER-LIMIT>
32     <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00100000</UPPER-LIMIT>
33     <COMPU-CONST>
34         <VT>unbalanced</VT>
35     </COMPU-CONST>
36 </COMPU-SCALE>
37 <COMPU-SCALE>
38     <SHORT-LABEL>problem</SHORT-LABEL>
39     <SYMBOL>problem_unknown</SYMBOL>
40     <MASK>0b11110000</MASK>
41     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00110000</LOWER-LIMIT>
42     <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00110000</UPPER-LIMIT>
43     <COMPU-CONST>
44         <VT>unknown</VT>
45     </COMPU-CONST>
46 </COMPU-SCALE>
47 <COMPU-SCALE>
48     <SHORT-LABEL>problem</SHORT-LABEL>
49     <SYMBOL>problem_invalid</SYMBOL>
50     <MASK>0b11110000</MASK>
51     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b11110000</LOWER-LIMIT>
52     <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b11110000</UPPER-LIMIT>
53     <COMPU-CONST>
54         <VT>invalid</VT>
55     </COMPU-CONST>
56 </COMPU-SCALE>
57 <!-- rear right -->
58 <COMPU-SCALE>
59     <SHORT-LABEL>rearRight</SHORT-LABEL>
60     <SYMBOL>rearRight_no</SYMBOL>
61     <MASK>0b11001000</MASK>
62     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</LOWER-LIMIT>
63     <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</UPPER-LIMIT>
64     <COMPU-CONST>
65         <VT>no</VT>
66     </COMPU-CONST>
67 </COMPU-SCALE>
68 <COMPU-SCALE>
69     <SHORT-LABEL>rearRight</SHORT-LABEL>
70     <SYMBOL>rearRight_yes</SYMBOL>
71     <MASK>0b11001000</MASK>
72     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00001000</LOWER-LIMIT>
73     <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00001000</UPPER-LIMIT>
74     <COMPU-CONST>
75         <VT>yes</VT>
76     </COMPU-CONST>
77 </COMPU-SCALE>
78 <!-- rear left -->
79 <COMPU-SCALE>

```



```

80      <SHORT-LABEL>rearLeft</SHORT-LABEL>
81      <SYMBOL>rearLeft_no</SYMBOL>
82      <MASK>0b11000100</MASK>
83      <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</LOWER-LIMIT>
84      <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</UPPER-LIMIT>
85      <COMPU-CONST>
86          <VT>no</VT>
87      </COMPU-CONST>
88  </COMPU-SCALE>
89  <COMPU-SCALE>
90      <SHORT-LABEL>rearLeft</SHORT-LABEL>
91      <SYMBOL>rearLeft_yes</SYMBOL>
92      <MASK>0b11000100</MASK>
93      <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00000100</LOWER-LIMIT>
94      <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00000100</UPPER-LIMIT>
95      <COMPU-CONST>
96          <VT>yes</VT>
97      </COMPU-CONST>
98  </COMPU-SCALE>
99  <!-- front right -->
100 <COMPU-SCALE>
101     <SHORT-LABEL>frontRight</SHORT-LABEL>
102     <SYMBOL>frontRight_no</SYMBOL>
103     <MASK>0b11000010</MASK>
104     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</LOWER-LIMIT>
105     <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</UPPER-LIMIT>
106     <COMPU-CONST>
107         <VT>no</VT>
108     </COMPU-CONST>
109 </COMPU-SCALE>
110 <COMPU-SCALE>
111     <SHORT-LABEL>frontRight</SHORT-LABEL>
112     <SYMBOL>frontRight_yes</SYMBOL>
113     <MASK>0b11000010</MASK>
114     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00000010</LOWER-LIMIT>
115     <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00000010</UPPER-LIMIT>
116     <COMPU-CONST>
117         <VT>yes</VT>
118     </COMPU-CONST>
119 </COMPU-SCALE>
120 <!-- front left -->
121 <COMPU-SCALE>
122     <SHORT-LABEL>frontLeft</SHORT-LABEL>
123     <SYMBOL>frontLeft_no</SYMBOL>
124     <MASK>0b11000001</MASK>
125     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</LOWER-LIMIT>
126     <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00000000</UPPER-LIMIT>
127     <COMPU-CONST>
128         <VT>no</VT>
129     </COMPU-CONST>
130 </COMPU-SCALE>
131 <COMPU-SCALE>
132     <SHORT-LABEL>frontLeft</SHORT-LABEL>
133     <SYMBOL>frontLeft_yes</SYMBOL>
134     <MASK>0b11000001</MASK>
135     <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0b00000001</LOWER-LIMIT>

```

```

136         <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0b00000001</UPPER-LIMIT>
137         <COMPU-CONST>
138             <VT>yes</VT>
139         </COMPU-CONST>
140     </COMPU-SCALE>
141 </COMPU-SCALES>
142 </COMPU-INTERNAL-TO-PHYS>
143 </COMPU-METHOD>

```

results in this definitions:

Listing F.2: literals for bit field text table **CompuMethod**

```

1  /* [SWS_Rte_07410] unique "shortLabel" / "mask" pair "problem" / 0
   b11110000 */
2  #ifndef problem_BflMask
3  #define problem_BflMask 240U
4  #endif /* problem_BflMask */
5
6  /* [SWS_Rte_07411] unique "shortLabel" / "mask" pair "problem" / 0
   b11110000 with a single contiguous bit field*/
7  #ifndef problem_BflPn
8  #define problem_BflPn 4U
9  #endif /* problem_BflPn */
10
11 /* [SWS_Rte_07412] unique "shortLabel" / "mask" pair "problem" / 0
   b11110000 with a single contiguous bit field*/
12 #ifndef problem_BflLn
13 #define problem_BflLn 4U
14 #endif /* problem_BflLn */
15
16 /* [SWS_Rte_03810] CompuScale with point range "0b00000000", symbol
   attribute "problem_flat_tire"*/
17 #ifndef problem_flat_tire
18 #define problem_flat_tire 0U
19 #endif /* problem_flat_tire */
20
21 /* [SWS_Rte_03810] CompuScale with point range "0b00010000", symbol
   attribute "problem_low_pressure"*/
22 #ifndef problem_low_pressure
23 #define problem_low_pressure 16U
24 #endif /* problem_low_pressure */
25
26 /* [SWS_Rte_03810] CompuScale with point range "0b00100000", symbol
   attribute "problem_unbalanced"*/
27 #ifndef problem_unbalanced
28 #define problem_unbalanced 32U
29 #endif /* problem_unbalanced */
30
31 /* [SWS_Rte_03810] CompuScale with point range "0b00110000", symbol
   attribute "problem_unknown"*/
32 #ifndef problem_unknown
33 #define problem_unknown 48U
34 #endif /* problem_unknown */
35

```

```

36  /* [SWS_Rte_03810] CompuScale with point range "0b11110000", symbol
    attribute "problem_invalid"*/
37  #ifndef problem_invalid
38  #define problem_invalid 240U
39  #endif /* problem_invalid */
40
41  /* [SWS_Rte_07410] unique "shortLabel" / "mask" pair "rearRight" / 0
    b11001000 */
42  #ifndef rearRight_BflMask
43  #define rearRight_BflMask 200U
44  #endif /* rearRight_BflMask */
45
46  /* [SWS_Rte_07411] unique "shortLabel" / "mask" pair "rearRight" / 0
    b11001000 but not a single contiguous bit field*/
47
48  /* [SWS_Rte_07412] unique "shortLabel" / "mask" pair "rearRight" / 0
    b11001000 bot not a single contiguous bit field*/
49
50  /* [SWS_Rte_03810] CompuScale with point range "0b00000000", symbol
    attribute "rearRight_no"*/
51  #ifndef rearRight_no
52  #define rearRight_no 0U
53  #endif /* rearRight_no */
54
55  /* [SWS_Rte_03810] CompuScale with point range "0b00001000", symbol
    attribute "rearRight_yes"*/
56  #ifndef rearRight_yes
57  #define rearRight_yes 8U
58  #endif /* rearRight_yes */
59
60  /* [SWS_Rte_07410] unique "shortLabel" / "mask" pair "rearLeft" / 0
    b11000100 */
61  #ifndef rearLeft_BflMask
62  #define rearLeft_BflMask 200U
63  #endif /* rearLeft_BflMask */
64
65  /* [SWS_Rte_07411] unique "shortLabel" / "mask" pair "rearLeft" / 0
    b11000100 but not a single contiguous bit field*/
66
67  /* [SWS_Rte_07412] unique "shortLabel" / "mask" pair "rearLeft" / 0
    b11000100 bot not a single contiguous bit field*/
68
69  /* [SWS_Rte_03810] CompuScale with point range "0b00000000", symbol
    attribute "rearLeft_no"*/
70  #ifndef rearLeft_no
71  #define rearLeft_no 0U
72  #endif /* rearLeft_no */
73
74  /* [SWS_Rte_03810] CompuScale with point range "0b00000100", symbol
    attribute "rearLeft_yes"*/
75  #ifndef rearLeft_yes
76  #define rearLeft_yes 4U
77  #endif /* rearLeft_yes */
78
79  /* [SWS_Rte_07410] unique "shortLabel" / "mask" pair "frontRight" / 0
    b11000010 */

```

```

80 #ifndef frontRight_BflMask
81 #define frontRight_BflMask 194U
82 #endif /* frontRight_BflMask */
83
84 /* [SWS_Rte_07411] unique "shortLabel" / "mask" pair "frontRight" / 0
   b11000010 but not a single contiguous bit field*/
85
86 /* [SWS_Rte_07412] unique "shortLabel" / "mask" pair "frontRight" / 0
   b11000010 bot not a single contiguous bit field*/
87
88 /* [SWS_Rte_03810] CompuScale with point range "0b00000000", symbol
   attribute "frontRight_no"*/
89 #ifndef frontRight_no
90 #define frontRight_no 0U
91 #endif /* frontRight_no */
92
93 /* [SWS_Rte_03810] CompuScale with point range "0b00000010", symbol
   attribute "frontRight_yes"*/
94 #ifndef frontRight_yes
95 #define frontRight_yes 2U
96 #endif /* frontRight_yes */
97
98 /* [SWS_Rte_07410] unique "shortLabel" / "mask" pair "frontLeft" / 0
   b11000001 */
99 #ifndef frontLeft_BflMask
100 #define frontLeft_BflMask 193U
101 #endif /* frontLeft_BflMask */
102
103 /* [SWS_Rte_07411] unique "shortLabel" / "mask" pair "frontLeft" / 0
   b11000001 but not a single contiguous bit field*/
104
105 /* [SWS_Rte_07412] unique "shortLabel" / "mask" pair "frontLeft" / 0
   b11000001 bot not a single contiguous bit field*/
106
107 /* [SWS_Rte_03810] CompuScale with point range "0b00000000", symbol
   attribute "frontLeft_no"*/
108 #ifndef frontLeft_no
109 #define frontLeft_no 0U
110 #endif /* frontLeft_no */
111
112 /* [SWS_Rte_03810] CompuScale with point range "0b00000001", symbol
   attribute "frontLeft_yes"*/
113 #ifndef frontLeft_yes
114 #define frontLeft_yes 1U
115 #endif /* frontLeft_yes */

```

F.4 Structure type with self-reference

The example **Structure type with self-reference** in the following ARXML shows a structure type which contains as an element a pointer witch can point to objects being of the type of the structure. Those types are usually needed for linked lists.

```
<?xml version="1.0" encoding="UTF-8"?>
```

```

<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="
  http://autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.
  org/schema/r4.0_AUTOSAR_4-2-1.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Demo</SHORT-NAME>
      <DESC>
        <L-2 L="EN">Example about structure with a reference to its own
          type</L-2>
      </DESC>
      <CATEGORY>EXAMPLE</CATEGORY>
    </AR-PACKAGE>
    <AR-PACKAGE>
      <SHORT-NAME>ImplementationDataTypes</SHORT-NAME>
      <ELEMENTS>
        <IMPLEMENTATION-DATA-TYPE>
          <SHORT-NAME>DataSet</SHORT-NAME>
          <CATEGORY>STRUCTURE</CATEGORY>
          <SUB-ELEMENTS>
            <IMPLEMENTATION-DATA-TYPE-ELEMENT>
              <SHORT-NAME>data1</SHORT-NAME>
              <CATEGORY>TYPE_REFERENCE</CATEGORY>
              <SW-DATA-DEF-PROPS>
                <SW-DATA-DEF-PROPS-VARIANTS>
                  <SW-DATA-DEF-PROPS-CONDITIONAL>
                    <IMPLEMENTATION-DATA-TYPE-REF DEST="
                      IMPLEMENTATION-DATA-TYPE"/>/AUTOSAR_Platform
                      /ImplementationDataTypes/uint32</
                      IMPLEMENTATION-DATA-TYPE-REF>
                  </SW-DATA-DEF-PROPS-CONDITIONAL>
                </SW-DATA-DEF-PROPS-VARIANTS>
              </SW-DATA-DEF-PROPS>
            </IMPLEMENTATION-DATA-TYPE-ELEMENT>
            <IMPLEMENTATION-DATA-TYPE-ELEMENT>
              <SHORT-NAME>data2</SHORT-NAME>
              <CATEGORY>TYPE_REFERENCE</CATEGORY>
              <SW-DATA-DEF-PROPS>
                <SW-DATA-DEF-PROPS-VARIANTS>
                  <SW-DATA-DEF-PROPS-CONDITIONAL>
                    <IMPLEMENTATION-DATA-TYPE-REF DEST="
                      IMPLEMENTATION-DATA-TYPE"/>/AUTOSAR_Platform
                      /ImplementationDataTypes/uint8</
                      IMPLEMENTATION-DATA-TYPE-REF>
                  </SW-DATA-DEF-PROPS-CONDITIONAL>
                </SW-DATA-DEF-PROPS-VARIANTS>
              </SW-DATA-DEF-PROPS>
            </IMPLEMENTATION-DATA-TYPE-ELEMENT>
            <IMPLEMENTATION-DATA-TYPE-ELEMENT>
              <SHORT-NAME>dataSetPtr</SHORT-NAME>
              <CATEGORY>DATA_REFERENCE</CATEGORY>
              <SW-DATA-DEF-PROPS>
                <SW-DATA-DEF-PROPS-VARIANTS>
                  <SW-DATA-DEF-PROPS-CONDITIONAL>
                    <SW-POINTER-TARGET-PROPS>
                      <TARGET-CATEGORY>TYPE_REFERENCE</TARGET-
                        CATEGORY>

```

