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[1] Layered Software Architecture
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[2] Glossary
AUTOSAR_FO_TR_Glossary

[3] Specification of Standard Types
AUTOSAR_CP_SWS_StandardTypes

[4] Generic Structure Template
AUTOSAR_FO_TPS_GenericStructureTemplate

[5] Standardized M1 Models used for the Definition of AUTOSAR
AUTOSAR_FO_MOD_GeneralDefinitions

1 Introduction

This modeling guide describes the applied modeling techniques and rules, used to specify the AUTOSAR Basic Software within a UML model.

The information contained in the BSW model is processed by the AUTOSAR Meta Model Tool (MMT) and provides a major input of the several Software Specifications (SWS) defined by AUTOSAR. In order to make the BSW model accessible by the MMT, it is essential that the model observes the rules described in this document.

1.1 Artifacts

The main purpose of the AUTOSAR BSW UML model is keeping the 99+ documents synchronous with respect to file structure, provided and required interfaces, sequence diagrams, state machines etc. Therefore, all the relevant information is kept in the BSW model according to the modeling rules specified in chapter 2.

The following artifacts are contributed to the SWS documents by the BSW UML model:

1.1.1 Header Files

Chapter 5.1 of each SWS document contains the BSW module's file structure, in particular its file inclusion structure. Most modules' include file relationships have a similar structure, in fact some parts are actually identically modeled. Therefore, the Header File structure is being modeled using a class diagram, with stereotyped classes representing the source code- and header files; see section 2.12.1.

1.1.2 Imported Type Definitions

SWS chapter 8.1 contains a tabular list of imported types. This table is automatically generated from the module dependency as explained in section 2.6.

1.1.3 Type Definitions

SWS chapter 8.2 contains detailed descriptions of all types defined within a given BSW module. For details on the modeling of type definitions refer to section 2.8.

1.1.4 Function Definitions

SWS chapter 8.3 contains a detailed description for each function provided by the BSW module. The description is presented in form of a table with a specific layout.

The individual fields of the table are filled from the API function definitions according to section 2.5.

1.1.5 Callback Notifications

Very similar to the Function Definitions, SWS chapter 8.4 contains the callback definitions the BSW module provides. These are callbacks which will be called by other BSW modules, where the lower layer module is typically the caller. A table for each callback notification will be generated for a module's specified callbacks according to section 2.5.4.

1.1.6 Scheduled Functions

Scheduled Functions are described in SWS chapter 8.5. The definition of scheduled functions in the BSW UML model is described in section 2.5.1.

1.1.7 Mandatory Interfaces

SWS chapter 8.6.1 contains a list of "mandatory interfaces" expected by the module. The list is generated from the BSW UML model according to the mandatory dependencies as described in section 2.6.2.

1.1.8 Optional Interfaces

Similarly, the list of "optional interfaces" contained in SWS chapter 8.6.2 is generated from the BSW UML model according to the optional dependencies as described in section 2.6.3.

1.1.9 Configurable Interfaces

SWS Chapter 8.6.3 contains a BSW module's "Configurable Interfaces". These are interfaces whose called function name can be configured using ECU configuration parameters. In AUTOSAR, these are typically used for issuing callback notifications, i.e. the module owning the configurable interface uses it to notify a (configurable) upper layer module's callback. In other words the module defining a "Configurable Interface" calls an other module that implements these interface definition. A table for each callback notification will be generated for a module's specified callbacks according to section 2.5.4.2.

1.1.10 Sequence Diagrams

In order to visualize the interaction of a BSW module with other modules, SWS Chapter 9 contains UML Sequence Diagrams for the module's typical use cases. In order to keep such Sequence Diagrams consistent between different modules within the AUTOSAR BSW stack, they are also modeled within the BSW UML model. The diagrams are being exported to image files by the mmt tool; they are then being included by the SWS document files. For the detailed modeling guidelines see section 2.12.2.

1.1.11 Various Diagrams

The SWS documents of various BSW modules use additional UML diagrams e.g. for either specifying core functionality, or for additionally illustrating dependencies between modules. Some concrete examples are the various state machines used throughout the AUTOSAR BSW stack, for example in the CAN State Manager or in COM manager. Whenever possible, such diagrams should also be modeled in the BSW UML model. This ensures that the sources of the document diagrams will not get lost, and also facilitates their maintenance and keeping a uniform modeling style.

1.1.12 Modeling of services

BSW Modules belonging to the Service Layer of the AUTOSAR Basic Software Architecture may offer their services in the form of AUTOSAR Service Interfaces. AUTOSAR Service Interfaces are described in terms of the Software Component Template rather than C-language interfaces, and they come in different flavors, e.g. ClientServerInterface, SenderReceiverInterface, ModeSwitchInterface. Consequently, their properties require a different style of modeling than the standard BSW API functions. Modeling of AUTOSAR services is described in section 2.7.

1.1.13 Error classification

The SWS chapter "Error classification" (usually located within SWS chapter 7) contains detailed descriptions of all error codes the module uses for

- Development Errors
- Runtime Errors

For details on the modeling of these errors refer to section 2.10.

1.1.14 BSW Module List

The complete list of BSW modules is generated from the modeled components that represent the BSW modules, see section 2.4.2.

2 Modeling Guide

This Chapter contains the modeling rules that shall be followed when modeling AUTOSAR BSW artifacts within the BSW UML model. It is important that these rules are used consistently throught the model for the following reasons: The model stays readable, additions and modifications are done in a reproducible way preventing the duplication of elements, and most importantly, the automated artifact generation using the MMT tool depends on nonambiguous modeling conventions.

2.1 Terminology

The agreed tool for UML modeling in AUTOSAR is *Enterprise Architect* by Sparx Systems. Accordingly the BSW model is being maintained using Enterprise Architect version 7.5 and above. This guide focusses on modeling techniques rather than tools, therefore this document strives to describe the concepts in terms of UML. Nevertheless, in order to be precise, sometimes terms specific to Enterprise Architect are used.

2.2 Model Structure

The root structure of the BSW UML model consists of the following packages:

ReadMe: Contains diagrams providing version number, known limitations and disclaimer.

ExportConfiguations: Contains static configuration of exports from the model to be read by export tools.

Interaction Views: Contains sequence charts for modeling interactions of different modules. Only sequence diagrams shall be placed into this packages. The modules are arranged by stack vertically.

SoftwarePackages: Contains the BSW modules definitions including interfaces and type definitions. Moreover state and header diagrams are modelled here. The modules are arranged by layer horizontally.

Documentation Drawings: Used for additional illustrations of the BSW modules and for state diagrams to be included into SWS documents.

Specification Diagrams: Used for diagrams that shall explicitly be exported as SWS Items i.e. as normative part of the AUTOSAR Specification. Diagrams here are exported in a way that allows relevant changes (non-layout changes) to be tracked and documented. The following diagram types of the UML are supported in this package:

- Sequence charts
- State diagrams

- Activity diagrams

2.3 Common modeling mechanisms

2.3.1 Modeling of element names

Element names in the BSWUMLModel might be arbitrarily long, ambiguous, and contain various special characters e.g. for expressing different variants of an element.

This might cause issues when

- exporting elements to files with the file name containing the element name
- exporting elements to Blueprint files in ARXML format and cross-referencing to elements in Blueprints.

[TR_BSWMG_00031] Alternative Anchor Name ⌈The optional tagged value `aName` is used to specify an alternative anchor name for BSWUML elements intended for further processing by tools.

This alternative anchor name shall be used in cases where the element name is not suitable because it is either ambiguous or contains special characters.

Hence, if the alternative anchor name is set it shall

- start with a letter, followed by only letters, numbers, and underscore characters
- be unique within its scope[1]
- not be too long[2].

⌋

2.3.2 Modeling of Tagged Values

Whenever a tagged value in the BSWUML has a long value (more than 255 characters) or the value contains line breaks it cannot be entered in Enterprise Architect.

To mitigate this problem the following specification was introduced using tagged value notes that can contain arbitrarily long text with line breaks:

[TR_BSWMG_00176] Modeling of tagged values as tagged value notes ⌈Alternatively to setting text into the value of a tagged value the desired text may be put into the tagged value note.

[1] The scope is dependent of the UML type of the element. E.g. within a function, all parameters shall have a unique name. The function itself, however, shall have a unique name within the entire BSWUMLModel.

[2] E.g. the maximal shortName length in ARXML is 128 characters - there might be other tools that restrict the length even more.

To mark that the desired value text is found in the tagged value note the value of the tagged value shall be exactly the term **“@note”**.⌋

2.3.3 Modeling of predefined order of elements

Elements in the BSWUMLModel are ordered either by the explicitly set order in Enterprise Architect (e.g. for parameters of operations) or – if the order has no meaning in UML – they are ordered alphabetically by name. This order guarantees a stable generation of artifacts from the model.

In case the alphabetical order does not provide an satisfying result (e.g. for a enumeration with the literals MAX_VALUE and MIN_VALUE) there is the option to override the alphabetical order by setting tagged values.

[TR_BSWMG_00925] Explicit ordering of model elements ⌈To apply an explicit order to model elements to appear in the generated artifacts from BSWUMLModel the tagged value `bsw.sequenceOffset` shall be set at the elements that are listed.

The values of `bsw.sequenceOffset` shall be integer numbers.

For the ordering of the elements during the artifact generation the following rules apply:

1. The default value for all elements where `bsw.sequenceOffset` is not set is 0.
2. Elements with lower value of `bsw.sequenceOffset` appear in the list before elements with higher value of `bsw.sequenceOffset`.
3. Elements with the same value of `bsw.sequenceOffset` are ordered alphabetically by name.

⌋

The order of elements can not always be changed as sometimes the order also has semantical meaning (e.g. for the above mentioned parameters of operations):

[TR_BSWMG_00926] Restriction on explicit ordering of model elements ⌈The tagged value `bsw.sequenceOffset` may only be applied at the following model elements:

- Enumeration Literals (see [TR_BSWMG_00073])
- Values and Ranges of Simple Type Definitions (see [TR_BSWMG_00927], [TR_BSWMG_00071])
- ClientServerOperations (see [TR_BSWMG_00103])
- SenderReceiver-DataElements (see [TR_BSWMG_00302])
- Modes in ModeDeclarationGroups (see [TR_BSWMG_00204])
- Errors in ErrorSets (see [TR_BSWMG_00169], [TR_BSWMG_00170])

⌋

2.3.4 Modeling of elements with an external specification

There might be elements (e.g. datatypes or interfaces) that are used in the AUTOSAR context, but are specified in another, external Standard (e.g. the TickType or the GetResource interface are specified in OSEK and are used in the AUTOSAR Os module).

It is not desired to repeat that specification in an AUTOSAR document. So, those elements shall only be modelled as detailed as required for a correct appearance in diagrams.

Additionally, they shall not be given an SWS Item ID as they are not part of the AUTOSAR Specification.