```

<SW-DATA-DEF-PROPS>
  <SW-DATA-DEF-PROPS-VARIANTS>
    <SW-DATA-DEF-PROPS-CONDITIONAL>
      <IMPLEMENTATION-DATA-TYPE-REF DEST="
        IMPLEMENTATION-DATA-TYPE">/Demo/
        ImplementationDataTypes/DataSet</
        IMPLEMENTATION-DATA-TYPE-REF>
      </SW-DATA-DEF-PROPS-CONDITIONAL>
    </SW-DATA-DEF-PROPS-VARIANTS>
  </SW-DATA-DEF-PROPS>
</SW-POINTER-TARGET-PROPS>
</SW-DATA-DEF-PROPS-CONDITIONAL>
</SW-DATA-DEF-PROPS-VARIANTS>
</SW-DATA-DEF-PROPS>
</IMPLEMENTATION-DATA-TYPE-ELEMENT>
<IMPLEMENTATION-DATA-TYPE-ELEMENT>
  <SHORT-NAME>substruct</SHORT-NAME>
  <CATEGORY>STRUCTURE</CATEGORY>
  <SUB-ELEMENTS>
    <IMPLEMENTATION-DATA-TYPE-ELEMENT>
      <SHORT-NAME>sub1</SHORT-NAME>
      <CATEGORY>TYPE_REFERENCE</CATEGORY>
      <SW-DATA-DEF-PROPS>
        <SW-DATA-DEF-PROPS-VARIANTS>
          <SW-DATA-DEF-PROPS-CONDITIONAL>
            <IMPLEMENTATION-DATA-TYPE-REF DEST="
              IMPLEMENTATION-DATA-TYPE">/
              AUTOSAR_Platform/
              ImplementationDataTypes/uint8</
              IMPLEMENTATION-DATA-TYPE-REF>
            </SW-DATA-DEF-PROPS-CONDITIONAL>
          </SW-DATA-DEF-PROPS-VARIANTS>
        </SW-DATA-DEF-PROPS>
      </IMPLEMENTATION-DATA-TYPE-ELEMENT>
    <IMPLEMENTATION-DATA-TYPE-ELEMENT>
      <SHORT-NAME>sub2</SHORT-NAME>
      <CATEGORY>TYPE_REFERENCE</CATEGORY>
      <SW-DATA-DEF-PROPS>
        <SW-DATA-DEF-PROPS-VARIANTS>
          <SW-DATA-DEF-PROPS-CONDITIONAL>
            <IMPLEMENTATION-DATA-TYPE-REF DEST="
              IMPLEMENTATION-DATA-TYPE">/
              AUTOSAR_Platform/
              ImplementationDataTypes/uint8</
              IMPLEMENTATION-DATA-TYPE-REF>
            </SW-DATA-DEF-PROPS-CONDITIONAL>
          </SW-DATA-DEF-PROPS-VARIANTS>
        </SW-DATA-DEF-PROPS>
      </IMPLEMENTATION-DATA-TYPE-ELEMENT>
    </SUB-ELEMENTS>
  </IMPLEMENTATION-DATA-TYPE-ELEMENT>
</SUB-ELEMENTS>
<TYPE-EMITTER>RTE</TYPE-EMITTER>
</IMPLEMENTATION-DATA-TYPE>
</ELEMENTS>
</AR-PACKAGE>

```

```

    </AR-PACKAGES>
  </AR-PACKAGE>
</AR-PACKAGES>
</AUTOSAR>

```

This results according [SWS_Rte_07114] and [SWS_Rte_06812] in following code in the `Rte_Type.h` file.

Listing F.3: Structure type with self-reference

```

1  /* typedef is created as forward declaration according SWS_Rte_06812 */
2  typedef struct Rte_struct_DataSet DataSet;
3
4  /* declaration of the structure according SWS_Rte_07114 */
5  struct Rte_struct_DataSet
6  {
7      uint32 data1;
8      uint8 data2;
9      DataSet * dataSetPtr;
10     struct
11     {
12         uint8 sub1;
13         uint8 sub2;
14     } substruct;
15 };

```

F.5 Multiple calibration parameters instances

The example **Multiple calibration parameters instances** in the following ARXML shows the example of multiple calibration data instances as explained in section 4.2.9.3.7.

```

<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns="http://autosar.org/schema/r4.0" xmlns:xsi="http://www.
w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://autosar.
org/schema/r4.0_AUTOSAR_4-2-1.xsd">
  <ADMIN-DATA>
    <LANGUAGE>EN</LANGUAGE>
    <DOC-REVISIONS>
      <DOC-REVISION>
        <REVISION-LABEL>0.1.0</REVISION-LABEL>
        <DATE>2014-07-31</DATE>
      </DOC-REVISION>
    </DOC-REVISIONS>
  </ADMIN-DATA>
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Demo</SHORT-NAME>
    </AR-PACKAGE>
    <AR-PACKAGE>
      <SHORT-NAME>PortInterfaces</SHORT-NAME>
      <ELEMENTS>
        <PARAMETER-INTERFACE>

```

```

<SHORT-NAME>EP</SHORT-NAME>
<PARAMETERS>
  <PARAMETER-DATA-PROTOTYPE>
    <SHORT-NAME>Prm1</SHORT-NAME>
    <SW-DATA-DEF-PROPS>
      <SW-DATA-DEF-PROPS-VARIANTS>
        <SW-DATA-DEF-PROPS-CONDITIONAL>
          <SW-ADDR-METHOD-REF DEST="SW-ADDR-METHOD">/
            AUTOSAR_MemMap/SwAddrMethods/CALIB_QM</SW-
              ADDR-METHOD-REF>
          <SW-CALIBRATION-ACCESS>READ-WRITE</SW-
            CALIBRATION-ACCESS>
          <SW-IMPL-POLICY>STANDARD</SW-IMPL-POLICY>
        </SW-DATA-DEF-PROPS-CONDITIONAL>
      </SW-DATA-DEF-PROPS-VARIANTS>
    </SW-DATA-DEF-PROPS>
    <TYPE-TREF DEST="APPLICATION-PRIMITIVE-DATA-TYPE">/
      AUTOSAR_AISpecification/ApplicationDataTypes/Flg1
    </TYPE-TREF>
  </PARAMETER-DATA-PROTOTYPE>
</PARAMETERS>
</PARAMETER-INTERFACE>
</ELEMENTS>
</AR-PACKAGE>
<AR-PACKAGE>
  <SHORT-NAME>SwComponentTypes</SHORT-NAME>
  <ELEMENTS>
    <PARAMETER-SW-COMPONENT-TYPE>
      <SHORT-NAME>PSWC</SHORT-NAME>
      <PORTS>
        <P-PORT-PROTOTYPE>
          <SHORT-NAME>EP</SHORT-NAME>
          <PROVIDED-COM-SPECS>
            <PARAMETER-PROVIDE-COM-SPEC>
              <INIT-VALUE>
                <APPLICATION-VALUE-SPECIFICATION>
                  <SW-VALUE-CONT>
                    <UNIT-REF DEST="UNIT">/AUTOSAR/
                      AISpecification/Units/NoUnit</UNIT-REF>
                  <SW-VALUES-PHYS>
                    <VT>Rst</VT>
                  </SW-VALUES-PHYS>
                </SW-VALUE-CONT>
              </APPLICATION-VALUE-SPECIFICATION>
            </INIT-VALUE>
            <PARAMETER-REF DEST="PARAMETER-DATA-PROTOTYPE">/
              Demo/PortInterfaces/EP/Prm1</PARAMETER-REF>
          </PARAMETER-PROVIDE-COM-SPEC>
        </PROVIDED-COM-SPECS>
        <PROVIDED-INTERFACE-TREF DEST="PARAMETER-INTERFACE">/
          Demo/PortInterfaces/EP</PROVIDED-INTERFACE-TREF>
      </P-PORT-PROTOTYPE>
    </PORTS>
  </PARAMETER-SW-COMPONENT-TYPE>
  <APPLICATION-SW-COMPONENT-TYPE>
    <SHORT-NAME>ASWC</SHORT-NAME>

```



```

<PORTS>
  <R-PORT-PROTOTYPE>
    <SHORT-NAME>EP</SHORT-NAME>
    <REQUIRED-INTERFACE-TREF DEST="PARAMETER-INTERFACE">/
      Demo/PortInterfaces/EP</REQUIRED-INTERFACE-TREF>
  </R-PORT-PROTOTYPE>
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G Changes History

G.1 Changes in Rel. 4.0 Rev. 2 compared to Rel. 4.0 Rev. 1

G.1.1 Deleted SWS Items

The following SWS Items were removed in Rel. 4.0 Rev. 2:

rte_sws_1254, rte_sws_3552, rte_sws_3557, rte_sws_3559, rte_sws_3563,
rte_sws_3564, rte_sws_3568, rte_sws_3588, rte_sws_3593, rte_sws_3743,
rte_sws_5512.

G.1.2 Changed SWS Items

The following SWS Items were changed in Rel. 4.0 Rev. 2:

[SWS_Rte_01086], [SWS_Rte_01111], [SWS_Rte_01113], [SWS_Rte_01114],
[SWS_Rte_01118], [SWS_Rte_01156], [SWS_Rte_01355], [SWS_Rte_02517],
[SWS_Rte_02527], [SWS_Rte_02528], [SWS_Rte_02613], [SWS_Rte_02615],
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[SWS_Rte_05509], [SWS_Rte_06010], [SWS_Rte_06633], [SWS_Rte_07020],
[SWS_Rte_07021], [SWS_Rte_07041], [SWS_Rte_07184], [SWS_Rte_07187],
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[SWS_Rte_07409], [SWS_Rte_07586], [SWS_Rte_07589], [SWS_Rte_07632],
[SWS_Rte_07636], [SWS_Rte_07637], [SWS_Rte_07667], [SWS_Rte_07680],
[SWS_Rte_07683], rte_sws_ext_3811.

G.1.3 Added SWS Items

The following SWS Items were added in Rel. 4.0 Rev. 2:

[SWS_Rte_02761], rte_sws_3850, rte_sws_3851, [SWS_Rte_03852], [SWS_Rte_03853], [SWS_Rte_07045], [SWS_Rte_07046], [SWS_Rte_07047], [SWS_Rte_07048], [SWS_Rte_07049], [SWS_Rte_07050], [SWS_Rte_07051], [SWS_Rte_07052], [SWS_Rte_07053], [SWS_Rte_07054], [SWS_Rte_07055], [SWS_Rte_07056], [SWS_Rte_07057], [SWS_Rte_07058], [SWS_Rte_07059], [SWS_Rte_07060], [SWS_Rte_07061], [SWS_Rte_07062], [SWS_Rte_07063], [SWS_Rte_07064], [SWS_Rte_07065], [SWS_Rte_07066], [SWS_Rte_07067], [SWS_Rte_07068], [SWS_Rte_07069], [SWS_Rte_07070], [SWS_Rte_07071], [SWS_Rte_07072], [SWS_Rte_07073], [SWS_Rte_07074], [SWS_Rte_07075], [SWS_Rte_07076], [SWS_Rte_07077], [SWS_Rte_07078], [SWS_Rte_07079], [SWS_Rte_07080], [SWS_Rte_07081], [SWS_Rte_08000], [SWS_Rte_08001], [SWS_Rte_08002], [SWS_Rte_08300], [SWS_Rte_08301], [SWS_Rte_08302].

G.2 Changes in Rel. 4.0 Rev. 3 compared to Rel. 4.0 Rev. 2

G.2.1 Deleted SWS Items

The following SWS Items were removed in Rel. 4.0 Rev. 3:

rte_sws_3838, rte_sws_3844, rte_sws_3850, rte_sws_5171, rte_sws_7106, rte_sws_7108, rte_sws_7164, rte_sws_7165, rte_sws_7168, rte_sws_7176, rte_sws_7674.

G.2.2 Changed SWS Items

The following SWS Items were changed in Rel. 4.0 Rev. 3:

[SWS_Rte_01018], [SWS_Rte_01019], [SWS_Rte_01020], [SWS_Rte_01156], [SWS_Rte_01171], [SWS_Rte_01238], [SWS_Rte_01239], [SWS_Rte_01248], [SWS_Rte_01249], [SWS_Rte_01300], [SWS_Rte_02500], [SWS_Rte_02568], [SWS_Rte_02576], [SWS_Rte_02627], [SWS_Rte_02628], [SWS_Rte_02629], [SWS_Rte_02631], [SWS_Rte_02648], [SWS_Rte_02659], [SWS_Rte_02662], [SWS_Rte_02664], [SWS_Rte_02675], [SWS_Rte_02732], [SWS_Rte_03526], [SWS_Rte_03714], [SWS_Rte_03731], [SWS_Rte_03782], [SWS_Rte_03793], [SWS_Rte_03809], [SWS_Rte_03810], [SWS_Rte_03813], [SWS_Rte_03827], [SWS_Rte_03828], [SWS_Rte_03829], [SWS_Rte_03831], [SWS_Rte_03832], [SWS_Rte_03833], [SWS_Rte_03837], [SWS_Rte_03839], [SWS_Rte_03840], [SWS_Rte_03841], [SWS_Rte_03842], [SWS_Rte_03843], [SWS_Rte_03845], [SWS_Rte_03846], [SWS_Rte_03847], [SWS_Rte_03848], [SWS_Rte_03849], [SWS_Rte_03851], [SWS_Rte_03907], [SWS_Rte_03949], [SWS_Rte_04526], [SWS_Rte_05051], [SWS_Rte_05052], SWS_Rte_05059, [SWS_Rte_05062], [SWS_Rte_05078], [SWS_Rte_05127], [SWS_Rte_05128], [SWS_Rte_06513], [SWS_Rte_06515], [SWS_Rte_06518], [SWS_Rte_06519], [SWS_Rte_06520],

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[SWS_Rte_07175], [SWS_Rte_07182], [SWS_Rte_07185], [SWS_Rte_07190],
[SWS_Rte_07194], [SWS_Rte_07195], [SWS_Rte_07200], [SWS_Rte_07203],
[SWS_Rte_07214], [SWS_Rte_07224], [SWS_Rte_07250], [SWS_Rte_07253],
[SWS_Rte_07255], [SWS_Rte_07260], [SWS_Rte_07261], [SWS_Rte_07263],
[SWS_Rte_07266], [SWS_Rte_07282], [SWS_Rte_07292], [SWS_Rte_07293],
[SWS_Rte_07294], [SWS_Rte_07295], [SWS_Rte_07310], [SWS_Rte_07315],
[SWS_Rte_07381], [SWS_Rte_07382], [SWS_Rte_07383], [SWS_Rte_07501],
[SWS_Rte_07503], [SWS_Rte_07504], [SWS_Rte_07543], [SWS_Rte_07544],
[SWS_Rte_07552], [SWS_Rte_07554], [SWS_Rte_07555], [SWS_Rte_07556],
[SWS_Rte_07670], [SWS_Rte_07682], [SWS_Rte_08300].

G.2.3 Added SWS Items

The following SWS Items were added in Rel. 4.0 Rev. 3:

[SWS_Rte_03854], [SWS_Rte_03855], [SWS_Rte_03856], [SWS_Rte_03857],
[SWS_Rte_03858], [SWS_Rte_03859], [SWS_Rte_03860], [SWS_Rte_03861],
[SWS_Rte_06700], [SWS_Rte_06701], [SWS_Rte_06702], [SWS_Rte_06703],
[SWS_Rte_06704], [SWS_Rte_06705], [SWS_Rte_06706], [SWS_Rte_06707],
[SWS_Rte_06708], [SWS_Rte_06709], [SWS_Rte_06710], [SWS_Rte_06711],
[SWS_Rte_06712], [SWS_Rte_06713], [SWS_Rte_06714], [SWS_Rte_06715],
[SWS_Rte_06716], [SWS_Rte_06717], [SWS_Rte_06718], [SWS_Rte_06719],
[SWS_Rte_06720], [SWS_Rte_06721], [SWS_Rte_06722], [SWS_Rte_06723],
[SWS_Rte_06724], [SWS_Rte_06725], [SWS_Rte_06726], [SWS_Rte_07082],
[SWS_Rte_07083], [SWS_Rte_07084], [SWS_Rte_07085], [SWS_Rte_07086],
[SWS_Rte_07087], [SWS_Rte_07088], [SWS_Rte_07089], [SWS_Rte_07090],
[SWS_Rte_07091], [SWS_Rte_07092], [SWS_Rte_07093], [SWS_Rte_07094],
[SWS_Rte_07095], [SWS_Rte_07096], [SWS_Rte_07097], [SWS_Rte_07099],
[SWS_Rte_07593], [SWS_Rte_07594], [SWS_Rte_07595], [SWS_Rte_07596],
[SWS_Rte_07692], [SWS_Rte_07693], [SWS_Rte_07694], [SWS_Rte_07920],
[SWS_Rte_07921], [SWS_Rte_07922], [SWS_Rte_07923], [SWS_Rte_07924],
[SWS_Rte_08004], [SWS_Rte_08005], [SWS_Rte_08007], [SWS_Rte_08008],
[SWS_Rte_08009], [SWS_Rte_08016], [SWS_Rte_08017], [SWS_Rte_08018],
[SWS_Rte_08020], [SWS_Rte_08021], [SWS_Rte_08022], [SWS_Rte_08023],
[SWS_Rte_08024], [SWS_Rte_08025], [SWS_Rte_08026], [SWS_Rte_08027],
[SWS_Rte_08028], [SWS_Rte_08029], [SWS_Rte_08030], [SWS_Rte_08031],
[SWS_Rte_08032], [SWS_Rte_08033], [SWS_Rte_08034], [SWS_Rte_08035],
[SWS_Rte_08036], [SWS_Rte_08037], [SWS_Rte_08038], [SWS_Rte_08039],
[SWS_Rte_08040], [SWS_Rte_08041], [SWS_Rte_08042], [SWS_Rte_08043],

[\[SWS_Rte_08044\]](#), [\[SWS_Rte_08045\]](#), [\[SWS_Rte_08303\]](#), [\[SWS_Rte_08304\]](#),
[\[SWS_Rte_08305\]](#), [\[SWS_Rte_08306\]](#), [\[SWS_Rte_08307\]](#), [\[SWS_Rte_08308\]](#),
[\[SWS_Rte_08400\]](#), [\[SWS_Rte_08401\]](#), [\[SWS_Rte_08402\]](#), [\[SWS_Rte_08403\]](#),
[\[SWS_Rte_08404\]](#), [\[SWS_Rte_08500\]](#), [\[SWS_Rte_08501\]](#), [SWS_Rte_08503](#),
[\[SWS_Rte_08504\]](#), [\[SWS_Rte_08505\]](#), [\[SWS_Rte_08506\]](#), [\[SWS_Rte_08507\]](#),
[\[SWS_Rte_08509\]](#), [\[SWS_Rte_08510\]](#), [rte_sws_ext_7597](#), [rte_sws_ext_7598](#),
[rte_sws_ext_8502](#), [rte_sws_ext_8508](#).

G.3 Changes in Rel. 4.1 Rev. 1 compared to Rel. 4.0 Rev. 3

G.3.1 Renamed SWS Items

The external requirements are redefined as AUTOSAR constraints.

rte_sws_ext_3811 [constr_9004]	Usage of WaitPoints is restricted depending on <i>ExclusiveAreaImplMechanism</i>
rte_sws_ext_7598 [SWS_Rte_CONSTR_09005]	The references RteSwcTriggerSourceRef has to be consistent with the RteSoftwareComponentInstanceRef
rte_sws_ext_7597 [SWS_Rte_CONSTR_09006]	The references RteBswTriggerSourceRef has to be consistent with the RteBswImplementationRef
rte_sws_ext_7547 [SWS_Rte_CONSTR_09007]	<i>issuedTrigger</i> and <i>BswTriggerDirectImplementation</i> are mutually exclusive
rte_sws_ext_7040 [SWS_Rte_CONSTR_09008]	The same Trigger in a <i>Trigger Sink</i> must not be connected to multiple <i>Trigger Sources</i>
rte_sws_ext_7550 [SWS_Rte_CONSTR_09009]	Synchronized Trigger shall not be referenced by more than one type of access method
rte_sws_ext_7521 [SWS_Rte_CONSTR_09010]	Worst case execution time shall be less than the GCD
rte_sws_ext_7351 [SWS_Rte_CONSTR_09011]	NvMBlockDescriptor related to a RAM Block of a NvBlockSwComponentType shall use NvMBlockUseSyncMechanism
rte_sws_ext_7816 [SWS_Rte_CONSTR_09012]	Category 1 interrupts shall not access the RTE
rte_sws_ext_2542 [SWS_Rte_CONSTR_09013]	Exactly one mode or one mode transition shall be active
rte_sws_ext_7565 [SWS_Rte_CONSTR_09014]	<i>ModeSwitchPoint(s)</i> and <i>managedModeGroup(s)</i> are mutually exclusive for synchronized <i>ModeDeclarationGroupPrototypes</i>
rte_sws_ext_7818 [SWS_Rte_CONSTR_09015]	Rte_Write API may only be used by the runnable that describe its usage
rte_sws_ext_7819 [SWS_Rte_CONSTR_09016]	Rte_Send API may only be used by the runnable that describes its usage
rte_sws_ext_2681 [SWS_Rte_CONSTR_09017]	Rte_Switch API may only be used by the runnable that describes its usage
rte_sws_ext_2682 [SWS_Rte_CONSTR_09018]	Rte_Invalidate API may only be used by the runnable that describe its usage
rte_sws_ext_2687 [SWS_Rte_CONSTR_09019]	Rte_Feedback API may only be used by the runnable that describe its usage
rte_sws_ext_2726 [SWS_Rte_CONSTR_09020]	Rte_SwitchAck API may only be used by the runnable that describe its usage

rte_sws_ext_2683	[SWS_Rte_CONSTR_09021]	<code>Rte_Read</code> API may only be used by the runnable that describe its usage
rte_sws_ext_7397	[SWS_Rte_CONSTR_09022]	<code>Rte_DRead</code> API may only be used by the runnable that describe its usage
rte_sws_ext_2684	[SWS_Rte_CONSTR_09023]	<code>Rte_Receive</code> API may only be used by the runnable that describe its usage
rte_sws_ext_2685	[SWS_Rte_CONSTR_09024]	<code>Rte_Call</code> API may only be used by the runnable that describe its usage
rte_sws_ext_2686	[SWS_Rte_CONSTR_09025]	Blocking <code>Rte_Result</code> API may only be used by the runnable that describe the <code>WaitPoint</code>
rte_sws_ext_7679	[SWS_Rte_CONSTR_09026]	<code>Rte_IWriteRef</code> may not return values written in previous executions
rte_sws_ext_2601	[SWS_Rte_CONSTR_09027]	<code>Rte_IStatus</code> API shall only be used by a <code>RunnableEntity</code> describing an access to the data or which is triggered by an error event related to this data
rte_sws_ext_7171	[SWS_Rte_CONSTR_09028]	<code>Rte_Enter</code> and <code>Rte_Exit</code> API may only be used by runnables describing its usage
rte_sws_ext_7172	[SWS_Rte_CONSTR_09029]	Nested call of <code>Rte_Enter</code> and <code>Rte_Exit</code> is restricted
rte_sws_ext_7568	[SWS_Rte_CONSTR_09030]	<code>Rte_Mode</code> API may only be used by the runnable that describe its usage
rte_sws_ext_8502	[SWS_Rte_CONSTR_09031]	<code>Rte_Mode</code> API may only be used by the runnable that describe its usage
rte_sws_ext_7202	[SWS_Rte_CONSTR_09032]	<code>Rte_Trigger</code> API may only be used by the runnable that describe its usage
rte_sws_ext_7205	[SWS_Rte_CONSTR_09033]	<code>Rte_IrTrigger</code> API may only be used by the runnable that describe its usage
rte_sws_ext_7603	[SWS_Rte_CONSTR_09034]	<code>Rte_IsUpdated</code> API may only be used by the runnable that describe the access to the corresponding data
rte_sws_ext_2582	[SWS_Rte_CONSTR_09035]	<code>Rte_Start</code> shall be called only once
rte_sws_ext_7577	[SWS_Rte_CONSTR_09036]	<code>Rte_Start</code> API may only be used after call of <code>SchM_Init</code>
rte_sws_ext_2714	[SWS_Rte_CONSTR_09037]	<code>Rte_Start</code> API shall be called on every core
rte_sws_ext_2583	[SWS_Rte_CONSTR_09038]	<code>Rte_Stop</code> shall be called before BSW shutdown
rte_sws_ext_7332	[SWS_Rte_CONSTR_09039]	<code>Rte_PartitionTerminated</code> shall be called only once
rte_sws_ext_7618	[SWS_Rte_CONSTR_09040]	<code>Rte_PartitionRestarting</code> shall be called only once
rte_sws_ext_7337	[SWS_Rte_CONSTR_09041]	<code>Rte_RestartPartition</code> shall be called from <code>RestartTask</code>
rte_sws_ext_1190	[SWS_Rte_CONSTR_09042]	<i>Array Implementation Data Types</i> needs at least one element
rte_sws_ext_1192	[SWS_Rte_CONSTR_09043]	<i>Structure Implementation Data Types</i> needs at least one element
rte_sws_ext_7147	[constr_9044]	<i>Union Implementation Data Type</i> shall include at least two elements
rte_sws_ext_2704	[SWS_Rte_CONSTR_09045]	The upper two bits of the of the server return value are reserved
rte_sws_ext_7285	[SWS_Rte_CONSTR_09046]	<code>SchM_Enter</code> and <code>SchM_Exit</code> API may only be used by <code>BswModuleEntitys</code> describing its usage
rte_sws_ext_7529	[SWS_Rte_CONSTR_09047]	Nested call of <code>SchM_Enter</code> and <code>SchM_Exit</code> API is restricted

rte_sws_ext_7189	[SWS_Rte_CONSTR_09048]	SchM_Exit API may only be used by BswModuleEntitys that describe its usage
rte_sws_ext_7257	[SWS_Rte_CONSTR_09049]	SchM_Switch API may only be used by BswModuleEntitys that describe its usage
rte_sws_ext_7587	[SWS_Rte_CONSTR_09050]	SchM_Mode API may only be used by BswModuleEntitys that describe its usage
rte_sws_ext_8508	[SWS_Rte_CONSTR_09051]	SchM_Mode API may only be used by BswModuleEntitys that describe its usage
rte_sws_ext_7567	[SWS_Rte_CONSTR_09052]	SchM_SwitchAck API may only be used by BswModuleEntitys that describe its usage
rte_sws_ext_7265	[SWS_Rte_CONSTR_09053]	SchM_Trigger API may only be used by the BswModuleEntitys that describe its usage
rte_sws_ext_7268	[SWS_Rte_CONSTR_09054]	SchM_ActMainFunction API may only be used by the BswModuleEntitys that describe its usage
rte_sws_ext_7272	[SWS_Rte_CONSTR_09055]	SchM_Init shall be called only once
rte_sws_ext_7576	[SWS_Rte_CONSTR_09056]	SchM_Deinit API may only be used after the was RTE finalized
rte_sws_ext_7276	[SWS_Rte_CONSTR_09057]	SchM_Deinit shall be called before shut down of BSW
rte_sws_ext_7287	[SWS_Rte_CONSTR_09058]	BswSchedulableEntity is not allowed to have service arguments or return value
rte_sws_ext_7512	[SWS_Rte_CONSTR_09059]	Usage of Basic Software Scheduler API prerequisites the include of the Module Interlink Header File

Table G.1: external requirements converted to constraints

rte_sws_7649	[SWS_Rte_CONSTR_09000]	Rte_IFeedback API may only be used by the RunnableEntitys that describe its usage
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Table G.2: requirements converted to constraints

G.3.2 Added constraints

The following constraints were added in Rel. 4.1 Rev. 1:

[SWS_Rte_CONSTR_03510], [SWS_Rte_CONSTR_09060],
[SWS_Rte_CONSTR_09061], [SWS_Rte_CONSTR_09062],
[SWS_Rte_CONSTR_09063], [SWS_Rte_CONSTR_09064]

G.3.3 Deleted SWS Items

The following SWS items were removed in Rel. 4.1 Rev. 1:

SWS_Rte_02652,	SWS_Rte_02731,	SWS_Rte_03555,	SWS_Rte_03569,
SWS_Rte_03581,	SWS_Rte_03747,	SWS_Rte_03803,	SWS_Rte_05020,
SWS_Rte_05033,	SWS_Rte_05054,	SWS_Rte_05055,	SWS_Rte_05056,
SWS_Rte_05057,	SWS_Rte_05058,	SWS_Rte_05059,	SWS_Rte_05066,

SWS_Rte_05067, SWS_Rte_05110, SWS_Rte_05163, SWS_Rte_06028,
SWS_Rte_07296, SWS_Rte_07649, SWS_Rte_07656, SWS_Rte_07657,
SWS_Rte_07658, SWS_Rte_07665, SWS_Rte_07687, SWS_Rte_07688,
SWS_Rte_07690, SWS_Rte_07691, SWS_Rte_08503.

G.3.4 Changed SWS Items

The following SWS items were changed in Rel. 4.1 Rev. 1:

[SWS_Rte_01003], [SWS_Rte_01019], [SWS_Rte_01058], [SWS_Rte_01060],
[SWS_Rte_01061], [SWS_Rte_01064], [SWS_Rte_01065], [SWS_Rte_01071],
[SWS_Rte_01072], [SWS_Rte_01083], [SWS_Rte_01091], [SWS_Rte_01092],
[SWS_Rte_01102], [SWS_Rte_01111], [SWS_Rte_01118], [SWS_Rte_01120],
[SWS_Rte_01123], [SWS_Rte_01126], [SWS_Rte_01150], [SWS_Rte_01206],
[SWS_Rte_01252], [SWS_Rte_01284], [SWS_Rte_01285], [SWS_Rte_01286],
[SWS_Rte_01317], [SWS_Rte_01354], [SWS_Rte_01358], [SWS_Rte_01360],
[SWS_Rte_01368], [SWS_Rte_02516], [SWS_Rte_02530], [SWS_Rte_02544],
[SWS_Rte_02571], [SWS_Rte_02579], [SWS_Rte_02594], [SWS_Rte_02599],
[SWS_Rte_02600], [SWS_Rte_02610], [SWS_Rte_02611], [SWS_Rte_02612],
[SWS_Rte_02613], [SWS_Rte_02614], [SWS_Rte_02615], [SWS_Rte_02619],
[SWS_Rte_02623], [SWS_Rte_02628], [SWS_Rte_02631], [SWS_Rte_02649],
[SWS_Rte_02651], [SWS_Rte_02679], [SWS_Rte_02702], [SWS_Rte_02707],
[SWS_Rte_02709], [SWS_Rte_02712], [SWS_Rte_02713], [SWS_Rte_02725],
[SWS_Rte_02736], [SWS_Rte_02739], [SWS_Rte_02747], [SWS_Rte_02757],
[SWS_Rte_02759], [SWS_Rte_02760], [SWS_Rte_03001], [SWS_Rte_03002],
[SWS_Rte_03004], [SWS_Rte_03005], [SWS_Rte_03012], [SWS_Rte_03503],
[SWS_Rte_03504], [SWS_Rte_03526], [SWS_Rte_03527], [SWS_Rte_03550],
[SWS_Rte_03553], [SWS_Rte_03560], [SWS_Rte_03565], [SWS_Rte_03589],
[SWS_Rte_03595], [SWS_Rte_03598], [SWS_Rte_03602], [SWS_Rte_03603],
[SWS_Rte_03714], [SWS_Rte_03741], [SWS_Rte_03744], [SWS_Rte_03755],
[SWS_Rte_03760], [SWS_Rte_03764], [SWS_Rte_03770], [SWS_Rte_03775],
[SWS_Rte_03776], [SWS_Rte_03788], [SWS_Rte_03800], [SWS_Rte_03809],
[SWS_Rte_03827], [SWS_Rte_03828], [SWS_Rte_03843], [SWS_Rte_03849],
[SWS_Rte_03857], [SWS_Rte_03927], [SWS_Rte_03928], [SWS_Rte_03952],
[SWS_Rte_03955], [SWS_Rte_03970], [SWS_Rte_04508], [SWS_Rte_04515],
[SWS_Rte_04516], [SWS_Rte_04518], [SWS_Rte_05021], [SWS_Rte_05026],
[SWS_Rte_05048], [SWS_Rte_05052], [SWS_Rte_05065], [SWS_Rte_05084],
[SWS_Rte_05085], [SWS_Rte_05090], [SWS_Rte_05111], [SWS_Rte_05131],
[SWS_Rte_05145], [SWS_Rte_05146], [SWS_Rte_05147], [SWS_Rte_05164],
[SWS_Rte_05189], SWS_Rte_05506, [SWS_Rte_05509], [SWS_Rte_06532],
[SWS_Rte_06533], [SWS_Rte_06713], [SWS_Rte_06714], [SWS_Rte_06715],
[SWS_Rte_06718], [SWS_Rte_07006], [SWS_Rte_07008], [SWS_Rte_07031],
[SWS_Rte_07047], [SWS_Rte_07048], [SWS_Rte_07054], [SWS_Rte_07056],
[SWS_Rte_07059], [SWS_Rte_07075], [SWS_Rte_07092], [SWS_Rte_07093],
[SWS_Rte_07099], [SWS_Rte_07101], [SWS_Rte_07122], [SWS_Rte_07135],
[SWS_Rte_07140], [SWS_Rte_07152], [SWS_Rte_07170], [SWS_Rte_07175],

[\[SWS_Rte_07178\]](#), [\[SWS_Rte_07187\]](#), [\[SWS_Rte_07194\]](#), [\[SWS_Rte_07195\]](#),
[\[SWS_Rte_07200\]](#), [\[SWS_Rte_07203\]](#), [\[SWS_Rte_07251\]](#), [\[SWS_Rte_07254\]](#),
[\[SWS_Rte_07270\]](#), [\[SWS_Rte_07282\]](#), [\[SWS_Rte_07283\]](#), [\[SWS_Rte_07289\]](#),
[\[SWS_Rte_07290\]](#), [\[SWS_Rte_07293\]](#), [\[SWS_Rte_07294\]](#), [\[SWS_Rte_07346\]](#),
[\[SWS_Rte_07367\]](#), [\[SWS_Rte_07384\]](#), [\[SWS_Rte_07385\]](#), [\[SWS_Rte_07387\]](#),
[\[SWS_Rte_07390\]](#), [\[SWS_Rte_07394\]](#), [\[SWS_Rte_07396\]](#), [\[SWS_Rte_07530\]](#),
[\[SWS_Rte_07559\]](#), [\[SWS_Rte_07562\]](#), [\[SWS_Rte_07563\]](#), [\[SWS_Rte_07575\]](#),
[\[SWS_Rte_07586\]](#), [\[SWS_Rte_07590\]](#), [\[SWS_Rte_07621\]](#), [\[SWS_Rte_07647\]](#),
[\[SWS_Rte_07648\]](#), [\[SWS_Rte_07654\]](#), [\[SWS_Rte_07655\]](#), [\[SWS_Rte_07675\]](#),
[\[SWS_Rte_07680\]](#), [\[SWS_Rte_08001\]](#), [\[SWS_Rte_08002\]](#), [\[SWS_Rte_08016\]](#),
[\[SWS_Rte_08039\]](#), [\[SWS_Rte_08301\]](#), [\[SWS_Rte_08500\]](#), [\[SWS_Rte_08505\]](#).