[TR_BSWMG_00930] Model elements with an external specification ⌈Model elements used in AUTOSAR that come from an external Standard/Specification shall be marked with the tagged value `bsw.externalSpecification` with the value being the name of that Standard/Specification.⌋

2.4 Modeling of BSW Modules

2.4.1 Packages

[TR_BSWMG_00001] BSW Module Packages ⌈For each basic software module a UML package (the “module package”) shall be placed within the package structure according to the module’s role in the Layered Software Architecture[1].⌋

[TR_BSWMG_00002] Naming of BSW Module Packages ⌈The name of the *module package* shall be the ‘module abbreviation’ of the BSW module.⌋

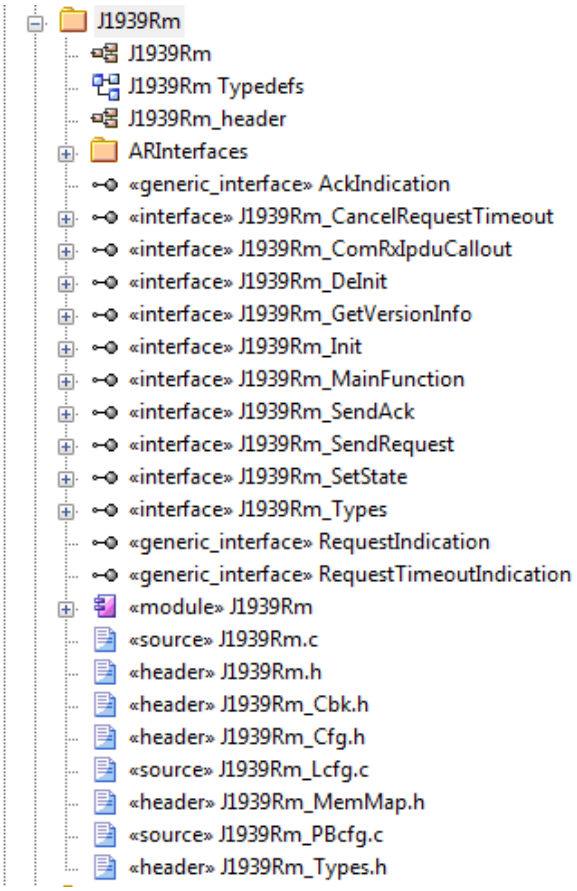


Figure 2.1: Example of a module package

2.4.2 Components

[TR_BSWMG_00003] BSW Module Components ⌈Each basic software module shall be modeled as an UML component with stereotype ≪`module`≫ (the “module component”).⌋

[TR_BSWMG_00004] Naming of BSW Module components ⌈The name of the *module component* shall be the ‘module abbreviation’ of the BSW module.⌋

[TR_BSWMG_00036] BSW Module ID ⌈The tagged value `bsw.moduleId` shall be set to the module ID of the BSW module.⌋

[TR_BSWMG_00931] BSW Module Name ⌈The tagged value `bsw.moduleLongName` shall be set to the module name of the BSW module.⌋

[TR_BSWMG_00005] Location of BSW Module components ⌈Each *module component* shall be modeled as a top-level element of its containing module package.⌋

[TR_BSWMG_00098] SWS Item ID of the Imported Types table of the module ⌈The tagged value `bsw.importedTypes.swsItemId` is used to specify the SWS Item ID for the table of datatypes imported into the module.⌋

[TR_BSWMG_00099] Up-traces of the Imported Types table of the module ⌈The tagged value `bsw.importedTypes.traceRefs` is used to specify up-traces to requirements of the SWS Item containing the table of datatypes imported into the module. Multiple requirement IDs have to be separated by a comma.⌋

[TR_BSWMG_00936] Tracking the latest used SWS-ID of the module ⌈The tagged value `bsw.lastUsedSwsItemId` is used to denote the latest used SWS-ID within the module. Its only purpose is to help the modelers to keep track of the SWS-IDs when assigning new ones.⌋

[TR_BSWMG_00937] Tracking the latest used Service-ID of the module ⌈The tagged value `bsw.lastUsedServiceId` is used to denote the latest used Service-ID within the module (see [TR_BSWMG_00024]). Its only purpose is to help the modelers to keep track of the Service-IDs when assigning new ones.⌋

2.4.3 Module Extensions

Module extensions serve to provide additional interfaces for specific modules (e.g. *CanXL* is a module extension to *Can*). They are particular in the way that on the one hand they are needed to provide the same module ID to the outside world as they are an optional part of the same module. On the other hand, they are decribed in a separate document (e.g. *SWS_CANXLDriver* and *SWS_CANDriver*) and therefore are best modeled in a separate module to make clear during the development of the AUTOSAR Standard: which part belongs to which document.

It follows from the sections before (in particular [TR_BSWMG_00002] and [TR_BSWMG_00004]) that BSW modules shall be modeled as a component named equally to its parent package.

This rule cannot be applied here if the module and its extension shall be kept distinguishable. Clearly, the component of a module extension needs to be named as the module to ensure that e.g. it is correctly in UML diagrams that are exported and visible to the outside world. Hence, the only place to distinguish the extension from the module is the package name. The following shall be modelled:

[TR_BSWMG_00183] BSW Module Extensions ⌈A BSW Module Extension shall be modelled as BSW Module with the same name as the extended module. The module package shall be named as the abbreviation of the BSW Module Extension according to [TR_BSWMG_00002]. In particular, [TR_BSWMG_00004] does not apply to this case.⌋

[TR_BSWMG_00184] Explicit modeling of BSW Module Extensions ⌈To make explicit that a component is a BSW Module Extension it shall be tagged with the tagged

value `bsw.extendsModule`. The value of this tagged value shall be the name of extended module.⌋

To conclude the example, the modelling of *CanXL* shall be

package `Can`
component ≪`module`≫ `Can`
package `CanXL`
component ≪`module`≫ `Can` with tagged value `bsw.extendsModule=Can`

2.4.4 Component Diagrams

[TR_BSWMG_00006] Component Diagrams ⌈The module package shall contain a "component diagram" (Enterprise Architect: UML Component Diagram).⌋

[TR_BSWMG_00007] Naming of Component Diagrams ⌈The name of the component diagram shall be identical to the name of the *module component* (module abbreviation).⌋

[TR_BSWMG_00008] Content of Component Diagrams ⌈The component diagram contains the module component as well as all of the module's interface relationships.⌋

2.4.5 Type Diagrams

[TR_BSWMG_00009] Type Diagrams ⌈If a BSW module defines data types, its module package shall contain a "types diagram" (Enterprise Architect: UML Class Diagram).⌋

[TR_BSWMG_00010] Naming of Types Diagrams ⌈The name of the types diagram shall be the name of the *module component* followed by a space character followed by `Types`, e.g. `FrTp Types`.⌋

[TR_BSWMG_00011] Content of Types Diagrams ⌈The *types diagram* shall contain all types defined by the BSW module.⌋

2.5 Modeling of API Functions

An AUTOSAR BSW module provides services to other BSW modules in the form of C-syntax functions. These functions are also the underlying implementation of AUTOSAR Services accessed by Software Components over the RTE.

This section explains how each such function is modeled in the form of an UML operation. Each operation is placed in an UML interface owned by the BSW module realizing the service. This UML interface is hereinafter called Function interface.

[TR_BSWMG_00012] Function interfaces ⌈For each function to be provided by a BSW module, an UML interface (the "function interface") shall be created in its module package. The stereotype of the interface shall be ≪interface≫.⌋

[TR_BSWMG_00013] Naming of function interfaces ⌈The *function interface* shall have the same name as the actual function (depends on TR_BSWMG_00017, TR_BSWMG_00030).⌋

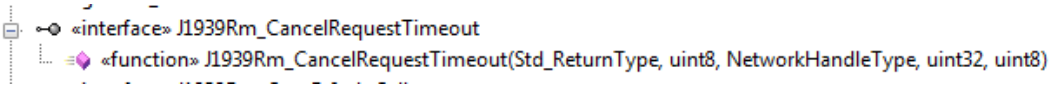


Figure 2.2: Naming example of a function interface

[TR_BSWMG_00014] API functions in component diagrams ⌈API functions shall be visible in the providing BSW module's component diagram.⌋

Note: The easiest way to achieve this is to drag the new Interface directly into the providing module's component diagram when creating the interface.

[TR_BSWMG_00015] Realization relationships ⌈The BSW module providing the service shall have a directed "Realization" association to the interface. The association shall be stereotyped ≪realize≫.⌋

Note: To differ associations from explanatory diagrams from generation relevant associations the stereotype ≪realize≫ has to be added to each generation relevant realize association.

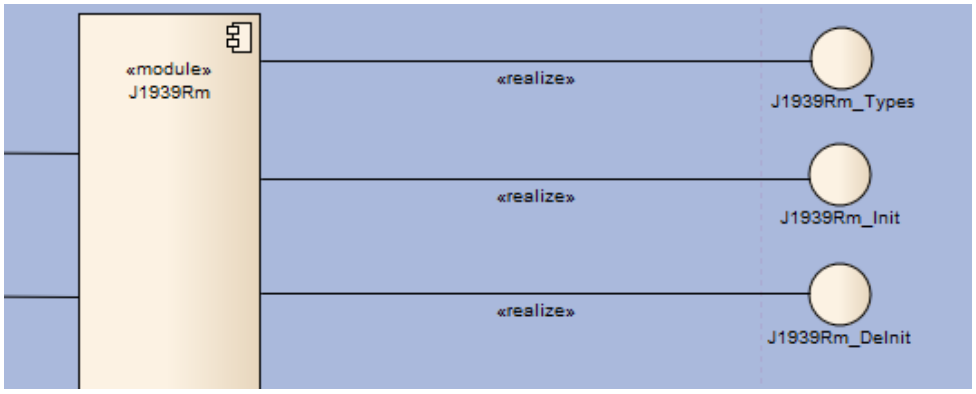


Figure 2.3: Realization example of an interface

[TR_BSWMG_00016] API Functions ⌈The function itself shall be modeled as an UML operation (the "operation") having one of the following stereotypes: ≪function≫, ≪scheduled_function≫, ≪callout≫, ≪callback≫.⌋

[TR_BSWMG_00017] Naming of API Functions ⌈The name of the *operation* shall be the API function name.⌋

[TR_BSWMG_00030] Name prefixes of API Functions ⌈The name of the *operation* shall be prefixed with the name of the realizing module (module abbreviation) followed by an underscore, i.e.: “<Ma>_<operation_name>” (*Ma = Module Abbreviation*)⌋

[TR_BSWMG_00018] Model Location of API Functions ⌈The operation shall be placed into its corresponding provider’s realized interface.⌋

[TR_BSWMG_00019] API Function documentation ⌈Each API function shall provide a short description.⌋

Note: EA provides a text-field called “Notes” to take the operation’s description.

[TR_BSWMG_00034] “Return Type” field in API Functions ⌈The operation’s “Return Type” field shall be left empty. See [TR_BSWMG_00023] for modeling return parameters.⌋

[TR_BSWMG_00024] Service ID of an API Function ⌈The tagged value `ServiceID` shall contain a service identifier (the ‘Service ID’) which shall be unique within the BSW module. The parameter is specified in hexadecimal notation using lowercase characters and shall be padded to two hexadecimal digits, e.g. “0x0d”.

Multiple Service IDs are permissable for genericly defined API functions. In that case, the values shall be written in one of the following forms, with an optional comment/hint in parentheses:

- Concatenate different Service IDs by “,”, “;”, or “and”, e.g. “0x0e and 0x0f”.
- Define a range by “to”, e.g. “0x10 to 0x15 (see [SWS_Abc_12345])”.