G.3.5 Added SWS Items

The following SWS items were added in Rel. 4.1 Rev. 1:

[\[SWS_Rte_03862\]](#), [\[SWS_Rte_06727\]](#), [\[SWS_Rte_06728\]](#), [\[SWS_Rte_06729\]](#),
[\[SWS_Rte_06730\]](#), [\[SWS_Rte_06731\]](#), [\[SWS_Rte_06732\]](#), [\[SWS_Rte_06733\]](#),
[\[SWS_Rte_06734\]](#), [\[SWS_Rte_06735\]](#), [\[SWS_Rte_06736\]](#), [\[SWS_Rte_06737\]](#),
[\[SWS_Rte_06738\]](#), [\[SWS_Rte_06739\]](#), [\[SWS_Rte_06740\]](#), [\[SWS_Rte_06741\]](#),
[\[SWS_Rte_06742\]](#), [\[SWS_Rte_06743\]](#), [\[SWS_Rte_06744\]](#), [\[SWS_Rte_06745\]](#),
[\[SWS_Rte_06746\]](#), [\[SWS_Rte_06747\]](#), [\[SWS_Rte_06748\]](#), [\[SWS_Rte_06749\]](#),
[\[SWS_Rte_06750\]](#), [\[SWS_Rte_06751\]](#), [\[SWS_Rte_06752\]](#), [\[SWS_Rte_06753\]](#),
[\[SWS_Rte_06754\]](#), [\[SWS_Rte_06755\]](#), [\[SWS_Rte_06756\]](#), [\[SWS_Rte_06757\]](#),
[\[SWS_Rte_06758\]](#), [\[SWS_Rte_06759\]](#), [\[SWS_Rte_06760\]](#), [\[SWS_Rte_06761\]](#),
[\[SWS_Rte_06762\]](#), [\[SWS_Rte_06764\]](#), [\[SWS_Rte_06765\]](#), [\[SWS_Rte_06766\]](#),
[\[SWS_Rte_06767\]](#), [\[SWS_Rte_06768\]](#), [\[SWS_Rte_06769\]](#), [\[SWS_Rte_06770\]](#),
[\[SWS_Rte_06771\]](#), [\[SWS_Rte_06772\]](#), [\[SWS_Rte_06773\]](#), [\[SWS_Rte_06774\]](#),
[\[SWS_Rte_06775\]](#), [\[SWS_Rte_06776\]](#), [\[SWS_Rte_06777\]](#), [\[SWS_Rte_06778\]](#),
[\[SWS_Rte_06779\]](#), [\[SWS_Rte_06780\]](#), [\[SWS_Rte_06781\]](#), [\[SWS_Rte_06782\]](#),
[\[SWS_Rte_06783\]](#), [\[SWS_Rte_06784\]](#), [\[SWS_Rte_06785\]](#), [\[SWS_Rte_06786\]](#),
[\[SWS_Rte_06787\]](#), [\[SWS_Rte_06788\]](#), [\[SWS_Rte_06789\]](#), [\[SWS_Rte_06791\]](#),
[\[SWS_Rte_06792\]](#), [\[SWS_Rte_06793\]](#), [\[SWS_Rte_06794\]](#), [\[SWS_Rte_06795\]](#),
[\[SWS_Rte_06796\]](#), [\[SWS_Rte_06797\]](#), [\[SWS_Rte_07828\]](#), [\[SWS_Rte_07829\]](#),
[\[SWS_Rte_07830\]](#), [\[SWS_Rte_07831\]](#), [\[SWS_Rte_07832\]](#), [\[SWS_Rte_07833\]](#),
[\[SWS_Rte_07834\]](#), [\[SWS_Rte_07835\]](#), [\[SWS_Rte_07836\]](#), [\[SWS_Rte_07837\]](#),
[\[SWS_Rte_07838\]](#), [\[SWS_Rte_07839\]](#), [\[SWS_Rte_07840\]](#), [\[SWS_Rte_07841\]](#),
[\[SWS_Rte_07925\]](#), [\[SWS_Rte_07926\]](#), [\[SWS_Rte_07927\]](#), [\[SWS_Rte_08046\]](#),
[\[SWS_Rte_08047\]](#), [\[SWS_Rte_08048\]](#), [\[SWS_Rte_08049\]](#), [\[SWS_Rte_08050\]](#),
[\[SWS_Rte_08051\]](#), [\[SWS_Rte_08052\]](#), [\[SWS_Rte_08053\]](#), [\[SWS_Rte_08054\]](#),
[\[SWS_Rte_08055\]](#), [\[SWS_Rte_08056\]](#), [\[SWS_Rte_08057\]](#), [\[SWS_Rte_08058\]](#),
[\[SWS_Rte_08059\]](#), [\[SWS_Rte_08060\]](#), [\[SWS_Rte_08061\]](#), [\[SWS_Rte_08062\]](#),
[\[SWS_Rte_08063\]](#), [\[SWS_Rte_08064\]](#), [\[SWS_Rte_08065\]](#), [\[SWS_Rte_08066\]](#),
[\[SWS_Rte_08067\]](#), [\[SWS_Rte_08068\]](#), [\[SWS_Rte_08069\]](#), [\[SWS_Rte_08070\]](#),
[\[SWS_Rte_08071\]](#), [\[SWS_Rte_08072\]](#), [\[SWS_Rte_08073\]](#), [\[SWS_Rte_08309\]](#),
[\[SWS_Rte_08310\]](#), [\[SWS_Rte_08311\]](#), [\[SWS_Rte_08405\]](#), [\[SWS_Rte_08406\]](#),

[SWS_Rte_08407], [SWS_Rte_08408], [SWS_Rte_08409], [SWS_Rte_08410],
[SWS_Rte_08411], [SWS_Rte_08412], [SWS_Rte_08511], [SWS_Rte_08512],
[SWS_Rte_08513], [SWS_Rte_08514], [SWS_Rte_08600], [SWS_Rte_08601],
[SWS_Rte_08700], [SWS_Rte_08701], [SWS_Rte_08702], [SWS_Rte_08703],
[SWS_Rte_08704], [SWS_Rte_08705], [SWS_Rte_08706], [SWS_Rte_08707],
[SWS_Rte_08708], [SWS_Rte_08709], [SWS_Rte_08710], [SWS_Rte_08711],
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[SWS_Rte_08735], [SWS_Rte_08736], [SWS_Rte_08737], [SWS_Rte_08738],
[SWS_Rte_08739], [SWS_Rte_08740], [SWS_Rte_08741], [SWS_Rte_08742],
[SWS_Rte_08743], [SWS_Rte_08744], [SWS_Rte_08745], [SWS_Rte_08746],
[SWS_Rte_08747], [SWS_Rte_08748], [SWS_Rte_08749], [SWS_Rte_08750],
[SWS_Rte_08751], [SWS_Rte_08752], [SWS_Rte_08753], [SWS_Rte_08754],
[SWS_Rte_08755], [SWS_Rte_08756], [SWS_Rte_08757], [SWS_Rte_08758],
[SWS_Rte_08759], [SWS_Rte_08761], [SWS_Rte_08762], [SWS_Rte_08763],
[SWS_Rte_08764], [SWS_Rte_08765], [SWS_Rte_08766].

G.4 Changes in Rel. 4.1 Rev. 2 compared to Rel. 4.1 Rev. 1

G.4.1 Added Traceables in 4.1.2

[SWS_Rte_01371] [SWS_Rte_01372] [SWS_Rte_07410] [SWS_Rte_07411] [SWS_Rte_07412] [SWS_Rte_07842] [SWS_Rte_07843] [SWS_Rte_07844] [SWS_Rte_07928] [SWS_Rte_08074] [SWS_Rte_08075] [SWS_Rte_08076] [SWS_Rte_08312] [SWS_Rte_08313] [SWS_Rte_08314] [SWS_Rte_08315] [SWS_Rte_08316] [SWS_Rte_08317] [SWS_Rte_08413] [SWS_Rte_08414] [SWS_Rte_08415] [SWS_Rte_08416] [SWS_Rte_08767] [SWS_Rte_08768] [SWS_Rte_08769] [SWS_Rte_08770] [SWS_Rte_08771] [SWS_Rte_08772] [SWS_Rte_08773] [SWS_Rte_08774] [SWS_Rte_08775] [SWS_Rte_08776] [SWS_Rte_08800] [SWS_Rte_08801]

G.4.2 Changed Traceables in 4.1.2

[SWS_Rte_01003] [SWS_Rte_01296] [SWS_Rte_01297] [SWS_Rte_01358] [SWS_Rte_01360] [SWS_Rte_01368] [SWS_Rte_02549] [SWS_Rte_02600] [SWS_Rte_02678] [SWS_Rte_03012] [SWS_Rte_03526] [SWS_Rte_03527] [SWS_Rte_03571] [SWS_Rte_03755] [SWS_Rte_03788] [SWS_Rte_03809] [SWS_Rte_03810] [SWS_Rte_03813] [SWS_Rte_03832] [SWS_Rte_03843] [SWS_Rte_03849] [SWS_Rte_03851] [SWS_Rte_03862] [SWS_Rte_03970] [SWS_Rte_04508] [SWS_Rte_05052] [SWS_Rte_05088] [SWS_Rte_05089] [SWS_Rte_05090] [SWS_Rte_05097] [SWS_Rte_05129] [SWS_Rte_05147] [SWS_Rte_05177] [SWS_Rte_05184] [SWS_Rte_05191] [SWS_Rte_05503] [SWS_Rte_06727] [SWS_Rte_06731] [SWS_Rte_06732]

[\[SWS_Rte_06737\]](#) [\[SWS_Rte_06738\]](#) [\[SWS_Rte_06780\]](#) [\[SWS_Rte_07006\]](#) [\[SWS_Rte_07027\]](#) [\[SWS_Rte_07085\]](#) [\[SWS_Rte_07101\]](#) [\[SWS_Rte_07135\]](#) [\[SWS_Rte_07170\]](#) [\[SWS_Rte_07175\]](#) [\[SWS_Rte_07188\]](#) [\[SWS_Rte_07196\]](#) [\[SWS_Rte_07260\]](#) [\[SWS_Rte_07261\]](#) [\[SWS_Rte_07385\]](#) [\[SWS_Rte_07538\]](#) [\[SWS_Rte_07620\]](#) [\[SWS_Rte_07621\]](#) [\[SWS_Rte_07654\]](#) [\[SWS_Rte_07662\]](#) [\[SWS_Rte_07694\]](#) [\[SWS_Rte_07831\]](#) [\[SWS_Rte_07832\]](#) [\[SWS_Rte_07927\]](#) [\[SWS_Rte_08017\]](#) [\[SWS_Rte_08018\]](#) [\[SWS_Rte_08020\]](#) [\[SWS_Rte_08021\]](#) [\[SWS_Rte_08022\]](#) [\[SWS_Rte_08023\]](#) [\[SWS_Rte_08043\]](#) [\[SWS_Rte_08044\]](#) [\[SWS_Rte_08045\]](#) [\[SWS_Rte_08064\]](#) [\[SWS_Rte_08072\]](#) [\[SWS_Rte_08403\]](#) [\[SWS_Rte_08404\]](#) [\[SWS_Rte_08407\]](#) [\[SWS_Rte_08501\]](#) [\[SWS_Rte_08507\]](#) [\[SWS_Rte_08513\]](#) [\[SWS_Rte_08514\]](#) [\[SWS_Rte_08733\]](#) [\[SWS_Rte_08743\]](#)

G.4.3 Deleted Traceables in 4.1.2

[\[SWS_Rte_02673\]](#) [\[SWS_Rte_05001\]](#) [\[SWS_Rte_05506\]](#)

G.4.4 Added Constraints in 4.1.2

Id	Heading
[constr_9080]	The <i>shortNames</i> of <i>PortInterfaces</i> shall be unique within a software component if it supports multiple instantiation or indirectAPI attribute is set to 'true'
[constr_9081]	Mapping to partition vs the value of <i>VariableAccess.scope</i>

Table G.3: Added Constraints in 4.1.2

G.4.5 Changed Constraints in 4.1.2

Id	Heading
[constr_9020]	The blocking Rte_SwitchAck API may only be used by the runnable that describes its usage.