⌋

[TR_BSWMG_00938] Service ID Groups ⌈Two or more API functions provided by the same BSW module that are accepted to share the same Service ID (see [TR_BSWMG_00024]) shall be tagged with the tagged value `ServiceIDGroup`. The value of that tagged value shall be the same among all API functions sharing the same Service ID.

Functions tagged with `ServiceIDGroup` are an exception to the uniqueness of [TR_BSWMG_00024].⌋

Note: Usually, functions that are accepted to share the same Service ID also share the same function name. In this case, the value of ServiceIDGroup should be set to the function name.

[TR_BSWMG_00025] Reentrancy value of an API Function ⌈The tagged value `Reentrant` shall determine whether the function needs to be implemented as reentrant or not. The values are “Reentrant”, “Non Reentrant”, “Conditionally Reentrant” should be used. However, this is no hard restriction and arbitrary values are also allowed.⌋

[TR_BSWMG_00026] Synchronicity value of an API Function ⌈The tagged value `Synchronous` shall be set either to “Synchronous”, “Asynchronous”, or “Depends on configuration”.⌋

[TR_BSWMG_00906] Comment on synchronicity of an API Function ⌈The tagged value `Synchronous.comment` may be set to give additional information to the synchronicity (see [TR_BSWMG_00026]) of the API function.⌋

[TR_BSWMG_00150] SWS Item ID of an API Function ⌈The tagged value `bsw.swsItemId` is used to specify the SWS Item ID of a API function.⌋

[TR_BSWMG_00940] Custom SWS Item Title of an API Function ⌈The tagged value `bsw.swsItemNameForTitle` is used to override the function name in the title of the SWS Item representing the API function. (Usecase: If two functions share the same name more explicite names in the SWS Item title can be helpful for the reader.)⌋

[TR_BSWMG_00151] Up-traces of an API Function ⌈The tagged value `bsw.traceRefs` is used to specify up-traces to requirements. Multiple requirement IDs have to be separated by a comma.⌋

[TR_BSWMG_00140] Header File Reference of an API Function ⌈The tagged value `bsw.headerFile` is used to specify the header file where the API function is provided.⌋

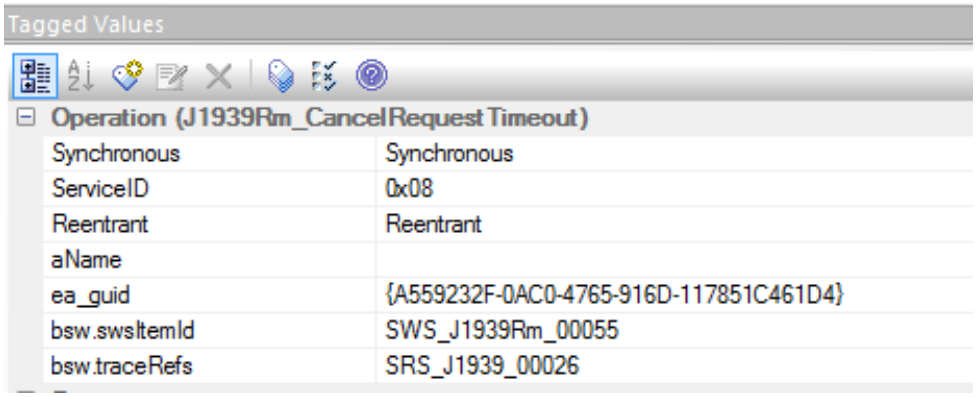


Figure 2.4: TaggedValues example of a API function

2.5.1 Scheduled Functions

[TR_BSWMG_00037] Stereotype for Scheduled Functions ⌈Scheduled Functions shall be modeled by setting the operation’s stereotype to ≪`scheduled_function`≫.⌋

Note: The Schedule attribute of a Scheduled Function is not used in any artifact any more.

2.5.2 API Function Parameters

[TR_BSWMG_00020] API Function Parameters ⌈The function parameters shall have mandatory entries for “Name”, “Type”, “Direction” and “Notes”.⌋

[TR_BSWMG_00032] API Function Parameter types ⌈The parameter “Type” shall be one of the existing types defined in the BSW model.⌋

[TR_BSWMG_00033] C-Style Pointers as API Function Parameters ⌈Parameters may be modeled as C-Style pointers by appending * to the parameter type, e.g. `PduInfoType*`⌋

[TR_BSWMG_00035] Mandatory constant types for pointers of API Function Input Parameters ⌈Pointer-type parameters of direction type “in”, i.e. parameters that represent read-only structures or arrays, may prepend the parameter type with the `const` keyword. This enforces that the data pointed to by the parameter is read-only and will not be altered by the function. Example: `const FrIf_ConfigType*`⌋

[TR_BSWMG_00021] API Function Parameter Direction ⌈The parameter’s direction type attribute shall be set to one of the values `in`, `out`, `inout`, `return`.⌋

[TR_BSWMG_00022] API Function Parameter Description ⌈Each parameter shall provide a short description about its purpose.⌋

Note: EA provides a textfield called ‘Notes’ to take the parameters description.

[TR_BSWMG_00023] API Function Return Parameter ⌈If the function’s return type is not equal to `void`, the return value shall be modeled like an operation parameter with the following exceptions: It shall be the first parameter in the list. Additionally, it shall be the only parameter to have its “Direction” set to “return”. The notes field shall concisely describe the possible return values.⌋

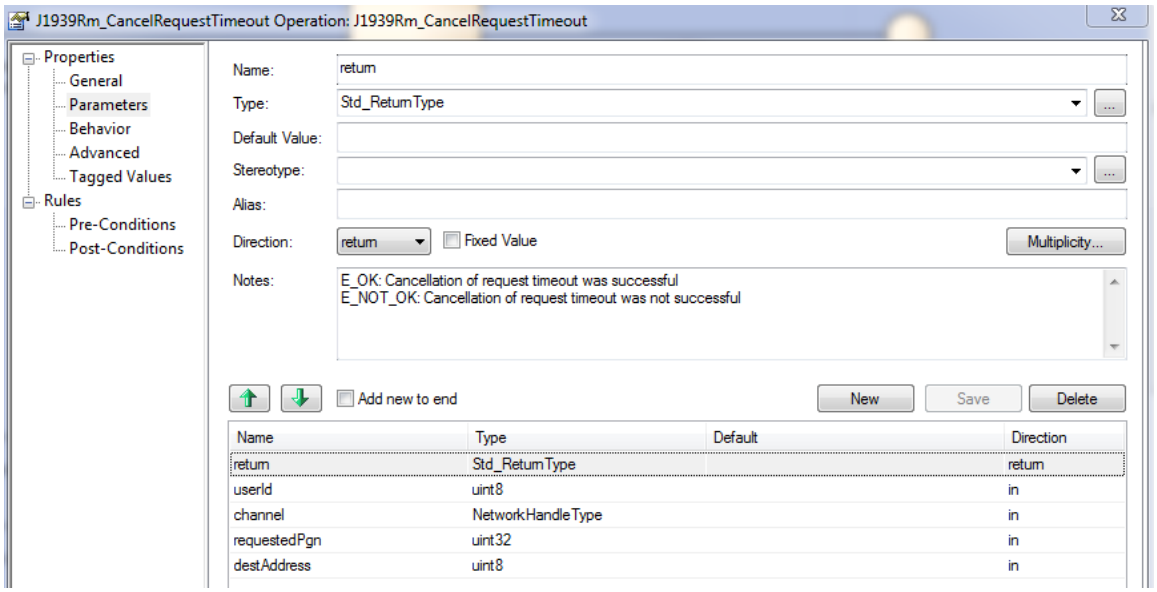


Figure 2.5: Parameter example of a API function

[TR_BSWMG_00922] API Function Return Value Links ⌈All possible return values for an API function's return parameter that are described in the notes field of the parameter shall be linked to the definition of the value.

In particular, if the function's return type is a simple type (see [TR_BSWMG_00066]) the link shall be put as
`[ARDataTypeElement{<AttributeName>}{<DataTypeName>}]`.

If it is an enumeration (see [TR_BSWMG_00072]) the link shall be put as
`[AREnumLiteral{<LiteralName>}{<DataTypeName>}]`.

Note that <DataTypeName> shall be set to the anchor name (see [TR_BSWMG_00031]) of the datatype if one is defined.⌋

Example: The correct way to link the return values in the example of Figure 2.5 is to put this description into the notes field of the return parameter:

```
[ARDataTypeElement{E_OK}{Std_ReturnType}]: Cancellation of request timeout was successful<br/>
[ARDataTypeElement{E_NOT_OK}{Std_ReturnType}]: Cancellation of request timeout was not
successful
```

Note: If the return type has an extension (as defined in 2.8.3) then always the type in the model defining the current value has to be linked.

Example: If an API function in the Csm module returns the Std_ReturnType then e.g. values E_OK and CRYPTO_E_BUSY may be returned as the latter value is defined in Csm_ReturnType, which is an extension to Std_ReturnType. In that case the links have to be set like this:

```
[ARDataTypeElement{E_OK}{Std_ReturnType}]: ...<br/>
[ARDataTypeElement{CRYPTO_E_BUSY}{Csm_ReturnType}]: ...
```

[TR_BSWMG_00129] Optional Parameters of API Functions ⌈The existence of a parameter may depend on the module configuration. In this case, the parameter shall have the stereotype ≪optional≫.⌋

[TR_BSWMG_00130] Multiplicity of API Function Parameters ⌈A parameter with a given type may occur several times, where the multiplicity is specified by configuration. In this case, the parameter shall have the stereotype ≪multiple≫.⌋

Hint: Don't use the multiplicity button in the parameter edit mask to configure the multiplicity.

[TR_BSWMG_00131] Mutual Exclusive Variants of API Function Parameters ⌈A parameter may appear in different variants within the same position of the function signature, where one specific variant will be selected by configuration. In this case, the parameter shall be modeled several times in all its possible variants and each variant of the parameter shall have the stereotype ≪mutualexcl≫.⌋

Example: The parameter "buffer" of the Xfrm function "<Mip>_<transformerId>" can be configured either as "inout" or "out". It therefore shall be modeled two times, one time with Direction "inout" and the second time with Direction "out". Since Enterprise Architect requires parameter names to be unique, the first parameter variant may be named "buffer{inout}" and the second one "buffer{out}".

Hint: All variants of a mutual exclusive parameter shall have the same name; the name without the curly brackets (including the text) have to be the same.

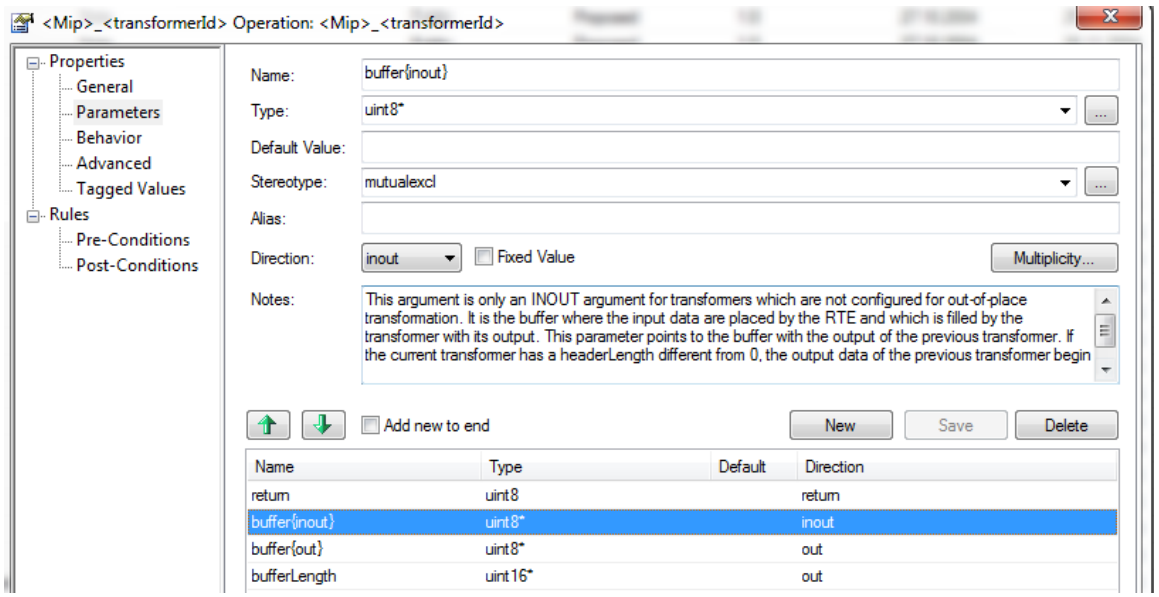


Figure 2.6: Mutual Exclusive Parameter example of a API function

2.5.3 Generic Interfaces

In some occasions the AUTOSAR BSW stack defines a number of interfaces which have basically the same function signature but slightly differ with regards to a module-specific naming. In these cases, redundant definitions of interfaces shall be prevented by usage of only one interface definition, called a “Generic Interface”. To define a specific realization and/or usage of such a “Generic Interface”, a “Derived Generic Interface” shall be used. A “Derived Generic Interface” inherits from the generic interface definition and sets the module specific properties, such as name, specitem-ID, and headerfile.

The following modeling pattern shall be used for defining “Generic Interfaces” and “Derived Generic Interfaces”:

[TR_BSWMG_00061] Generic Interface Definition ⌈The function definition shall be placed into an UML interface having the stereotype ≪generic_interface≫.⌋

[TR_BSWMG_00132] Generic Interface is abstract ⌈This “generic interface” definition shall be considered abstract and not directly be referenced by any module.⌋

[TR_BSWMG_00133] Generic Interface Function Definition ⌈A generic interface definition shall contain exactly one operation with stereotype ≪function_blueprint≫.⌋

[TR_BSWMG_00177] Generic Interface model location ⌈The generic interface definition shall be located within the package “GenericInterfaces” within the package path “SoftwarePackages/GenericElements”.⌋

[TR_BSWMG_00134] Derived Generic Interface ⌈In order to assign a derived generic interface to a generic interface definition, an interface stereotyped ≪derived_generic_interface≫ with a generalization association shall be modeled (targeting the generic interface definition).⌋

[TR_BSWMG_00156] Derived Generic Interface contains no function ⌈A derived generic interface shall not contain a function definition.⌋

[TR_BSWMG_00062] Derived Generic Interface Name ⌈In order to assign a concrete name to a function defined within a generic interface, the derived generic interface shall be named with the desired name.⌋

[TR_BSWMG_00178] Override the Derived Generic Interface Name ⌈If a module uses a derived generic interface that is realized by another module, but requires a name different from the derived generic interface, another interface stereotyped ≪derived_generic_interface≫ with a generalization association shall be modeled (targeting the derived generic interface definition). This new interface shall override the name as in [TR_BSWMG_00062] and shall be referenced by the module.⌋

[TR_BSWMG_00179] Override Generic Interface Properties ⌈Properties of the generic interface that are modeled as tagged values may be overridden on a derived generic interface by applying those tagged values to the derived generic interface with new values.

The description of the generic interface (modeled as “Notes” at the ≪function_blueprint≫) may be overridden by a description set as “Notes” at the derived generic interface.⌋

[TR_BSWMG_00180] Override Derived Generic Interface Properties ⌈Properties of the derived generic interface that are modeled as tagged values may be overridden on an interface with generalization association to the interface by applying those tagged values to the second interface with new values.

The description of the derived generic interface (modeled as “Notes” at the interface) may be overridden by a description set as “Notes” at the second interface.⌋

[TR_BSWMG_00181] Re-use existing interfaces as much as possible ⌈Only when no derived generic interface with desired name and properties is already present in the model, a new derived generic interface shall be created.⌋

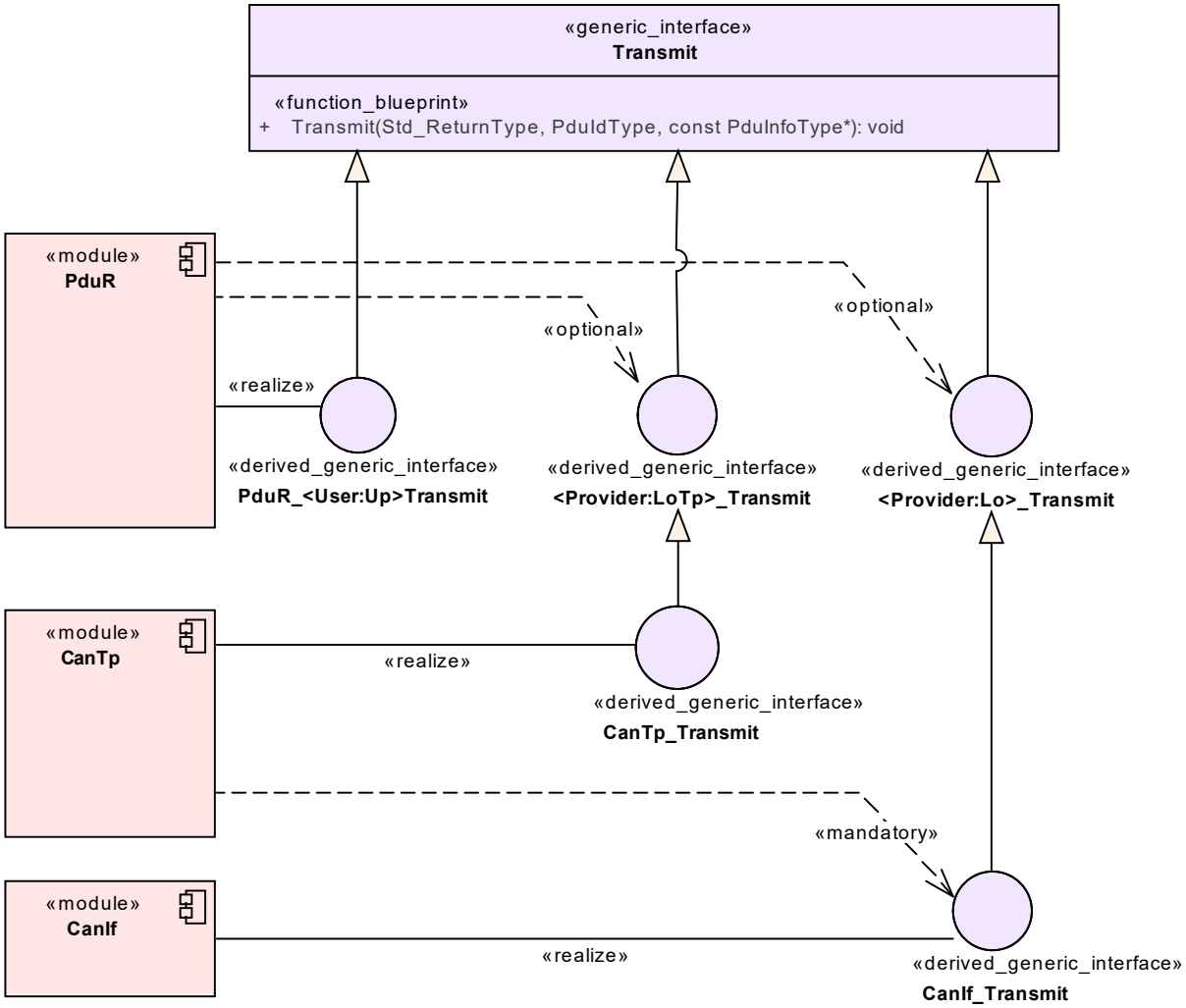


Figure 2.7: Generic Interface/Derived Generic Interface example

2.5.4 Callback Notifications

In AUTOSAR, a “callback” is defined as functionality in an upper-layer BSW module that is called by a lower-layer module in order to provide notification as required [2].

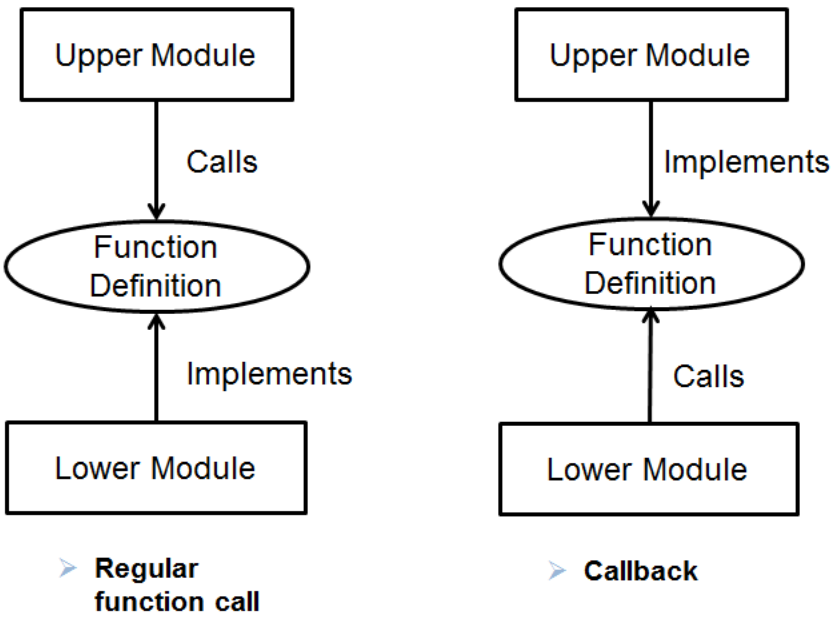


Figure 2.8: Difference between a callback and a regular function call

2.5.4.1 Callback definition and usage (non Configurable Callback)

[TR_BSWMG_00157] Callback definition ⌈Callback definitions shall be modeled as UML operations and shall use the stereotype ≪callback≫.⌋

[TR_BSWMG_00158] Callback interface ⌈For each callback to be called by a BSW module, an UML interface (the "function interface") shall be created in its module package. The stereotype of the interface shall be ≪interface≫.⌋

[TR_BSWMG_00159] Naming of callback interfaces ⌈The *callback interface* shall have the same name as the actual function (depends on [TR_BSWMG_00017], [TR_BSWMG_00030]).⌋

[TR_BSWMG_00161] Callback function definition ⌈The *callback interface* shall contain one function with stereotype ≪callback≫.⌋

The modeling of the function from [TR_BSWMG_00161] is described in chapter 2.5.