Table G.4: Changed Constraints in 4.1.2

G.4.6 Deleted Constraints in 4.1.2

none

G.5 Changes in Rel. 4.1 Rev. 3 compared to Rel. 4.1 Rev. 2

G.5.1 Added Traceables in 4.1.3

[SWS_Rte_01373] [SWS_Rte_01374] [SWS_Rte_01375] [SWS_Rte_06030] [SWS_Rte_06031] [SWS_Rte_06032] [SWS_Rte_06551] [SWS_Rte_06552] [SWS_Rte_06553] [SWS_Rte_06790] [SWS_Rte_06798] [SWS_Rte_06799] [SWS_Rte_06800] [SWS_Rte_06801] [SWS_Rte_06802] [SWS_Rte_06803] [SWS_Rte_06804] [SWS_Rte_06805] [SWS_Rte_06806] [SWS_Rte_06807] [SWS_Rte_06808] [SWS_Rte_06809] [SWS_Rte_06810] [SWS_Rte_07845] [SWS_Rte_07846] [SWS_Rte_07847] [SWS_Rte_07848] [SWS_Rte_07849] [SWS_Rte_07850] [SWS_Rte_07851] [SWS_Rte_08077] [SWS_Rte_08078] [SWS_Rte_08079] [SWS_Rte_08318] [SWS_Rte_08319] [SWS_Rte_08320] [SWS_Rte_08321] [SWS_Rte_08322] [SWS_Rte_08777] [SWS_Rte_08778] [SWS_Rte_08779] [SWS_Rte_08780] [SWS_Rte_08781] [SWS_Rte_08782] [SWS_Rte_08783] [SWS_Rte_08784] [SWS_Rte_08785] [SWS_Rte_08786]

G.5.2 Changed Traceables in 4.1.3

[SWS_Rte_01071] [SWS_Rte_01072] [SWS_Rte_01083] [SWS_Rte_01091] [SWS_Rte_01092] [SWS_Rte_01102] [SWS_Rte_01111] [SWS_Rte_01118] [SWS_Rte_01120] [SWS_Rte_01123] [SWS_Rte_01206] [SWS_Rte_01252] [SWS_Rte_01354] [SWS_Rte_02568] [SWS_Rte_02599] [SWS_Rte_02614] [SWS_Rte_02619] [SWS_Rte_02628] [SWS_Rte_02631] [SWS_Rte_02659] [SWS_Rte_02667] [SWS_Rte_02725] [SWS_Rte_02740] [SWS_Rte_02741] [SWS_Rte_02743] [SWS_Rte_02744] [SWS_Rte_02745] [SWS_Rte_03527] [SWS_Rte_03550] [SWS_Rte_03553] [SWS_Rte_03560] [SWS_Rte_03565] [SWS_Rte_03741] [SWS_Rte_03744] [SWS_Rte_03800] [SWS_Rte_03813] [SWS_Rte_03832] [SWS_Rte_03858] [SWS_Rte_03859] [SWS_Rte_03928] [SWS_Rte_05129] [SWS_Rte_05501] [SWS_Rte_05509] [SWS_Rte_06536] [SWS_Rte_07026] [SWS_Rte_07038] [SWS_Rte_07039] [SWS_Rte_07057] [SWS_Rte_07195] [SWS_Rte_07200] [SWS_Rte_07203] [SWS_Rte_07214] [SWS_Rte_07216] [SWS_Rte_07223] [SWS_Rte_07224] [SWS_Rte_07367] [SWS_Rte_07394] [SWS_Rte_07554] [SWS_Rte_07640] [SWS_Rte_07680] [SWS_Rte_07928] [SWS_Rte_08066] [SWS_Rte_08314] [SWS_Rte_08315] [SWS_Rte_08316] [SWS_Rte_08800]

G.5.3 Deleted Traceables in 4.1.3

[SWS_Rte_03012] [SWS_Rte_03790] [SWS_Rte_04525] [SWS_Rte_05116] [SWS_Rte_05134]

G.5.4 Added Constraints in 4.1.3

Id	Heading
[constr_9082]	RtePositionInTask and RteBswPositionInTask values shall be unique in a particular context

Table G.5: Added Constraints in 4.1.3

G.5.5 Changed Constraints in 4.1.3

none

G.5.6 Deleted Constraints in 4.1.3

Id	Heading
[constr_9004]	Usage of WaitPoints is restricted depending on <i>ExclusiveAreaImplMechanism</i>

Table G.6: Deleted Constraints in 4.1.3

G.6 Changes in Rel. 4.2 Rev. 1 compared to Rel. 4.1 Rev. 3

G.6.1 Added Traceables in 4.2.1

[\[SWS_Rte_01376\]](#) [\[SWS_Rte_01377\]](#) [\[SWS_Rte_01378\]](#) [\[SWS_Rte_01379\]](#) [\[SWS_Rte_01380\]](#) [\[SWS_Rte_01381\]](#) [\[SWS_Rte_01382\]](#) [\[SWS_Rte_01383\]](#) [\[SWS_Rte_01384\]](#) [\[SWS_Rte_01385\]](#) [\[SWS_Rte_01386\]](#) [\[SWS_Rte_01387\]](#) [\[SWS_Rte_01388\]](#) [\[SWS_Rte_01389\]](#) [\[SWS_Rte_01390\]](#) [\[SWS_Rte_01391\]](#) [\[SWS_Rte_01392\]](#) [\[SWS_Rte_01393\]](#) [\[SWS_Rte_01394\]](#) [\[SWS_Rte_01395\]](#) [\[SWS_Rte_01396\]](#) [\[SWS_Rte_01397\]](#) [\[SWS_Rte_01398\]](#) [\[SWS_Rte_01399\]](#) [\[SWS_Rte_01400\]](#) [\[SWS_Rte_01401\]](#) [\[SWS_Rte_01402\]](#) [\[SWS_Rte_01403\]](#) [\[SWS_Rte_01404\]](#) [\[SWS_Rte_01405\]](#) [\[SWS_Rte_01406\]](#) [\[SWS_Rte_01407\]](#) [\[SWS_Rte_01408\]](#) [\[SWS_Rte_01409\]](#) [\[SWS_Rte_01410\]](#) [\[SWS_Rte_01411\]](#) [\[SWS_Rte_01412\]](#) [\[SWS_Rte_01413\]](#) [\[SWS_Rte_02307\]](#) [\[SWS_Rte_02308\]](#) [\[SWS_Rte_02309\]](#) [\[SWS_Rte_03863\]](#) [\[SWS_Rte_03864\]](#) [\[SWS_Rte_03865\]](#) [\[SWS_Rte_03983\]](#) [\[SWS_Rte_03984\]](#) [\[SWS_Rte_03985\]](#) [\[SWS_Rte_03986\]](#) [\[SWS_Rte_03987\]](#) [\[SWS_Rte_03988\]](#) [\[SWS_Rte_03989\]](#) [\[SWS_Rte_03990\]](#) [\[SWS_Rte_03991\]](#) [\[SWS_Rte_03992\]](#) [\[SWS_Rte_03993\]](#) [\[SWS_Rte_03994\]](#) [\[SWS_Rte_03995\]](#) [\[SWS_Rte_03996\]](#) [\[SWS_Rte_03997\]](#) [\[SWS_Rte_06811\]](#) [\[SWS_Rte_06812\]](#) [\[SWS_Rte_06813\]](#) [\[SWS_Rte_06814\]](#) [\[SWS_Rte_06815\]](#) [\[SWS_Rte_06816\]](#) [\[SWS_Rte_06817\]](#) [\[SWS_Rte_06818\]](#) [\[SWS_Rte_06819\]](#) [\[SWS_Rte_06820\]](#) [\[SWS_Rte_06821\]](#) [\[SWS_Rte_06822\]](#) [\[SWS_Rte_06823\]](#) [\[SWS_Rte_06824\]](#) [\[SWS_Rte_06825\]](#) [\[SWS_Rte_06826\]](#) [\[SWS_Rte_06827\]](#) [\[SWS_Rte_06828\]](#) [\[SWS_Rte_06829\]](#) [\[SWS_Rte_06830\]](#) [\[SWS_Rte_07413\]](#) [\[SWS_Rte_08080\]](#) [\[SWS_Rte_08081\]](#) [\[SWS_Rte_08082\]](#) [\[SWS_Rte_08083\]](#) [\[SWS_Rte_08084\]](#) [\[SWS_Rte_08085\]](#) [\[SWS_Rte_08086\]](#) [\[SWS_Rte_08087\]](#) [\[SWS_Rte_08088\]](#) [\[SWS_Rte_08089\]](#) [\[SWS_Rte_08090\]](#) [\[SWS_Rte_08091\]](#) [\[SWS_Rte_08092\]](#) [\[SWS_Rte_08093\]](#) [\[SWS_Rte_08094\]](#) [\[SWS_Rte_08095\]](#) [\[SWS_Rte_08096\]](#) [\[SWS_Rte_08097\]](#) [\[SWS_Rte_08098\]](#) [\[SWS_Rte_08099\]](#) [\[SWS_Rte_08100\]](#) [\[SWS_Rte_08101\]](#) [\[SWS_Rte_08102\]](#) [\[SWS_Rte_08103\]](#)

[SWS_Rte_08515] [SWS_Rte_08516] [SWS_Rte_08517] [SWS_Rte_08518] [SWS_Rte_08519] [SWS_Rte_08520] [SWS_Rte_08521] [SWS_Rte_08522] [SWS_Rte_08523] [SWS_Rte_08524] [SWS_Rte_08525] [SWS_Rte_08526] [SWS_Rte_08527] [SWS_Rte_08528] [SWS_Rte_08529] [SWS_Rte_08530] [SWS_Rte_08531] [SWS_Rte_08532] [SWS_Rte_08533] [SWS_Rte_08534] [SWS_Rte_08535] [SWS_Rte_08536] [SWS_Rte_08537] [SWS_Rte_08538] [SWS_Rte_08539] [SWS_Rte_08540] [SWS_Rte_08541] [SWS_Rte_08542] [SWS_Rte_08543] [SWS_Rte_08544] [SWS_Rte_08545] [SWS_Rte_08546] [SWS_Rte_08547] [SWS_Rte_08548] [SWS_Rte_08549] [SWS_Rte_08550] [SWS_Rte_08551] [SWS_Rte_08552] [SWS_Rte_08553] [SWS_Rte_08554] [SWS_Rte_08555] [SWS_Rte_08556] [SWS_Rte_08557] [SWS_Rte_08558] [SWS_Rte_08559] [SWS_Rte_08560] [SWS_Rte_08561] [SWS_Rte_08562] [SWS_Rte_08563] [SWS_Rte_08564] [SWS_Rte_08565] [SWS_Rte_08566] [SWS_Rte_08567] [SWS_Rte_08568] [SWS_Rte_08569] [SWS_Rte_08570] [SWS_Rte_08571] [SWS_Rte_08572] [SWS_Rte_08573] [SWS_Rte_08574] [SWS_Rte_08575] [SWS_Rte_08576] [SWS_Rte_08577] [SWS_Rte_08578] [SWS_Rte_08579] [SWS_Rte_08580] [SWS_Rte_08581] [SWS_Rte_08582] [SWS_Rte_08583] [SWS_Rte_08584] [SWS_Rte_08585] [SWS_Rte_08586] [SWS_Rte_08587] [SWS_Rte_08588] [SWS_Rte_08589] [SWS_Rte_08590] [SWS_Rte_08591] [SWS_Rte_08787] [SWS_Rte_08788] [SWS_Rte_08789] [SWS_Rte_08790] [SWS_Rte_08791] [SWS_Rte_08792] [SWS_Rte_08793] [SWS_Rte_08794] [SWS_Rte_08795] [SWS_Rte_08796] [SWS_Rte_08797] [SWS_Rte_08798] [SWS_Rte_08799]

G.6.2 Changed Traceables in 4.2.1

[SWS_Rte_01071] [SWS_Rte_01072] [SWS_Rte_01091] [SWS_Rte_01092] [SWS_Rte_01102] [SWS_Rte_01111] [SWS_Rte_01118] [SWS_Rte_01119] [SWS_Rte_01166] [SWS_Rte_01206] [SWS_Rte_01238] [SWS_Rte_01239] [SWS_Rte_01252] [SWS_Rte_01282] [SWS_Rte_01299] [SWS_Rte_01300] [SWS_Rte_02599] [SWS_Rte_02600] [SWS_Rte_02607] [SWS_Rte_02608] [SWS_Rte_02648] [SWS_Rte_02651] [SWS_Rte_02662] [SWS_Rte_02663] [SWS_Rte_02665] [SWS_Rte_02710] [SWS_Rte_03530] [SWS_Rte_03531] [SWS_Rte_03532] [SWS_Rte_03594] [SWS_Rte_03600] [SWS_Rte_03754] [SWS_Rte_03758] [SWS_Rte_03759] [SWS_Rte_03770] [SWS_Rte_03795] [SWS_Rte_03801] [SWS_Rte_03830] [SWS_Rte_03833] [SWS_Rte_03927] [SWS_Rte_03928] [SWS_Rte_03929] [SWS_Rte_03952] [SWS_Rte_04505] [SWS_Rte_04526] [SWS_Rte_04527] [SWS_Rte_05021] [SWS_Rte_05024] [SWS_Rte_05025] [SWS_Rte_05026] [SWS_Rte_05049] [SWS_Rte_05062] [SWS_Rte_05081] [SWS_Rte_05088] [SWS_Rte_05126] [SWS_Rte_05127] [SWS_Rte_05128] [SWS_Rte_06002] [SWS_Rte_06023] [SWS_Rte_06613] [SWS_Rte_06630] [SWS_Rte_06631] [SWS_Rte_06632] [SWS_Rte_06633] [SWS_Rte_06634] [SWS_Rte_06635] [SWS_Rte_06637] [SWS_Rte_06734] [SWS_Rte_06735] [SWS_Rte_06772] [SWS_Rte_06773] [SWS_Rte_06774] [SWS_Rte_06804] [SWS_Rte_06805] [SWS_Rte_06806] [SWS_Rte_06807] [SWS_Rte_07032] [SWS_Rte_07114] [SWS_Rte_07144] [SWS_Rte_07163] [SWS_Rte_07173] [SWS_Rte_07195] [SWS_Rte_07214] [SWS_Rte_07282] [SWS_Rte_07317] [SWS_Rte_07355] [SWS_Rte_07356] [SWS_Rte_07394] [SWS_Rte_07554] [SWS_Rte_07670] [SWS_Rte_07675]

[SWS_Rte_07676] [SWS_Rte_07682] [SWS_Rte_07683] [SWS_Rte_07684] [SWS_Rte_07685] [SWS_Rte_07693] [SWS_Rte_07810] [SWS_Rte_07813] [SWS_Rte_07814] [SWS_Rte_07846] [SWS_Rte_07847] [SWS_Rte_07848] [SWS_Rte_07849] [SWS_Rte_07920] [SWS_Rte_07927] [SWS_Rte_07928] [SWS_Rte_08016] [SWS_Rte_08022] [SWS_Rte_08023] [SWS_Rte_08038] [SWS_Rte_08045] [SWS_Rte_08061] [SWS_Rte_08062] [SWS_Rte_08074] [SWS_Rte_08075] [SWS_Rte_08076] [SWS_Rte_08301] [SWS_Rte_08310] [SWS_Rte_08414] [SWS_Rte_08415] [SWS_Rte_08711] [SWS_Rte_08712] [SWS_Rte_08713] [SWS_Rte_08725] [SWS_Rte_08726] [SWS_Rte_08727] [SWS_Rte_08728] [SWS_Rte_08729] [SWS_Rte_08800]

G.6.3 Deleted Traceables in 4.2.1

[SWS_Rte_02724] [SWS_Rte_04506] [SWS_Rte_04507] [SWS_Rte_07136] [SWS_Rte_08702] [SWS_Rte_08704] [SWS_Rte_08706] [SWS_Rte_08708] [SWS_Rte_08710] [SWS_Rte_08730] [SWS_Rte_08761] [SWS_Rte_08762]

G.6.4 Added Constraints in 4.2.1

Id	Heading
[constr_9083]	Rte_IRead API may only be used by the runnable that describe its usage
[constr_9084]	Rte_IWrite API may only be used by the runnable that describe its usage
[constr_9085]	Rte_IWriteRef API may only be used by the runnable that describe its usage
[constr_9086]	Rte_IInvalidate API may only be used by the runnable that is describing an write access to the data
[constr_9087]	Rte_IrvIRead API may only be used by the runnable that describe its usage
[constr_9088]	Rte_IrvIWrite API may only be used by the runnable that describe its usage
[constr_9089]	Rte_IrvRead API may only be used by the runnable that describe its usage
[constr_9090]	Rte_IrvWrite API may only be used by the runnable that describe its usage
[constr_9091]	RteSwNvRamMappingRef and RteSwNvBlockDescriptorRef are excluding each other

Table G.7: Added Constraints in 4.2.1

G.6.5 Changed Constraints in 4.2.1

Id	Heading
[constr_9011]	NvMBlockDescriptor related to a RAM Block of a NvBlockSwComponentType shall use NvmBlockUseSyncMechanism
[constr_9027]	Rte_IStatus API shall only be used by a RunnableEntity describing an read access to the related data

Table G.8: Changed Constraints in 4.2.1

G.6.6 Deleted Constraints in 4.2.1

Id	Heading
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[constr_9044]	<i>Union Implementation Data Type</i> shall include at least two elements
[constr_9065]	Signature of Serializer
[constr_9066]	A BswModuleEntry representing a serializer shall comply to a serializer's signature
[constr_9068]	Return value for successful serialization
[constr_9069]	Return value for a serialization error
[constr_9071]	Signature of Deserializer
[constr_9072]	A BswModuleEntry representing a deserializer shall comply to a deserializer's signature
[constr_9073]	Return value for successful deserialization
[constr_9074]	Return value for a deserialization error