[TR_BSWMG_00162] Callback function usage/call ⌈For all callbacks a lower module can call, a dependency of stereotype ≪mandatory≫ or ≪optional≫ (target callback interfaces) shall be modeled.⌋

For details to [TR_BSWMG_00162] see also chapter 2.6.2 and 2.6.3.

[TR_BSWMG_00163] Callback function realization/implementation ⌈For all callbacks a upper module implements, a realization of stereotype ≪realize≫ (target callback interfaces) shall be modeled.⌋

[TR_BSWMG_00164] Callback function realization/implementation ⌈Each callback interface shall be referenced by exactly ONE dependency of stereotype ≪mandatory≫ or ≪optional≫ or ≪configurable≫ (There is only one caller, but multiple implementation can exit and will be assigned by configuration).⌋

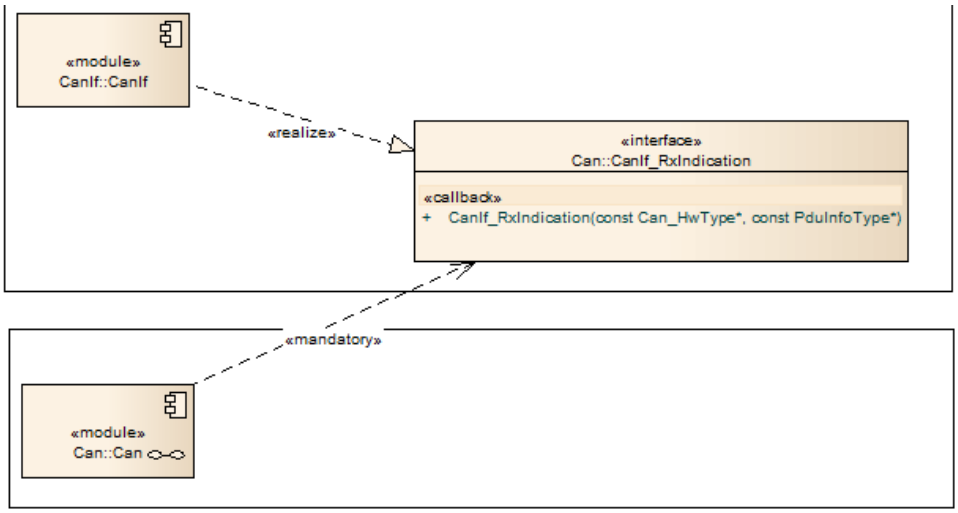


Figure 2.9: Example of a Callback definition and usage

2.5.4.2 Configurable Callback definition and usage

Lower-layer modules are caller of callbacks. Often, these modules can configure which actual instance of a callback definition will be called, i.e. which upper layer will be called in the callback situation. In the SWS the configurability of a callback is described in two parts: An API table for the configurable callback function including details like the callback signature and arguments, and the actual ECU configuration parameters described in chapter 10.

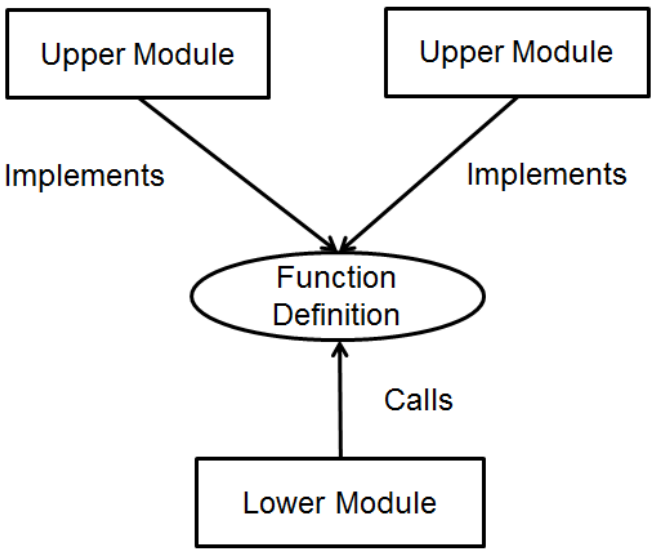


Figure 2.10: Configurable Callback: The lower module have to be configured which implementation of an upper module will be called.

[TR_BSWMG_00059] Configurable Dependency for Callback definitions ⌈A lower-layer module shall have dependencies with stereotype ≪`configurable`≫ to each of its configurable callback definitions.⌋

[TR_BSWMG_00060] Target of a Configurable Dependency is a Generic Definition ⌈A lower-layer module shall have a generic callback definition as target of the configurable dependency.⌋

The naming of callback functions currently differs between BSW modules, and in particular between BSW stacks. Therefore, no definitive rules for naming patterns of callbacks can be stated here. However, as a guideline for adding new callback functions, either one of the following patterns should be followed:

(1) Module abbreviation, followed by an underscore, followed by the callback function name.

(2) The literal string “User”, followed by an underscore, followed by the callback function name. Additionally, the whole function name is put in angular brackets “<>” in order to emphasize that this is just a placeholder for the real, configurable name.

[TR_BSWMG_00904] Overriding the entryKind of a Configurable Callback ⌈Configurable Callbacks are by default exported as BswModuleEntry with entryKind = “abstract”. This value may be overriden by adding the tagged value `bsw.entryKind` at the ≪`configurable`≫ dependency from module to interface with the value “concrete”.⌋

2.5.4.3 Callback Generic Interfaces

Similar to the definition of Generic Interfaces, it is possible to define Generic Interfaces for Callbacks. The purpose of a Callback Generic Interface is to serve as a one-time definition of a callback. The callback may then be referenced in different contexts, using different names in the contexts of different modules, and also varying in attributes like Service ID.

[TR_BSWMG_00049] Callback Generic Interface Definitions ⌈Callback definitions shall be modeled as UML operations and shall use the stereotype ≪`callback`≫ and ≪`function_blueprint`≫.⌋

[TR_BSWMG_00050] Callback Generic Interface Name ⌈The Callback definition name shall be set as in [TR_BSWMG_00062].⌋

[TR_BSWMG_00051] Callback Blueprint Interface placement ⌈Each callback blueprint definition shall be placed inside an UML interface having the same name as the contained operation with stereotype ≪`generic_interface`≫.⌋

Note that [TR_BSWMG_00177] also applies for Callback Generic Interfaces when determining the package that shall contain the interfaces.

[TR_BSWMG_00903] Overriding the calltype of a Configurable Generic Interface ⌈The calltype of a Generic Interface for a specific user module may be overridden to “callout” by adding the tagged value `bsw.calltype` at the ≪`configurable`≫ dependency from module to derived generic interface with the value “callout”.⌋

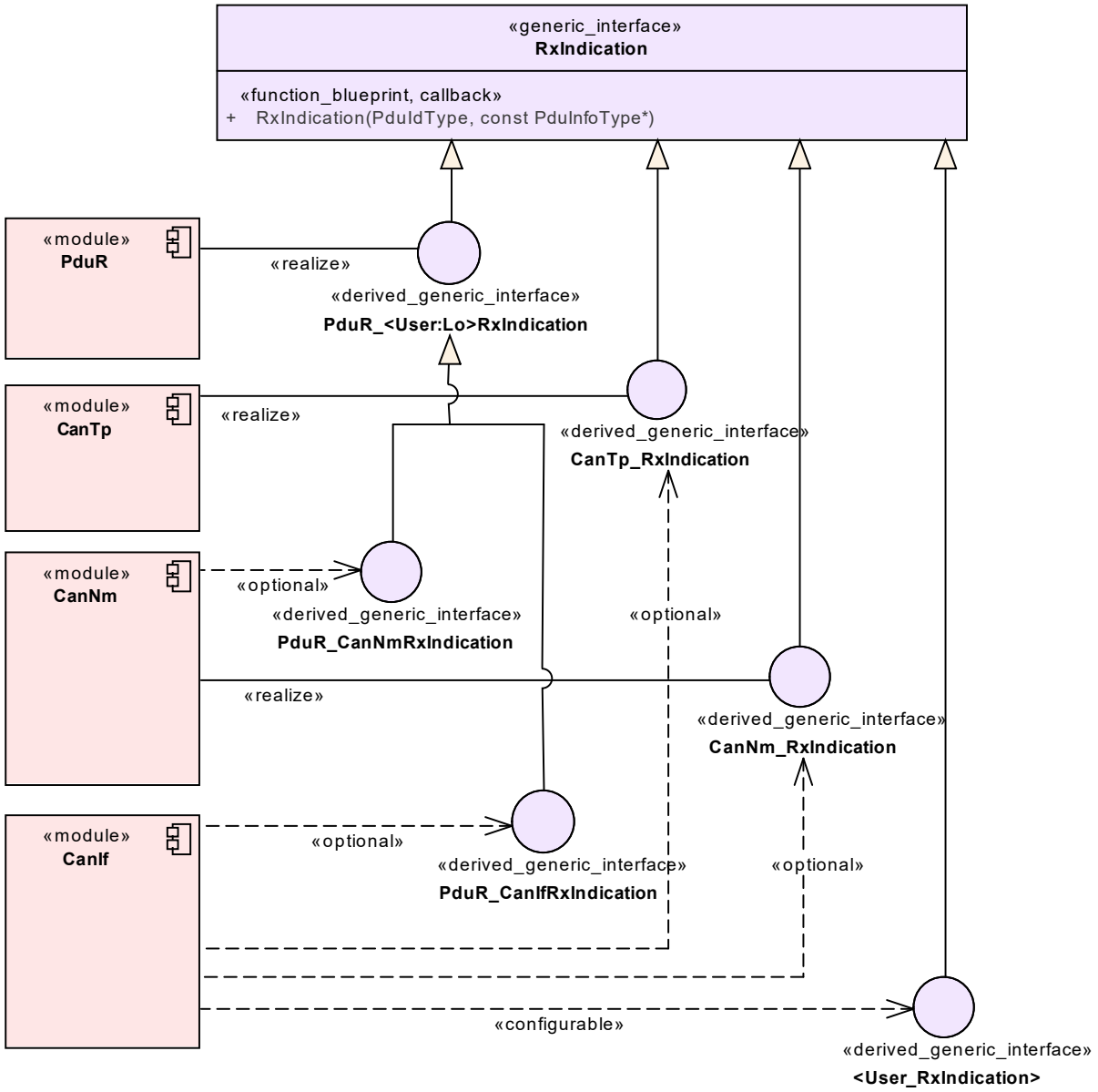


Figure 2.11: Generic Interface/Derived Generic Interface callback example

2.6 Module Dependencies

2.6.1 Virtual Interfaces

In general AUTOSAR BSW modules require functions from the APIs of other BSW modules in order to fulfill their own functionality. The general modeling pattern of dependencies between one BSW module and another uses so called *function interfaces*: Due to the fact that dependencies between APIs have to be expressed on a single API level of detail, each API function requires a representation on module level. For this purpose, the *function interfaces* have been introduced (see 2.5).