Table G.9: Deleted Constraints in 4.2.1

G.7 Changes in Rel. 4.2 Rev. 2 compared to Rel. 4.2 Rev. 1

G.7.1 Added Traceables in 4.2.2

[SWS_Rte_03866] [SWS_Rte_03998] [SWS_Rte_05300] [SWS_Rte_05301] [SWS_Rte_06200] [SWS_Rte_06201] [SWS_Rte_06203] [SWS_Rte_06204] [SWS_Rte_06205] [SWS_Rte_06206] [SWS_Rte_06207] [SWS_Rte_06208] [SWS_Rte_06209] [SWS_Rte_06831] [SWS_Rte_07414] [SWS_Rte_07415] [SWS_Rte_07416] [SWS_Rte_07417] [SWS_Rte_07418] [SWS_Rte_07419] [SWS_Rte_07420] [SWS_Rte_08104] [SWS_Rte_08105] [SWS_Rte_08106] [SWS_Rte_08107] [SWS_Rte_08108] [SWS_Rte_08109] [SWS_Rte_08110] [SWS_Rte_08417] [SWS_Rte_08418] [SWS_Rte_08419] [SWS_Rte_08592] [SWS_Rte_08593] [SWS_Rte_08594] [SWS_Rte_08595] [SWS_Rte_08596] [SWS_Rte_08597] [SWS_Rte_08598] [SWS_Rte_08599]

G.7.2 Changed Traceables in 4.2.2

[SWS_Rte_01156] [SWS_Rte_01366] [SWS_Rte_01403] [SWS_Rte_02250] [SWS_Rte_02254] [SWS_Rte_02572] [SWS_Rte_02604] [SWS_Rte_02703] [SWS_Rte_03724] [SWS_Rte_03793] [SWS_Rte_03832] [SWS_Rte_05094] [SWS_Rte_05095] [SWS_Rte_05096] [SWS_Rte_05097] [SWS_Rte_05098] [SWS_Rte_05105] [SWS_Rte_05500] [SWS_Rte_06545] [SWS_Rte_06611] [SWS_Rte_06630] [SWS_Rte_06631] [SWS_Rte_06799] [SWS_Rte_06811] [SWS_Rte_06818] [SWS_Rte_06829] [SWS_Rte_07038] [SWS_Rte_07089] [SWS_Rte_07200] [SWS_Rte_07207] [SWS_Rte_07310] [SWS_Rte_07315] [SWS_Rte_07408] [SWS_Rte_07409] [SWS_Rte_07413] [SWS_Rte_07623] [SWS_Rte_07627] [SWS_Rte_07676] [SWS_Rte_07686] [SWS_Rte_07817] [SWS_Rte_08064] [SWS_Rte_08409] [SWS_Rte_08411] [SWS_Rte_08412] [SWS_Rte_08515] [SWS_Rte_08516] [SWS_Rte_08518] [SWS_Rte_08523] [SWS_Rte_08526] [SWS_Rte_08533] [SWS_Rte_08558] [SWS_Rte_08711] [SWS_Rte_08712] [SWS_Rte_08732] [SWS_Rte_08794] [SWS_Rte_08795] [SWS_Rte_08800]

G.7.3 Deleted Traceables in 4.2.2

[SWS_Rte_01231] [SWS_Rte_01276] [SWS_Rte_02251] [SWS_Rte_05022] [SWS_Rte_05063] [SWS_Rte_08713]

G.7.4 Added Constraints in 4.2.2

Id	Heading
[constr_9092]	Rte_IrvIWriteRef API may only be used by the runnable that describe its usage
[constr_9093]	Rte_IrvIWriteRef may not return values written in previous executions

Table G.10: Added Constraints in 4.2.2

G.7.5 Changed Constraints in 4.2.2

none

G.7.6 Deleted Constraints in 4.2.2

none

G.8 Changes in Rel. 4.3 Rev. 0 compared to Rel. 4.2 Rev. 2

G.8.1 Added Traceables in 4.3.0

[SWS_Rte_03867] [SWS_Rte_03868] [SWS_Rte_03999] [SWS_Rte_04528] [SWS_Rte_04529] [SWS_Rte_04530] [SWS_Rte_04531] [SWS_Rte_04532] [SWS_Rte_04533] [SWS_Rte_04534] [SWS_Rte_04535] [SWS_Rte_04536] [SWS_Rte_04537] [SWS_Rte_04538] [SWS_Rte_04539] [SWS_Rte_04540] [SWS_Rte_04541] [SWS_Rte_04542] [SWS_Rte_04543] [SWS_Rte_04544] [SWS_Rte_04545] [SWS_Rte_04546] [SWS_Rte_04547] [SWS_Rte_04548] [SWS_Rte_04549] [SWS_Rte_04550] [SWS_Rte_04551] [SWS_Rte_06033] [SWS_Rte_06034] [SWS_Rte_06035] [SWS_Rte_06036] [SWS_Rte_06037] [SWS_Rte_06038] [SWS_Rte_06039] [SWS_Rte_06040] [SWS_Rte_06041] [SWS_Rte_06042] [SWS_Rte_06043] [SWS_Rte_06044] [SWS_Rte_06045] [SWS_Rte_06046] [SWS_Rte_06047] [SWS_Rte_06048] [SWS_Rte_06049] [SWS_Rte_06050] [SWS_Rte_06051] [SWS_Rte_06052] [SWS_Rte_06053] [SWS_Rte_06054] [SWS_Rte_06055] [SWS_Rte_06056] [SWS_Rte_06057] [SWS_Rte_06058] [SWS_Rte_06059] [SWS_Rte_06060] [SWS_Rte_06061] [SWS_Rte_06064] [SWS_Rte_06065] [SWS_Rte_06066] [SWS_Rte_06067] [SWS_Rte_06068] [SWS_Rte_06069] [SWS_Rte_06073] [SWS_Rte_06074] [SWS_Rte_06075] [SWS_Rte_06076] [SWS_Rte_06077] [SWS_Rte_06079] [SWS_Rte_06080] [SWS_Rte_06081] [SWS_Rte_06082] [SWS_Rte_06083] [SWS_Rte_06084] [SWS_Rte_06085] [SWS_Rte_06086] [SWS_Rte_06087] [SWS_Rte_06088] [SWS_Rte_06089]

[SWS_Rte_06090] [SWS_Rte_06091] [SWS_Rte_06092] [SWS_Rte_06093] [SWS_Rte_06094] [SWS_Rte_06095] [SWS_Rte_06096] [SWS_Rte_06097] [SWS_Rte_06098] [SWS_Rte_06099] [SWS_Rte_06100] [SWS_Rte_06101] [SWS_Rte_06102] [SWS_Rte_06103] [SWS_Rte_06104] [SWS_Rte_06105] [SWS_Rte_06106] [SWS_Rte_06107] [SWS_Rte_06108] [SWS_Rte_06109] [SWS_Rte_06110] [SWS_Rte_06111] [SWS_Rte_06112] [SWS_Rte_06113] [SWS_Rte_06114] [SWS_Rte_06115] [SWS_Rte_06120] [SWS_Rte_06210] [SWS_Rte_06211] [SWS_Rte_06212] [SWS_Rte_08111] [SWS_Rte_08420] [SWS_Rte_08421] [SWS_Rte_08422] [SWS_Rte_08423] [SWS_Rte_08424] [SWS_Rte_08603] [SWS_Rte_08604] [SWS_Rte_08605]

G.8.2 Changed Traceables in 4.3.0

[SWS_Rte_01072] [SWS_Rte_01092] [SWS_Rte_01120] [SWS_Rte_01123] [SWS_Rte_01150] [SWS_Rte_01168] [SWS_Rte_01238] [SWS_Rte_01239] [SWS_Rte_01240] [SWS_Rte_01241] [SWS_Rte_01319] [SWS_Rte_01342] [SWS_Rte_01354] [SWS_Rte_01408] [SWS_Rte_01411] [SWS_Rte_02579] [SWS_Rte_02599] [SWS_Rte_02614] [SWS_Rte_02619] [SWS_Rte_02653] [SWS_Rte_02679] [SWS_Rte_03602] [SWS_Rte_03603] [SWS_Rte_03712] [SWS_Rte_03714] [SWS_Rte_03731] [SWS_Rte_03739] [SWS_Rte_03741] [SWS_Rte_03744] [SWS_Rte_03799] [SWS_Rte_03810] [SWS_Rte_03827] [SWS_Rte_03828] [SWS_Rte_03832] [SWS_Rte_03984] [SWS_Rte_04504] [SWS_Rte_05509] [SWS_Rte_06533] [SWS_Rte_06612] [SWS_Rte_06620] [SWS_Rte_06638] [SWS_Rte_06768] [SWS_Rte_06769] [SWS_Rte_06770] [SWS_Rte_06813] [SWS_Rte_07053] [SWS_Rte_07100] [SWS_Rte_07138] [SWS_Rte_07170] [SWS_Rte_07250] [SWS_Rte_07253] [SWS_Rte_07270] [SWS_Rte_07386] [SWS_Rte_07411] [SWS_Rte_07556] [SWS_Rte_07574] [SWS_Rte_07675] [SWS_Rte_07683] [SWS_Rte_07810] [SWS_Rte_07811] [SWS_Rte_07928] [SWS_Rte_08080] [SWS_Rte_08081] [SWS_Rte_08090] [SWS_Rte_08312] [SWS_Rte_08517] [SWS_Rte_08524] [SWS_Rte_08538] [SWS_Rte_08541] [SWS_Rte_08700] [SWS_Rte_08733] [SWS_Rte_08736] [SWS_Rte_08740] [SWS_Rte_08743] [SWS_Rte_08744] [SWS_Rte_08795] [SWS_Rte_08801]

G.8.3 Deleted Traceables in 4.3.0

[SWS_Rte_02627] [SWS_Rte_03503] [SWS_Rte_03773] [SWS_Rte_05094] [SWS_Rte_05095] [SWS_Rte_05096] [SWS_Rte_05097] [SWS_Rte_05098] [SWS_Rte_05103] [SWS_Rte_05104] [SWS_Rte_05105] [SWS_Rte_06544] [SWS_Rte_06545] [SWS_Rte_06630] [SWS_Rte_07283] [SWS_Rte_07292] [SWS_Rte_07357] [SWS_Rte_07813] [SWS_Rte_07814] [SWS_Rte_08106] [SWS_Rte_08701] [SWS_Rte_08759] [SWS_Rte_08781]

G.8.4 Renamed Constraints in 4.3.0

constr_9081	[SWS_Rte_CONSTR_09081]	Mapping to partition vs the value of VariableAccess.scope
constr_9010	[SWS_Rte_CONSTR_09010]	Worst case execution time shall be less than the GCD
constr_9012	[SWS_Rte_CONSTR_09012]	Category 1 interrupts shall not access the RTE.
constr_9011	[SWS_Rte_CONSTR_09011]	NvMBlockDescriptor related to a RAM Block of a NvBlockSwComponentType shall use NvMBlockDescriptor.NvmBlockUseSyncMechanism
constr_9001	[SWS_Rte_CONSTR_09001]	Whole DataPrototypeGroup in role ConsistencyNeeds.dpgRequiresCoherency shall be propagated coherently
constr_9002	[SWS_Rte_CONSTR_09002]	The whole DataPrototypeGroup shall be read stable for the whole RunnableEntityGroup in the role ConsistencyNeeds.regRequiresStability
constr_9013	[SWS_Rte_CONSTR_09013]	Exactly one mode or one mode transition shall be active
constr_9014	[SWS_Rte_CONSTR_09014]	ModeSwitchPoint(s) and managedModeGroup(s) are mutually exclusive for synchronized ModeDeclarationGroupPrototypes
constr_9007	[SWS_Rte_CONSTR_09007]	issuedTrigger and BswTriggerDirectImplementation are mutually exclusive
constr_9008	[SWS_Rte_CONSTR_09008]	The same Trigger in a trigger sink must not be connected to multiple trigger sources
constr_9009	[SWS_Rte_CONSTR_09009]	Synchronized Trigger shall not be referenced by more than one type of access method
constr_9042	[SWS_Rte_CONSTR_09042]	Array Implementation Data Type needs at least one element
constr_9043	[SWS_Rte_CONSTR_09043]	Structure Implementation Data Type needs at least one element
constr_9080	[SWS_Rte_CONSTR_09080]	The shortNames of PortInterfaces shall be unique within a software component if it supports multiple instantiation or PortAPIOption.indirectAPI attribute is set to 'true'
constr_9015	[SWS_Rte_CONSTR_09015]	Rte_Write API may only be used by the runnable that describe its usage
constr_9016	[SWS_Rte_CONSTR_09016]	Rte_Send API may only be used by the runnable that describes its usage
constr_9017	[SWS_Rte_CONSTR_09017]	Rte_Switch API may only be used by the runnable that describes its usage
constr_9018	[SWS_Rte_CONSTR_09018]	Rte_Invalidate API may only be used by the runnable that describe its usage
constr_9019	[SWS_Rte_CONSTR_09019]	Rte_Feedback API may only be used by the runnable that describe its usage
constr_9020	[SWS_Rte_CONSTR_09020]	The blocking Rte_SwitchAck API may only be used by the runnable that describes its usage.
constr_9021	[SWS_Rte_CONSTR_09021]	Rte_Read API may only be used by the runnable that describe its usage
constr_9022	[SWS_Rte_CONSTR_09022]	Rte_DRead API may only be used by the runnable that describe its usage
constr_9023	[SWS_Rte_CONSTR_09023]	Rte_Receive API may only be used by the runnable that describe its usage
constr_9024	[SWS_Rte_CONSTR_09024]	Rte_Call API may only be used by the runnable that describe its usage
constr_9025	[SWS_Rte_CONSTR_09025]	Blocking Rte_Result API may only be used by the runnable that describe the WaitPoint

constr_9083	[SWS_Rte_CONSTR_09083]	Rte_IRead API may only be used by the runnable that describe its usage
constr_9084	[SWS_Rte_CONSTR_09084]	Rte_IWrite API may only be used by the runnable that describe its usage
constr_9085	[SWS_Rte_CONSTR_09085]	Rte_IWriteRef API may only be used by the runnable that describe its usage
constr_9026	[SWS_Rte_CONSTR_09026]	Rte_IWriteRef may not return values written in previous executions
constr_9086	[SWS_Rte_CONSTR_09086]	Rte_IInvalidate API may only be used by the runnable that is describing an write access to the data
constr_9027	[SWS_Rte_CONSTR_09027]	Rte_IStatus API shall only be used by a RunnableEntity describing an read access to the related data
constr_9087	[SWS_Rte_CONSTR_09087]	Rte_IrvIRead API may only be used by the runnable that describe its usage
constr_9088	[SWS_Rte_CONSTR_09088]	Rte_IrvIWrite API may only be used by the runnable that describe its usage
constr_9092	[SWS_Rte_CONSTR_09092]	Rte_IrvIWriteRef API may only be used by the runnable that describe its usage
constr_9093	[SWS_Rte_CONSTR_09093]	Rte_IrvIWriteRef may not return values written in previous executions
constr_9089	[SWS_Rte_CONSTR_09089]	Rte_IrvRead API may only be used by the runnable that describe its usage
constr_9090	[SWS_Rte_CONSTR_09090]	Rte_IrvWrite API may only be used by the runnable that describe its usage
constr_9028	[SWS_Rte_CONSTR_09028]	Rte_Enter and Rte_Exit API may only be used by runnables describing its usage
constr_9029	[SWS_Rte_CONSTR_09029]	Nested call of Rte_Enter and Rte_Exit is restricted
constr_9030	[SWS_Rte_CONSTR_09030]	Rte_Mode API may only be used by the runnable that describe its usage
constr_9031	[SWS_Rte_CONSTR_09031]	Rte_Mode API may only be used by the runnable that describe its usage
constr_9032	[SWS_Rte_CONSTR_09032]	Rte_Trigger API may only be used by the runnable that describe its usage
constr_9033	[SWS_Rte_CONSTR_09033]	Rte_IrTrigger API may only be used by the runnable that describe its usage
constr_9000	[SWS_Rte_CONSTR_09000]	Rte_IFeedback API may only be used by the RunnableEntitys that describe its usage
constr_9034	[SWS_Rte_CONSTR_09034]	Rte_IsUpdated API may only be used by the runnable that describe the access to the corresponding data
constr_9045	[SWS_Rte_CONSTR_09045]	The upper two bits of the of the server return value are reserved
constr_9035	[SWS_Rte_CONSTR_09035]	Rte_Start shall be called only once
constr_9036	[SWS_Rte_CONSTR_09036]	Rte_Start API may only be used after call of SchM_Init
constr_9037	[SWS_Rte_CONSTR_09037]	Rte_Start API shall be called on every core
constr_9038	[SWS_Rte_CONSTR_09038]	Rte_Stop shall be called before BSW shutdown
constr_9039	[SWS_Rte_CONSTR_09039]	Rte_PartitionTerminated shall be called only once
constr_9040	[SWS_Rte_CONSTR_09040]	Rte_PartitionRestarting shall be called only once
constr_9041	[SWS_Rte_CONSTR_09041]	Rte_RestartPartition shall be called from RestartTask