In order to further enhance the expressiveness of the BSW module in UML diagrams, the concept of *function interfaces* is extended by *virtual interfaces*. *Virtual interfaces* are derived from *function interfaces* to merge a certain set of API functions. Recursive structures of *virtual interfaces* are also allowed, so a *virtual interface* is allowed to be derived from other *virtual interfaces*. This concept basically allows to reduce the number of visible module dependencies in diagrams, by e.g. providing a single *virtual interface* per providing module, collecting all functions required by this module.

[TR_BSWMG_00028] Virtual Interfaces ⌈A *virtual interface* shall be modeled as an interface with the stereotype ≪`interface`≫ (just like a normal interface).⌋

[TR_BSWMG_00041] Virtual Interface Contents ⌈A *virtual interface* shall inherit its functions from the realizer's function interfaces.⌋

[TR_BSWMG_00182] Illustrating purpose of Virtual Interfaces ⌈*Virtual interfaces* have illustrating purpose only and shall be ignored during the functional processing of the model.⌋

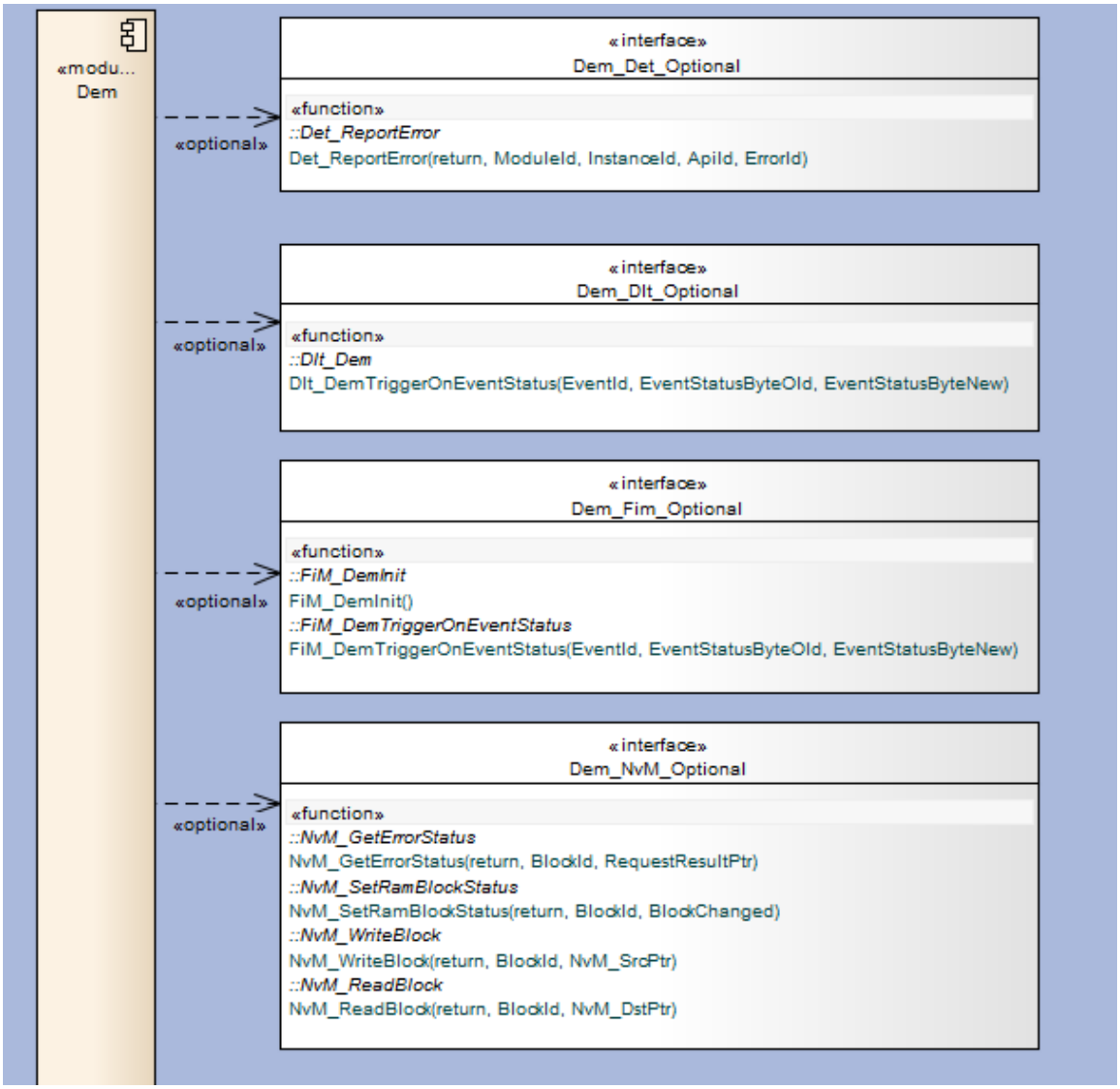


Figure 2.12: Virtual interfaces example for displaying optional interfaces

2.6.2 Mandatory Interfaces

[TR_BSWMG_00043] Stereotype for Mandatory Dependencies on Interfaces ⌈The user module shall have dependencies with stereotype ≪`mandatory`≫ to all its mandatory interfaces.⌋

[TR_BSWMG_00094] SWS Item ID of the Mandatory Interfaces table of the module ⌈The tagged value `bsw.mandatory.swsItemId` is used to specify the SWS Item ID for the table of mandatory interface dependencies of the module.⌋

[TR_BSWMG_00095] Up-traces of the Mandatory Interfaces table of the module ⌈The tagged value `bsw.mandatory.traceRefs` is used to specify up-traces to requirements of the SWS Item containing the table of mandatory interface dependencies of the module. Multiple requirement IDs have to be separated by a comma.⌋

2.6.3 Optional Interfaces

[TR_BSWMG_00046] Stereotypes for Optional Dependencies on Interfaces ⌈The user module shall have dependencies with stereotype ≪`optional`≫ to all its optional interfaces.⌋

[TR_BSWMG_00096] SWS Item ID of the Optional Interfaces table of the module ⌈The tagged value `bsw.optional.swsItemId` is used to specify the SWS Item ID for the table of optional interface dependencies of the module.⌋

[TR_BSWMG_00097] Up-traces of the Optional Interfaces table of the module ⌈The tagged value `bsw.optional.traceRefs` is used to specify up-traces to requirements of the SWS Item containing the table of optional interface dependencies of the module. Multiple requirement IDs have to be separated by a comma.⌋

2.6.4 Illustrative Dependencies

[TR_BSWMG_00921] Illustrating a module's usage of an interface ⌈If a module has a usage dependency to an interface, which has only illustrative purpose for diagrams, the dependency shall be modeled with the stereotype ≪`use`≫. This dependency shall be ignored during the functional processing of the model.⌋

2.7 Modeling of Service Interfaces

Services are provided through ports. A port implements a port interface. A port interface can be a ClientServerInterface, a SenderReceiverInterface or a ModeSwitchInterface.

A ClientServerInterface defines the available service operations. A service operation defines return, input and output parameters. Each service operation has a relationship to an existing api function (c function). Blueprints allow to configure things like parameters, services, ...

A SenderReceiverInterface defines DataElements. Each data element have to be linked to a data type.

A ModeSwitchInterface defines modes within a ModeDeclarationGroup.

Note: To get a better understanding of the modeling, listing examples of the informal textual definition of service interfaces in AUTOSAR R4.0.3 SWS documents are used. If you are not familiar with this old definition, please ignore these listings.

[TR_BSWMG_00160] Model location of Service Interfaces ⌈All additional elements of service modeling shall be placed in a package "ARInterfaces". This packages shall be a child package of the module package.⌋

[TR_BSWMG_00102] Port Interfaces ⌈A port interface shall be modeled as a class of stereotype ≪ClientServerInterface≫, a ≪SenderReceiverInterface≫ or a ≪ModeSwitchInterface≫. The stereotype ≪ClientServerInterface≫ shall be used to model a Client Server Interface. The stereotype ≪SenderReceiverInterface≫ shall be used to model a Sender Receiver Interface. The stereotype ≪ModeSwitchInterface≫ shall be used to model a Mode Switch Interface.⌋

[TR_BSWMG_00154] Port Interface isService attribute ⌈The value of the isService attribute of an interface is true by default. To set the attribute to false the tagged value `bsw.isService` shall be used. The value of the tagged value shall be "false".⌋

2.7.1 Client Server Interfaces

The following listing shows the old syntax of modeling / defining ClientServerInterface in AUTOSAR R4.0.3 SWS documents.

```
ClientServerInterface Csm_Hash {

  // errors assisioated with the ProtInterface
  PossibleErrors {
    CSM_E_NOT_OK       = 1
    CSM_E_BUSY         = 2
    CSM_E_SMALL_BUFFER = 3
  };


  //containing operations

  //parameter kinds can be IN, OUT and INOUT
  //
  //ERR is not a parameter
  //  -> should be a associated error to an operation
  HashStart (
    ERR(CSM_E_NOT_OK, CSM_E_BUSY)
  );

  HashUpdate (
    IN    HashDataBuffer  dataBuffer,
    IN    uint32  dataLength,
    ERR(CSM_E_NOT_OK, CSM_E_BUSY)
  );

```

```
27    HashFinish (
28      OUT    HashResultBuffer  resultBuffer,
29      INOUT  HashLengthBuffer  resultLength,
30      IN     boolean TruncationIsAllowed,
31      ERR(CSM_E_NOT_OK, CSM_E_BUSY, CSM_E_SMALL_BUFFER)
32    );
33  };
```

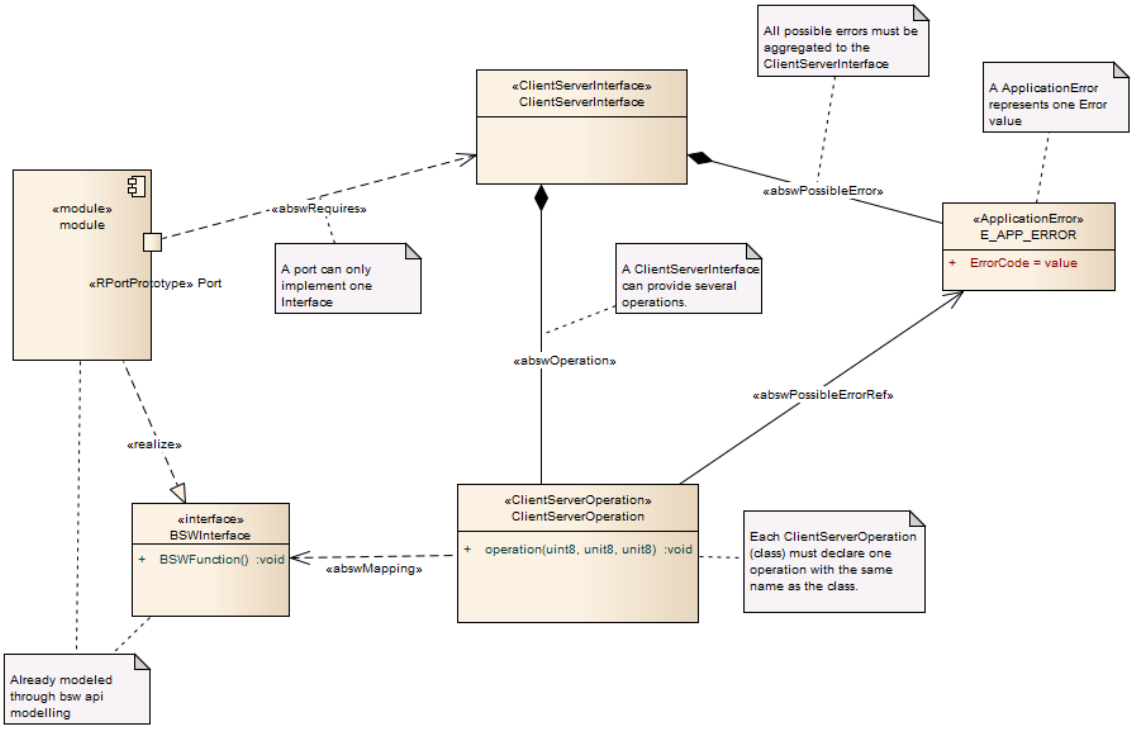


Figure 2.13: Schematic overview of Client Server Interfaces

[TR_BSWMG_00103] Modeling of ClientServerOperations ⌈The operations defined through a Client Server Interface shall be modeled as a class of stereotype ≪ClientServerOperation≫ per operation (for each operation a separate class).⌋