constr_9060	[SWS_Rte_CONSTR_09060]	Rte_Init API may only be used after call of Rte_Start
constr_9061	[SWS_Rte_CONSTR_09061]	Rte_StartTiming API may only be used after call of Rte_Start
constr_9059	[SWS_Rte_CONSTR_09059]	Usage of Basic Software Scheduler API prerequisites the include of the Module Interlink Header File
constr_9046	[SWS_Rte_CONSTR_09046]	SchM_Enter and SchM_Exit API may only be used by BswModuleEntitys describing its usage
constr_9047	[SWS_Rte_CONSTR_09047]	Nested call of SchM_Enter and SchM_Exit API is restricted
constr_9048	[SWS_Rte_CONSTR_09048]	SchM_Exit API may only be used by BswModuleEntitys that describe its usage
constr_9079	[SWS_Rte_CONSTR_09079]	SchM_Call API may only be used by the BswModuleEntity that describe its usage
constr_9076	[SWS_Rte_CONSTR_09076]	SchM_Result API may only be used by the BswModuleEntity that describe its usage
constr_9077	[SWS_Rte_CONSTR_09077]	SchM_Send API may only be used by the BswModuleEntity that describes its usage
constr_9078	[SWS_Rte_CONSTR_09078]	SchM_Receive API may only be used by the BswModuleEntity that describes its usage
constr_9049	[SWS_Rte_CONSTR_09049]	SchM_Switch API may only be used by BswModuleEntitys that describe its usage
constr_9050	[SWS_Rte_CONSTR_09050]	SchM_Mode API may only be used by BswModuleEntitys that describe its usage
constr_9051	[SWS_Rte_CONSTR_09051]	SchM_Mode API may only be used by BswModuleEntitys that describe its usage
constr_9052	[SWS_Rte_CONSTR_09052]	SchM_SwitchAck API may only be used by BswModuleEntitys that describe its usage
constr_9053	[SWS_Rte_CONSTR_09053]	SchM_Trigger API may only be used by the BswModuleEntitys that describe its usage
constr_9054	[SWS_Rte_CONSTR_09054]	SchM_ActMainFunction API may only be used by the BswModuleEntitys that describe its usage
constr_9058	[SWS_Rte_CONSTR_09058]	BswSchedulableEntity is not allowed to have service arguments or return value
constr_9055	[SWS_Rte_CONSTR_09055]	SchM_Init, SchM_Start, SchM_StartTiming shall be called only once
constr_9057	[SWS_Rte_CONSTR_09057]	SchM_Deinit shall be called before shut down of BSW
constr_9056	[SWS_Rte_CONSTR_09056]	SchM_Deinit API may only be used after the was RTE finalized
constr_9082	[SWS_Rte_CONSTR_09082]	RteEventToTaskMapping.RtePositionInTask and RteBswEventToTaskMapping.RteBswPositionInTask values shall be unique in a particular context
constr_3510	[SWS_Rte_CONSTR_03510]	Exclude usage of RteExclusiveAreaImplMechanism.OS_SPINLOCK in RteExclusiveAreaImplementation
constr_9091	[SWS_Rte_CONSTR_09091]	RteNvRamAllocation.RteSwNvRamMappingRef and RteNvRamAllocation.RteSwNvBlockDescriptorRef are excluding each other
constr_9005	[SWS_Rte_CONSTR_09005]	The references RteInternalTriggerConfig.RteSwcTriggerSourceRef has to be consistent with the RteSwComponentInstance.RteSoftwareComponentInstanceRef

constr_9006	[SWS_Rte_CONSTR_09006]	The references RteBswInternalTrigger-Config.RteBswTriggerSourceRef has to be consistent with the RteBswModuleInstance.RteBswImplementationRef
constr_9063	[SWS_Rte_CONSTR_09063]	Restricted kinds of RTEEvents which may mapped to RteInitializationRunnableBatch containers
constr_9064	[SWS_Rte_CONSTR_09064]	A single RteInitializationRunnableBatch container may not handle RTEEvents of different partitions
constr_9062	[SWS_Rte_CONSTR_09062]	Entire mapping of on-entry Runnable Entities for ModeDeclarationGroup.initialMode to RteInitializationRunnableBatch containers

Table G.11: Renamed Constraints in 4.3.0

G.8.5 Added Constraints in 4.3.0

none

G.8.6 Changed Constraints in 4.3.0

none

G.8.7 Deleted Constraints in 4.3.0

none

G.9 Changes in Rel. 4.3 Rev. 1 compared to Rel. 4.3 Rev. 0

G.9.1 Added Traceables in 4.3.1

[\[SWS_Rte_02310\]](#) [\[SWS_Rte_02311\]](#) [\[SWS_Rte_03608\]](#) [\[SWS_Rte_03609\]](#) [\[SWS_Rte_03610\]](#) [\[SWS_Rte_03869\]](#) [\[SWS_Rte_04552\]](#) [\[SWS_Rte_04553\]](#) [\[SWS_Rte_04554\]](#) [\[SWS_Rte_04555\]](#) [\[SWS_Rte_04556\]](#) [\[SWS_Rte_04557\]](#) [\[SWS_Rte_08802\]](#) [\[SWS_Rte_08803\]](#)

G.9.2 Changed Traceables in 4.3.1

[\[SWS_Rte_01058\]](#) [\[SWS_Rte_01060\]](#) [\[SWS_Rte_01061\]](#) [\[SWS_Rte_01064\]](#) [\[SWS_Rte_01065\]](#) [\[SWS_Rte_01106\]](#) [\[SWS_Rte_01238\]](#) [\[SWS_Rte_01239\]](#) [\[SWS_Rte_01248\]](#) [\[SWS_Rte_01317\]](#) [\[SWS_Rte_01339\]](#) [\[SWS_Rte_01379\]](#) [\[SWS_Rte_01389\]](#)

[SWS_Rte_02568] [SWS_Rte_02571] [SWS_Rte_02594] [SWS_Rte_02702] [SWS_Rte_02706] [SWS_Rte_02739] [SWS_Rte_02747] [SWS_Rte_02757] [SWS_Rte_03809] [SWS_Rte_03810] [SWS_Rte_03812] [SWS_Rte_03853] [SWS_Rte_03983] [SWS_Rte_04526] [SWS_Rte_05173] [SWS_Rte_06061] [SWS_Rte_06113] [SWS_Rte_06114] [SWS_Rte_06611] [SWS_Rte_06631] [SWS_Rte_06706] [SWS_Rte_06707] [SWS_Rte_06711] [SWS_Rte_06828] [SWS_Rte_07054] [SWS_Rte_07055] [SWS_Rte_07072] [SWS_Rte_07087] [SWS_Rte_07175] [SWS_Rte_07228] [SWS_Rte_07289] [SWS_Rte_07290] [SWS_Rte_07384] [SWS_Rte_07410] [SWS_Rte_07411] [SWS_Rte_07412] [SWS_Rte_07562] [SWS_Rte_07563] [SWS_Rte_07655] [SWS_Rte_07822] [SWS_Rte_07823] [SWS_Rte_08001] [SWS_Rte_08002] [SWS_Rte_08065] [SWS_Rte_08082] [SWS_Rte_08083] [SWS_Rte_08084] [SWS_Rte_08085] [SWS_Rte_08400] [SWS_Rte_08531] [SWS_Rte_08532] [SWS_Rte_08551] [SWS_Rte_08725] [SWS_Rte_08726]

G.9.3 Deleted Traceables in 4.3.1

[SWS_Rte_02579] [SWS_Rte_03714] [SWS_Rte_05111] [SWS_Rte_07132] [SWS_Rte_07676] [SWS_Rte_08533]

G.9.4 Added Constraints in 4.3.1

[SWS_Rte_CONSTR_03870]

G.9.5 Changed Constraints in 4.3.1

none

G.9.6 Deleted Constraints in 4.3.1

none

G.10 Changes in Rel. 4.4 Rev. 0 compared to Rel. 4.3 Rev. 1

G.10.1 Added Traceables in 4.4.0

[SWS_Rte_02312] [SWS_Rte_02313] [SWS_Rte_02314] [SWS_Rte_02315] [SWS_Rte_03611] [SWS_Rte_03612] [SWS_Rte_03613] [SWS_Rte_03614] [SWS_Rte_03615] [SWS_Rte_03616] [SWS_Rte_03617] [SWS_Rte_03618] [SWS_Rte_03871]

[SWS_Rte_03872] [SWS_Rte_04558] [SWS_Rte_04559] [SWS_Rte_06832] [SWS_Rte_06833] [SWS_Rte_06834] [SWS_Rte_06835] [SWS_Rte_06836] [SWS_Rte_06837] [SWS_Rte_06838] [SWS_Rte_06839] [SWS_Rte_06840] [SWS_Rte_07421] [SWS_Rte_07422] [SWS_Rte_07423] [SWS_Rte_07424] [SWS_Rte_07425] [SWS_Rte_07426] [SWS_Rte_07427] [SWS_Rte_70000] [SWS_Rte_70001] [SWS_Rte_70002] [SWS_Rte_70003] [SWS_Rte_70004] [SWS_Rte_70005] [SWS_Rte_70006] [SWS_Rte_70007] [SWS_Rte_70008] [SWS_Rte_70009] [SWS_Rte_70010] [SWS_Rte_70011] [SWS_Rte_70012] [SWS_Rte_70013] [SWS_Rte_70015] [SWS_Rte_70016] [SWS_Rte_70017] [SWS_Rte_70018] [SWS_Rte_70019] [SWS_Rte_70020] [SWS_Rte_70021] [SWS_Rte_70022] [SWS_Rte_70023] [SWS_Rte_70024] [SWS_Rte_70025] [SWS_Rte_70026] [SWS_Rte_70027] [SWS_Rte_70028] [SWS_Rte_70029] [SWS_Rte_70030] [SWS_Rte_70031] [SWS_Rte_70032] [SWS_Rte_70033] [SWS_Rte_70034] [SWS_Rte_70035] [SWS_Rte_70036] [SWS_Rte_70037] [SWS_Rte_70038] [SWS_Rte_70039] [SWS_Rte_70040] [SWS_Rte_70042] [SWS_Rte_70043] [SWS_Rte_70044] [SWS_Rte_70045] [SWS_Rte_70046] [SWS_Rte_70047] [SWS_Rte_70048] [SWS_Rte_70049] [SWS_Rte_70050] [SWS_Rte_70051] [SWS_Rte_70052] [SWS_Rte_70053] [SWS_Rte_70054] [SWS_Rte_70055] [SWS_Rte_70056] [SWS_Rte_70057] [SWS_Rte_70058] [SWS_Rte_70059] [SWS_Rte_70060] [SWS_Rte_70061] [SWS_Rte_70062] [SWS_Rte_70063] [SWS_Rte_70064] [SWS_Rte_70065] [SWS_Rte_70066] [SWS_Rte_70067] [SWS_Rte_70068] [SWS_Rte_70069] [SWS_Rte_70070] [SWS_Rte_70071] [SWS_Rte_70072] [SWS_Rte_70073] [SWS_Rte_70074] [SWS_Rte_70075] [SWS_Rte_70076] [SWS_Rte_70077] [SWS_Rte_70078] [SWS_Rte_70079] [SWS_Rte_70080] [SWS_Rte_70081] [SWS_Rte_70082] [SWS_Rte_70083] [SWS_Rte_70084] [SWS_Rte_70085] [SWS_Rte_70086] [SWS_Rte_70087] [SWS_Rte_70088] [SWS_Rte_70089] [SWS_Rte_70090] [SWS_Rte_70091] [SWS_Rte_70092] [SWS_Rte_70093] [SWS_Rte_70094] [SWS_Rte_70095] [SWS_Rte_70096] [SWS_Rte_70097] [SWS_Rte_70098] [SWS_Rte_70099] [SWS_Rte_70100] [SWS_Rte_70101] [SWS_Rte_70102] [SWS_Rte_70103] [SWS_Rte_70104] [SWS_Rte_70105] [SWS_Rte_70106] [SWS_Rte_70107] [SWS_Rte_70108] [SWS_Rte_70109] [SWS_Rte_70110] [SWS_Rte_70111] [SWS_Rte_70112] [SWS_Rte_70113] [SWS_Rte_70114] [SWS_Rte_70115] [SWS_Rte_80000] [SWS_Rte_80001] [SWS_Rte_80002] [SWS_Rte_80003] [SWS_Rte_80005] [SWS_Rte_80006] [SWS_Rte_80007] [SWS_Rte_80008] [SWS_Rte_80009] [SWS_Rte_80010] [SWS_Rte_80011] [SWS_Rte_80012] [SWS_Rte_80013] [SWS_Rte_80014] [SWS_Rte_80015] [SWS_Rte_80016] [SWS_Rte_80017] [SWS_Rte_80018] [SWS_Rte_80019] [SWS_Rte_80020] [SWS_Rte_80021] [SWS_Rte_80022] [SWS_Rte_80023] [SWS_Rte_80024] [SWS_Rte_80025] [SWS_Rte_80026] [SWS_Rte_80027] [SWS_Rte_80028] [SWS_Rte_80029] [SWS_Rte_80030] [SWS_Rte_80031] [SWS_Rte_80032] [SWS_Rte_80033] [SWS_Rte_80034] [SWS_Rte_80035] [SWS_Rte_80036] [SWS_Rte_80037] [SWS_Rte_80038] [SWS_Rte_80039] [SWS_Rte_80040] [SWS_Rte_80041] [SWS_Rte_80043] [SWS_Rte_80044] [SWS_Rte_80045] [SWS_Rte_80046] [SWS_Rte_80047] [SWS_Rte_80048] [SWS_Rte_80049] [SWS_Rte_80050] [SWS_Rte_80051] [SWS_Rte_80052] [SWS_Rte_80053] [SWS_Rte_80054] [SWS_Rte_80055] [SWS_Rte_80056] [SWS_Rte_80057] [SWS_Rte_80058] [SWS_Rte_80059] [SWS_Rte_80060] [SWS_Rte_80061] [SWS_Rte_80063] [SWS_Rte_80064]

[SWS_Rte_80065] [SWS_Rte_80066] [SWS_Rte_80067] [SWS_Rte_80068] [SWS_Rte_80069] [SWS_Rte_80070] [SWS_Rte_80071] [SWS_Rte_80072] [SWS_Rte_80073] [SWS_Rte_80074] [SWS_Rte_80075] [SWS_Rte_80076] [SWS_Rte_80077] [SWS_Rte_80078] [SWS_Rte_80079] [SWS_Rte_80080] [SWS_Rte_80081] [SWS_Rte_80082] [SWS_Rte_80083] [SWS_Rte_80084] [SWS_Rte_80085] [SWS_Rte_80100] [SWS_Rte_80101] [SWS_Rte_80102] [SWS_Rte_80103] [SWS_Rte_80104] [SWS_Rte_80105] [SWS_Rte_80106] [SWS_Rte_80107] [SWS_Rte_80108] [SWS_Rte_80109] [SWS_Rte_80110] [SWS_Rte_80111] [SWS_Rte_80112] [SWS_Rte_80113] [SWS_Rte_80114] [SWS_Rte_80115] [SWS_Rte_80116] [SWS_Rte_80117] [SWS_Rte_80118] [SWS_Rte_80119] [SWS_Rte_80120] [SWS_Rte_80121] [SWS_Rte_80122] [SWS_Rte_80123] [SWS_Rte_80124] [SWS_Rte_80125] [SWS_Rte_91102]