[TR_BSWMG_00104] Dependency from ClientServerInterface to ClientServerOperation ⌈The relationship between ClientServerInterface and ClientServerOperation shall be modeled as an aggregation of stereotype ≪abswOperation≫ (where the ClientServerInterface is the “whole” and the ClientServerOperation is the “part”).⌋

[TR_BSWMG_00105] UML operation within ClientServerOperation ⌈Each class of stereotype ≪ClientServerOperation≫ shall contain one operation with the same name as the class.⌋

[TR_BSWMG_00106] Modeling of ClientServerOperation Parameters ⌈The parameters of an operation shall be modeled as parameters of the UML operation. ≪ClientServerOperation≫ Class -> Operation -> Parameter⌋

[TR_BSWMG_00107] ClientServerOperation Parameter Direction ⌈The parameter's "Kind" attribute shall be set to one of the values 'in', 'out', 'inout'.⌋

[TR_BSWMG_00108] Modeling of ApplicationErrors ⌈For each possible error a class of stereotype ≪ApplicationError≫ shall be created. The name of the class shall be the error abbreviation (e.g. E_FORCE_RCRRP). The error code shall be modeled as a public attribute. The name shall be ErrorCode and the error code shall be modeled as initial value.⌋

[TR_BSWMG_00109] ApplicationErrors of an ClientServerInterface ⌈All possible errors of a Client Server Interface shall be referenced by an aggregation of stereotype ≪abswPossibleError≫ (target ApplicationError).⌋

[TR_BSWMG_00110] ApplicationErrors of an ClientServerOperation ⌈All possible errors of a Client Server Interface Operation shall be referenced by a dependency of stereotype ≪abswPossibleErrorRef≫ (target ApplicationError).⌋

[TR_BSWMG_00111] Mapping ClientServerOperations to API Functions ⌈Each ClientServerOperation, where the corresponding ClientServerInterface is implemented by a UML port of stereotype ≪PPortPrototype≫ or ≪PRPortPrototype≫, shall have a relationship to the corresponding bsw api function. So the relationship between ClientServerOperation and bsw api function (interface of the function) shall be modeled as a dependency of stereotype ≪abswMapping≫ (target bsw api function).⌋

[TR_BSWMG_00932] ClientServerOperation intentionally not mapped to an API Function ⌈In case there is an intention not to map a ClientServerOperation to an API Function according to [TR_BSWMG_00111], that intention shall be modeled by instead mapping the ClientServerOperation to a placeholder interface named "<Unmapped>". That interface shall be located in in the package "SoftwarePackages/GenericElements/Supplementary".⌋

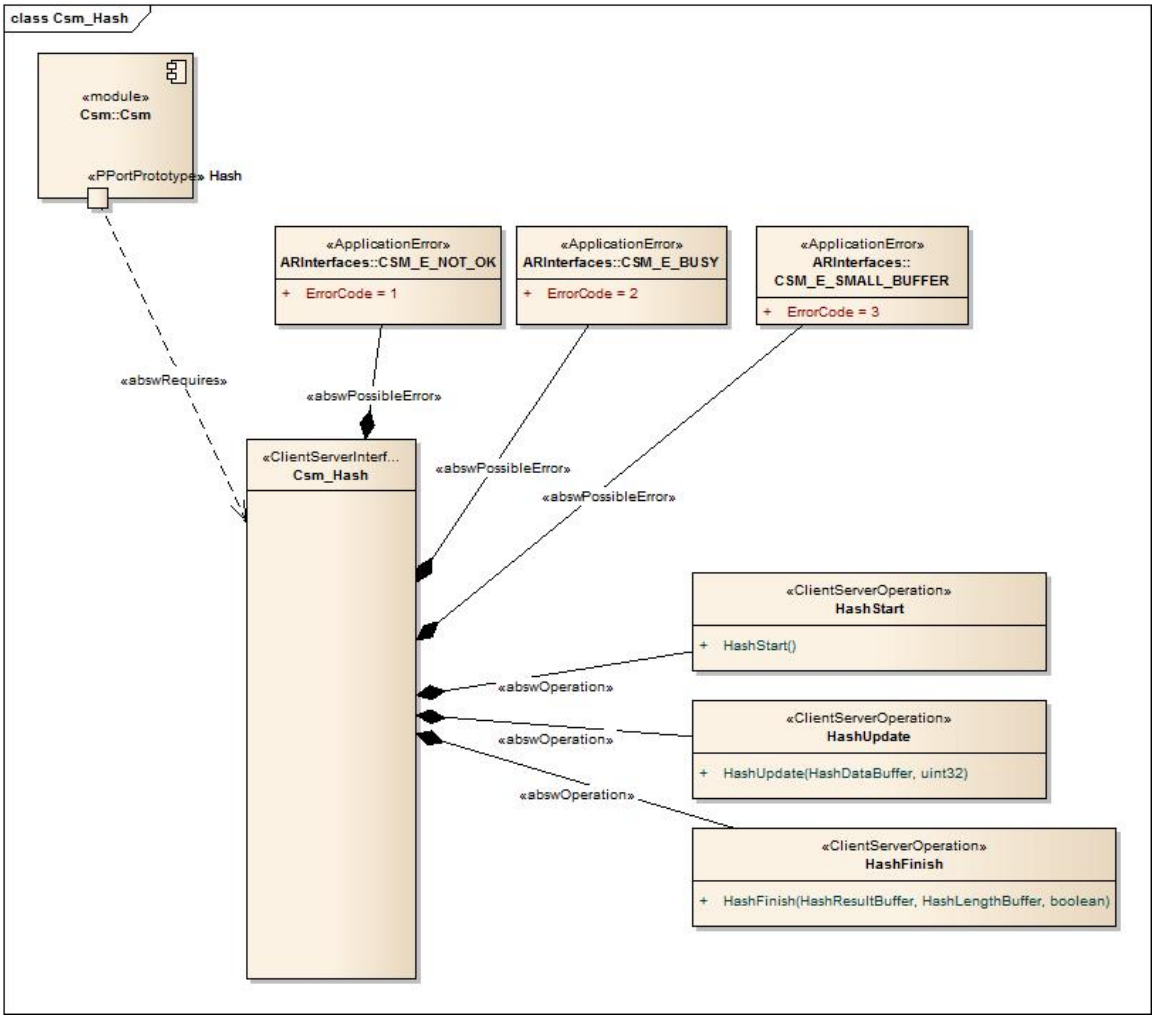


Figure 2.14: Example ClientServerInterface diagamm (CSI diagram)

[TR_BSWMG_00112] Naming of ClientServerInterface Diagrams ⌈For each Client Server Interface a class diagram (CSI diagram) shall be created. The name of the diagramm shall be the name of the Client Server Interface.⌋

[TR_BSWMG_00113] Content of ClientServerInterface Diagrams ⌈A CSI diagram shall contain the module, the ClientServerInterface, the Application Errors of the ClientServerInterface and the ClientServerOperations of the ClientServerInterface.⌋

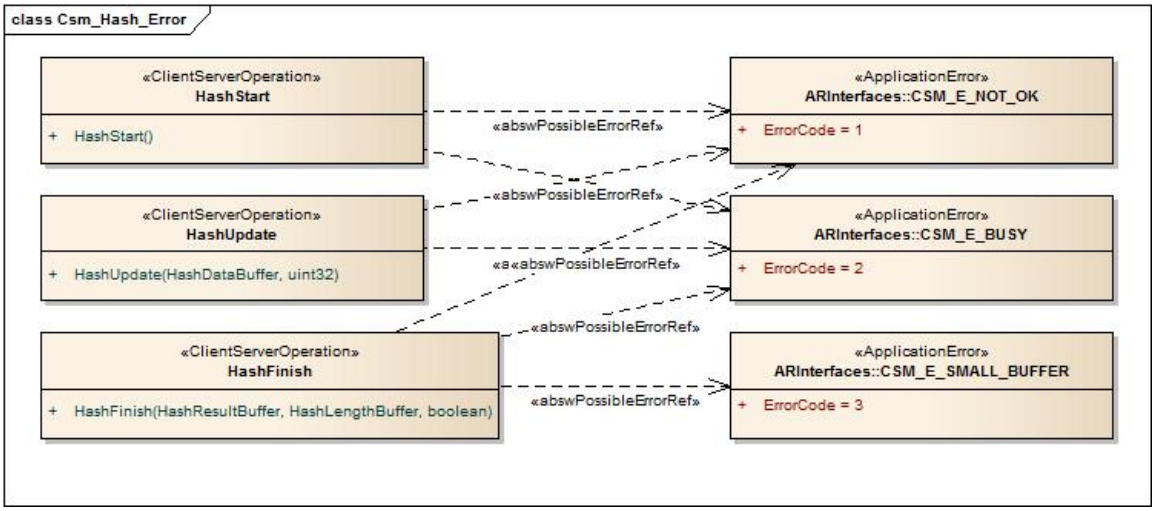


Figure 2.15: Example ClientServerInterface errors diagram (CSI errors diagram)

[TR_BSWMG_00114] Naming of ClientServerInterface Error Diagrams ⌈For each Client Server Interface a class diagram (CSI errors diagram) shall be created. The name of the diagram shall be the name of the Client Server Interface concatenated with "_Error".⌋

[TR_BSWMG_00115] Content of ClientServerInterface Error Diagrams ⌈A CSI errors diagram shall contain the Application Errors of the ClientServerInterface and the ClientServerOperations of the ClientServerInterface.⌋