G.10.2 Changed Traceables in 4.4.0

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G.10.3 Deleted Traceables in 4.4.0

[SWS_Rte_05193] [SWS_Rte_07025] [SWS_Rte_08306] [SWS_Rte_08307] [SWS_Rte_08308]

G.10.4 Added Constraints in 4.4.0

[SWS_Rte_CONSTR_03873] [SWS_Rte_CONSTR_03874] [SWS_Rte_CONSTR_04558] [SWS_Rte_CONSTR_04559] [SWS_Rte_CONSTR_09100] [SWS_Rte_CONSTR_09101] [SWS_Rte_CONSTR_09102] [SWS_Rte_CONSTR_80000] [SWS_Rte_CONSTR_80001] [SWS_Rte_CONSTR_80002] [SWS_Rte_CONSTR_80003] [SWS_Rte_CONSTR_80004] [SWS_Rte_CONSTR_80005] [SWS_Rte_CONSTR_80006] [SWS_Rte_CONSTR_80007] [SWS_Rte_CONSTR_80009] [SWS_Rte_CONSTR_80010] [SWS_Rte_CONSTR_80011] [SWS_Rte_CONSTR_80012] [SWS_Rte_CONSTR_80013] [SWS_Rte_CONSTR_80014] [SWS_Rte_CONSTR_80015] [SWS_Rte_CONSTR_80016] [SWS_Rte_CONSTR_80017]

G.10.5 Changed Constraints in 4.4.0

[SWS_Rte_CONSTR_09058] [SWS_Rte_CONSTR_09082]

G.10.6 Deleted Constraints in 4.4.0

none

G.11 Changes in R19-11 compared to Rel. 4.4 Rev. 0

G.11.1 Added Traceables in 19-11

[SWS_Rte_02316] [SWS_Rte_03619] [SWS_Rte_03620] [SWS_Rte_03621] [SWS_Rte_03622] [SWS_Rte_03623] [SWS_Rte_03624] [SWS_Rte_03625] [SWS_Rte_03626] [SWS_Rte_03627] [SWS_Rte_03628] [SWS_Rte_03629] [SWS_Rte_03875] [SWS_Rte_03876] [SWS_Rte_03877] [SWS_Rte_03878] [SWS_Rte_03879] [SWS_Rte_03880] [SWS_Rte_03881] [SWS_Rte_03882] [SWS_Rte_03883] [SWS_Rte_03884] [SWS_Rte_04560] [SWS_Rte_04561] [SWS_Rte_04562] [SWS_Rte_04563] [SWS_Rte_04564] [SWS_Rte_04565] [SWS_Rte_04566] [SWS_Rte_04567] [SWS_Rte_04568] [SWS_Rte_04569] [SWS_Rte_04570] [SWS_Rte_04571] [SWS_Rte_04572] [SWS_Rte_04573] [SWS_Rte_04574] [SWS_Rte_04575] [SWS_Rte_04576] [SWS_Rte_08900] [SWS_Rte_08901] [SWS_Rte_08902] [SWS_Rte_08903] [SWS_Rte_08904] [SWS_Rte_08905] [SWS_Rte_08906] [SWS_Rte_08907] [SWS_Rte_70116] [SWS_Rte_70117] [SWS_Rte_89000] [SWS_Rte_89001] [SWS_Rte_89002] [SWS_Rte_89003] [SWS_Rte_89004] [SWS_Rte_89005] [SWS_Rte_89006] [SWS_Rte_89007] [SWS_Rte_89008] [SWS_Rte_89009] [SWS_Rte_89010] [SWS_Rte_89011] [SWS_Rte_89012] [SWS_Rte_89013] [SWS_Rte_89014] [SWS_Rte_89015] [SWS_Rte_89016] [SWS_Rte_89017] [SWS_Rte_89018] [SWS_Rte_89019] [SWS_Rte_91100] [SWS_Rte_91101] [SWS_Rte_91103] [SWS_Rte_91104] [SWS_Rte_91105] [SWS_Rte_91106] [SWS_Rte_91107] [SWS_Rte_91108] [SWS_Rte_91109]

[SWS_Rte_91110] [SWS_Rte_91111] [SWS_Rte_CONSTR_09120] [SWS_Rte_-
CONSTR_09121] [SWS_Rte_CONSTR_09122] [SWS_Rte_CONSTR_09123]
[SWS_Rte_CONSTR_09124]

G.11.2 Changed Traceables in 19-11

[SWS_Rte_01071] [SWS_Rte_01072] [SWS_Rte_01091] [SWS_Rte_01092] [SWS_-
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G.11.3 Deleted Traceables in 19-11

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G.12 Changes in R20-11 compared to R19-11

G.12.1 Added Traceables in R20-11

[\[SWS_Rte_02317\]](#) [\[SWS_Rte_02318\]](#) [\[SWS_Rte_02319\]](#) [\[SWS_Rte_02320\]](#) [\[SWS_Rte_02321\]](#) [\[SWS_Rte_02322\]](#) [\[SWS_Rte_03630\]](#) [\[SWS_Rte_03631\]](#) [\[SWS_Rte_03632\]](#) [\[SWS_Rte_03885\]](#) [\[SWS_Rte_03886\]](#) [\[SWS_Rte_03887\]](#) [\[SWS_Rte_03888\]](#) [\[SWS_Rte_03889\]](#) [\[SWS_Rte_03890\]](#) [\[SWS_Rte_03891\]](#) [\[SWS_Rte_04577\]](#) [\[SWS_Rte_04578\]](#) [\[SWS_Rte_04579\]](#) [\[SWS_Rte_04580\]](#) [\[SWS_Rte_04581\]](#) [\[SWS_Rte_04582\]](#) [\[SWS_Rte_04583\]](#) [\[SWS_Rte_04584\]](#) [\[SWS_Rte_04585\]](#) [\[SWS_Rte_04586\]](#) [\[SWS_Rte_04587\]](#) [\[SWS_Rte_04588\]](#) [\[SWS_Rte_04591\]](#) [\[SWS_Rte_04592\]](#) [\[SWS_Rte_04593\]](#) [\[SWS_Rte_04594\]](#) [\[SWS_Rte_04595\]](#) [\[SWS_Rte_04596\]](#) [\[SWS_Rte_04597\]](#) [\[SWS_Rte_04598\]](#) [\[SWS_Rte_04599\]](#) [\[SWS_Rte_04600\]](#) [\[SWS_Rte_04601\]](#) [\[SWS_Rte_04602\]](#) [\[SWS_Rte_04603\]](#) [\[SWS_Rte_04604\]](#) [\[SWS_Rte_04605\]](#) [\[SWS_Rte_04606\]](#) [\[SWS_Rte_04607\]](#) [\[SWS_Rte_04608\]](#) [\[SWS_Rte_04609\]](#) [\[SWS_Rte_04610\]](#) [\[SWS_Rte_04611\]](#) [\[SWS_Rte_04612\]](#) [\[SWS_Rte_04613\]](#) [\[SWS_Rte_04614\]](#) [\[SWS_Rte_04615\]](#) [\[SWS_Rte_08908\]](#) [\[SWS_Rte_08909\]](#) [\[SWS_Rte_08910\]](#) [\[SWS_Rte_08911\]](#) [\[SWS_Rte_08912\]](#) [\[SWS_Rte_70118\]](#) [\[SWS_Rte_70119\]](#) [\[SWS_Rte_70120\]](#) [\[SWS_Rte_70121\]](#) [\[SWS_Rte_70122\]](#) [\[SWS_Rte_70123\]](#) [\[SWS_Rte_70124\]](#) [\[SWS_Rte_70125\]](#) [\[SWS_Rte_70126\]](#) [\[SWS_Rte_70127\]](#) [\[SWS_Rte_70128\]](#) [\[SWS_Rte_70129\]](#) [\[SWS_Rte_70130\]](#) [\[SWS_Rte_70131\]](#) [\[SWS_Rte_70132\]](#) [\[SWS_Rte_70133\]](#) [\[SWS_Rte_70134\]](#) [\[SWS_Rte_70135\]](#) [\[SWS_Rte_70136\]](#) [\[SWS_Rte_70137\]](#) [\[SWS_Rte_70138\]](#) [\[SWS_Rte_70139\]](#) [\[SWS_Rte_70140\]](#) [\[SWS_Rte_70141\]](#) [\[SWS_Rte_70142\]](#) [\[SWS_Rte_72000\]](#) [\[SWS_Rte_72001\]](#) [\[SWS_Rte_72002\]](#) [\[SWS_Rte_72003\]](#) [\[SWS_Rte_72004\]](#) [\[SWS_Rte_72005\]](#) [\[SWS_Rte_72006\]](#) [\[SWS_Rte_72007\]](#) [\[SWS_Rte_72008\]](#) [\[SWS_Rte_72009\]](#) [\[SWS_Rte_72010\]](#) [\[SWS_Rte_72011\]](#) [\[SWS_Rte_72012\]](#) [\[SWS_Rte_72013\]](#) [\[SWS_Rte_72014\]](#) [\[SWS_Rte_72015\]](#) [\[SWS_Rte_72016\]](#) [\[SWS_Rte_72017\]](#) [\[SWS_Rte_72018\]](#) [\[SWS_Rte_72019\]](#) [\[SWS_Rte_72020\]](#) [\[SWS_Rte_72021\]](#) [\[SWS_Rte_72022\]](#) [\[SWS_Rte_72023\]](#) [\[SWS_Rte_80126\]](#) [\[SWS_Rte_80127\]](#) [\[SWS_Rte_80128\]](#) [\[SWS_Rte_80129\]](#) [\[SWS_Rte_80130\]](#) [\[SWS_Rte_80131\]](#) [\[SWS_Rte_80132\]](#) [\[SWS_Rte_80133\]](#) [\[SWS_Rte_80134\]](#) [\[SWS_Rte_80135\]](#)

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G.12.2 Changed Traceables in R20-11

[SWS_Rte_01071] [SWS_Rte_01072] [SWS_Rte_01091] [SWS_Rte_01092] [SWS_Rte_01102] [SWS_Rte_01111] [SWS_Rte_01206] [SWS_Rte_01243] [SWS_Rte_01244] [SWS_Rte_01245] [SWS_Rte_01246] [SWS_Rte_01247] [SWS_Rte_01376] [SWS_Rte_01399] [SWS_Rte_02614] [SWS_Rte_02619] [SWS_Rte_02631] [SWS_Rte_02750] [SWS_Rte_03019] [SWS_Rte_03620] [SWS_Rte_03621] [SWS_Rte_03622] [SWS_Rte_03623] [SWS_Rte_03624] [SWS_Rte_03625] [SWS_Rte_03626] [SWS_Rte_03627] [SWS_Rte_03628] [SWS_Rte_03629] [SWS_Rte_03827] [SWS_Rte_03828] [SWS_Rte_03867] [SWS_Rte_03878] [SWS_Rte_03879] [SWS_Rte_03880] [SWS_Rte_03881] [SWS_Rte_03882] [SWS_Rte_03883] [SWS_Rte_03884] [SWS_Rte_03995] [SWS_Rte_03996] [SWS_Rte_03997] [SWS_Rte_04531] [SWS_Rte_04532] [SWS_Rte_04533] [SWS_Rte_04534] [SWS_Rte_04536] [SWS_Rte_04538] [SWS_Rte_04559] [SWS_Rte_04560] [SWS_Rte_04561] [SWS_Rte_04569] [SWS_Rte_04570] [SWS_Rte_04571] [SWS_Rte_05092] [SWS_Rte_05503] [SWS_Rte_06032] [SWS_Rte_06060] [SWS_Rte_06530] [SWS_Rte_06720] [SWS_Rte_06721] [SWS_Rte_06722] [SWS_Rte_06723] [SWS_Rte_06775] [SWS_Rte_06776] [SWS_Rte_06781] [SWS_Rte_06782] [SWS_Rte_06783] [SWS_Rte_06784] [SWS_Rte_06788] [SWS_Rte_06789] [SWS_Rte_06797] [SWS_Rte_07087] [SWS_Rte_07088] [SWS_Rte_07110] [SWS_Rte_07111] [SWS_Rte_07117] [SWS_Rte_07118] [SWS_Rte_07195] [SWS_Rte_07200] [SWS_Rte_07203] [SWS_Rte_07214]

[SWS_Rte_07224] [SWS_Rte_07263] [SWS_Rte_07266] [SWS_Rte_07410] [SWS_Rte_07411] [SWS_Rte_07412] [SWS_Rte_07419] [SWS_Rte_07541] [SWS_Rte_07543] [SWS_Rte_07544] [SWS_Rte_07552] [SWS_Rte_07554] [SWS_Rte_07555] [SWS_Rte_07627] [SWS_Rte_07629] [SWS_Rte_07631] [SWS_Rte_07662] [SWS_Rte_07843] [SWS_Rte_08069] [SWS_Rte_08530] [SWS_Rte_08535] [SWS_Rte_08777] [SWS_Rte_08906] [SWS_Rte_08907] [SWS_Rte_70015] [SWS_Rte_70016] [SWS_Rte_70017] [SWS_Rte_70018] [SWS_Rte_70019] [SWS_Rte_70020] [SWS_Rte_70021] [SWS_Rte_70022] [SWS_Rte_70023] [SWS_Rte_70024] [SWS_Rte_70025] [SWS_Rte_70026] [SWS_Rte_70027] [SWS_Rte_70028] [SWS_Rte_70032] [SWS_Rte_70038] [SWS_Rte_70039] [SWS_Rte_70043] [SWS_Rte_70050] [SWS_Rte_70051] [SWS_Rte_70056] [SWS_Rte_70057] [SWS_Rte_70062] [SWS_Rte_70063] [SWS_Rte_70070] [SWS_Rte_70078] [SWS_Rte_70087] [SWS_Rte_70088] [SWS_Rte_70096] [SWS_Rte_70097] [SWS_Rte_70099] [SWS_Rte_70103] [SWS_Rte_70104] [SWS_Rte_70105] [SWS_Rte_70106] [SWS_Rte_70107] [SWS_Rte_70110] [SWS_Rte_70111] [SWS_Rte_70112] [SWS_Rte_70113] [SWS_Rte_70114] [SWS_Rte_70116] [SWS_Rte_80007] [SWS_Rte_80010] [SWS_Rte_80011] [SWS_Rte_80016] [SWS_Rte_80017] [SWS_Rte_80018] [SWS_Rte_80019] [SWS_Rte_80020] [SWS_Rte_80021] [SWS_Rte_80030] [SWS_Rte_80040] [SWS_Rte_80046] [SWS_Rte_80056] [SWS_Rte_80065] [SWS_Rte_80066] [SWS_Rte_80068] [SWS_Rte_80069] [SWS_Rte_80074] [SWS_Rte_80075] [SWS_Rte_80079] [SWS_Rte_80080] [SWS_Rte_80081] [SWS_Rte_80082] [SWS_Rte_80100] [SWS_Rte_80101] [SWS_Rte_80105] [SWS_Rte_89010] [SWS_Rte_89011] [SWS_Rte_89012] [SWS_Rte_89013] [SWS_Rte_89015] [SWS_Rte_CONSTR_03873] [SWS_Rte_CONSTR_03874] [SWS_Rte_CONSTR_09122] [SWS_Rte_CONSTR_09123] [SWS_Rte_CONSTR_09124] [SWS_Rte_CONSTR_80005] [SWS_Rte_CONSTR_80006] [SWS_Rte_CONSTR_80009] [SWS_Rte_CONSTR_80017]

G.12.3 Deleted Traceables in R20-11

[SWS_Rte_04537] [SWS_Rte_04539] [SWS_Rte_06737] [SWS_Rte_06738] [SWS_Rte_07828] [SWS_Rte_07829] [SWS_Rte_07844] [SWS_Rte_08078] [SWS_Rte_CONSTR_80007]