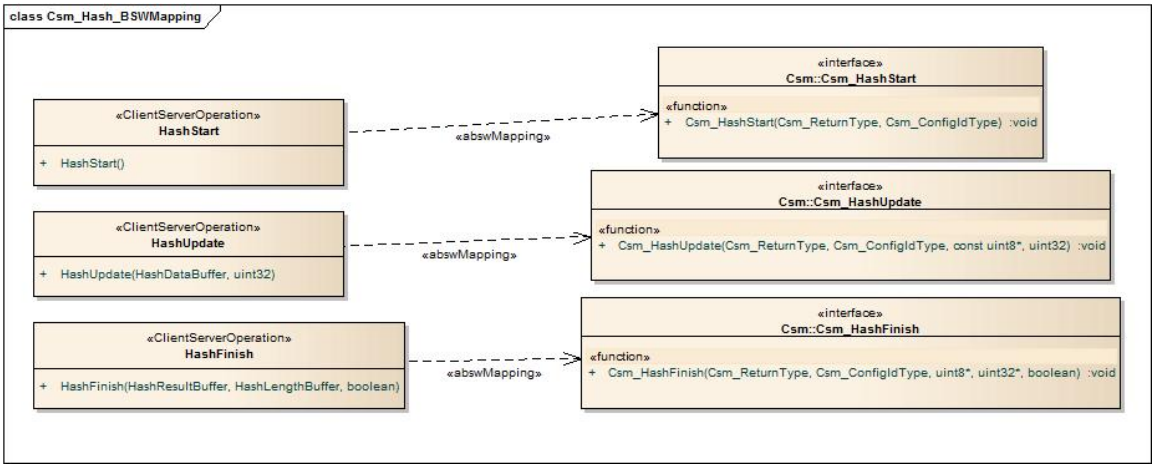


Figure 2.16: Example ClientServerInterface BSW mapping diagamm (CSI bsw mapping diagram)

[TR_BSWMG_00116] Naming of ClientServerInterface Mapping Diagrams ⌈For each Client Server Interface a class diagram (CSI mapping diagram) shall be created. The name of the diagram shall be the name of the Client Server Interface concatenated with "_BSWMapping".⌋

[TR_BSWMG_00117] Content of ClientServerInterface Mapping Diagrams ⌈A CSI errors diagram shall contain the ClientServerOperations of the ClientServerInterface and the corresponding bsw api interfaces.⌋

2.7.2 Mode Switch Interfaces

The following listing shows the old syntax of modeling / defining ModeSwitchInterfaces in AUTOSAR R4.0.3 SWS documents.

```
ModeSwitchInterface WdgM_IndividualMode {
  isService = true;
  WdgMMode currentMode;
};
```

Corresponding ModeDeclarationGroup:

```
ModeDeclarationGroup WdgMMode {
  { SUPERVISION_OK,
    SUPERVISION_FAILED,
    SUPERVISION_EXPIRED,
    SUPERVISION_STOPPED,
    SUPERVISION_DEACTIVATED
  }
  initialMode = SUPERVISION_OK
};
```

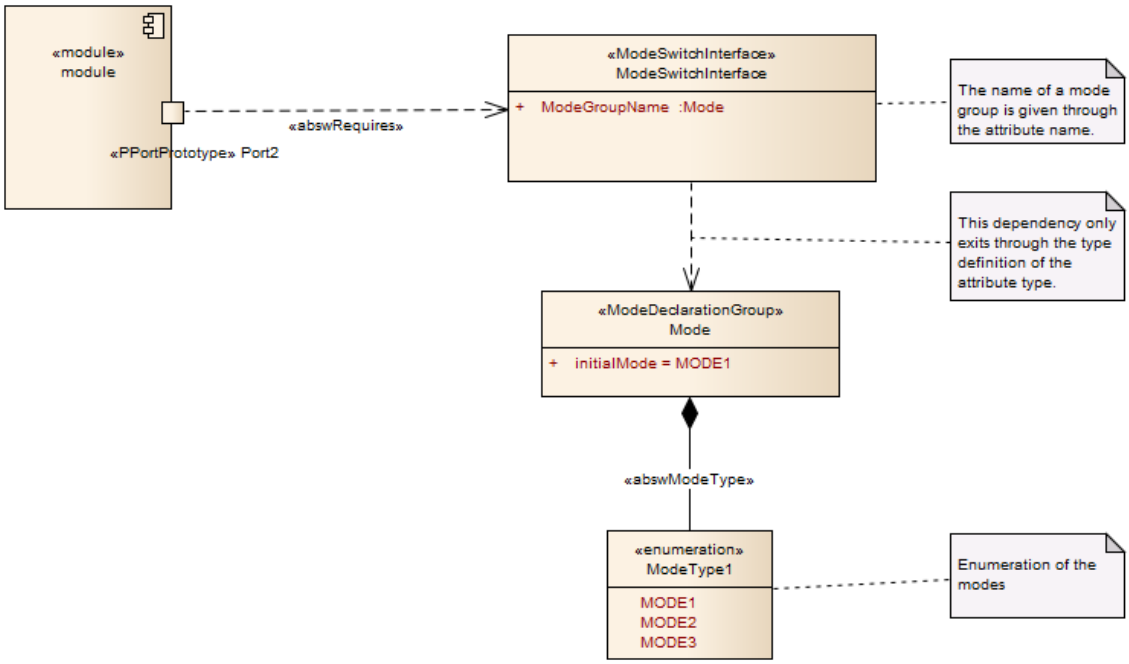


Figure 2.17: Schematic overview of a Mode Switch Interfaces

[TR_BSWMG_00203] Modeling of ModeDeclarationGroups ⌈For each ModeDeclarationGroup a class of stereotype ≪ModeDeclarationGroup≫ shall be created.⌋

[TR_BSWMG_00209] ModeDeclarationGroup initialMode attribute ⌈The initial mode of the ModeDeclarationGroup shall be modeled as a public attribute of the ModeDeclarationGroup class. The attribute's name shall be "initialMode", its initial value shall be set to one of the ModeDeclarationGroup's defined modes.⌋

[TR_BSWMG_00210] ModeDeclarationGroup onTransitionValue attribute ⌈A ModeDeclarationGroup's optional "onTransitionValue" shall be modeled as a public attribute of the ModeDeclarationGroup class. The attribute's name shall be "onTransitionValue", its initial value shall be set to a positive integer.⌋

[TR_BSWMG_00204] ModeDeclarationGroup Mode declarations ⌈The modes of a ModeDeclarationGroup (e.g. SUPERVISION_OK, SUPERVISION_FAILED, ...) shall be modeled as a UML class of stereotype ≪ModeDeclaration≫. Each mode shall be the name of a public attribute.⌋

[TR_BSWMG_00211] ModeDeclarationGroup Mode declaration integers ⌈It is possible to assign concrete integer values to ModeDeclarations. In this case, the mode attribute's initial value shall be set to a positive integer.⌋

[TR_BSWMG_00212] ModeDeclarationGroup category ⌈The category of the ModeDeclarationGroup shall be inferred from the existing information in the following way:

- EXPLICIT_ORDER if all of its associated ModeDeclaration attributes have a numerical value assigned to them.
- ALPHABETIC_ORDER otherwise.

⌋

[TR_BSWMG_00205] Modeling of ModeSwitchInterfaces ⌈The relationship between ModeDeclarationGroup and the enumeration of modes shall be modeled as aggregation of stereotype ≪abswModeType≫ (target enumeration).⌋

[TR_BSWMG_00206] ModeSwitchInterface relation to ModeDeclarationGroup ⌈The ModeSwitchInterface class shall be containing a public attribute with a reference name to the current ModeDeclarationGroup (e.g. currentMode). The type of the attribute shall be the ModeDeclarationGroup.⌋

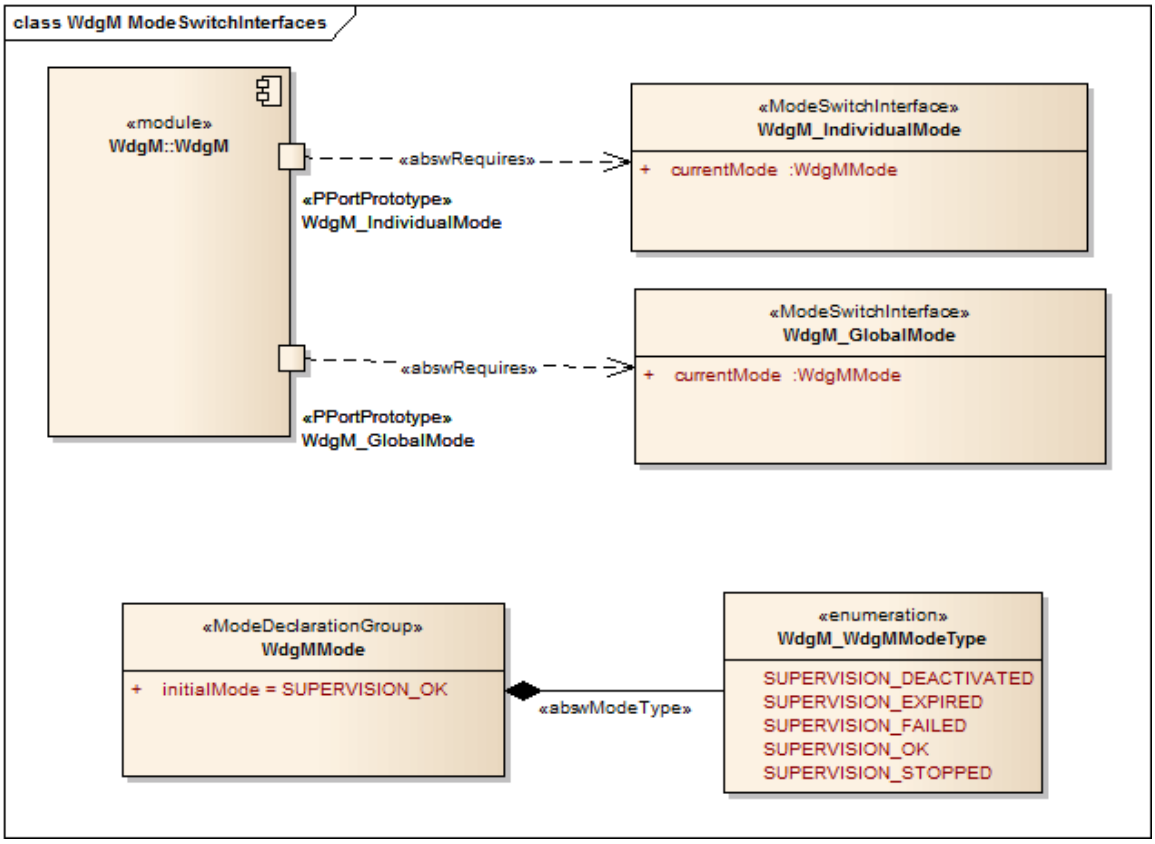


Figure 2.18: Example of a Mode Switch Interface

[TR_BSWMG_00207] Naming of ModeSwitchInterface Diagrams ⌈For each Mode Switch Interface a class diagram shall be created. The name of the diagramm shall be the name of the Mode Switch Interface.⌋

[TR_BSWMG_00208] Content of ModeSwitchInterface Diagrams ⌈A Mode Switch Interface diagram shall contain the module, the ModeSwitchInterface, the ModeDeclarationGroup and the enumeration of the modes.⌋

2.7.3 Sender Receiver Interfaces

The following listing shows the old syntax of modeling / defining SenderReceiverInterface in AUTOSAR R4.0.3 SWS documents.

```
1 SenderReceiverInterface AppModeRequestInterface {
2   isService = true;
3   AppModeRequestType requestedMode;
4 };
```

Corresponding Type:

```
1 ImplementationDataType AppModeRequestType {
2   lowerLimit = 0;
```

```
3     upperLimit = 2;
4   };
```

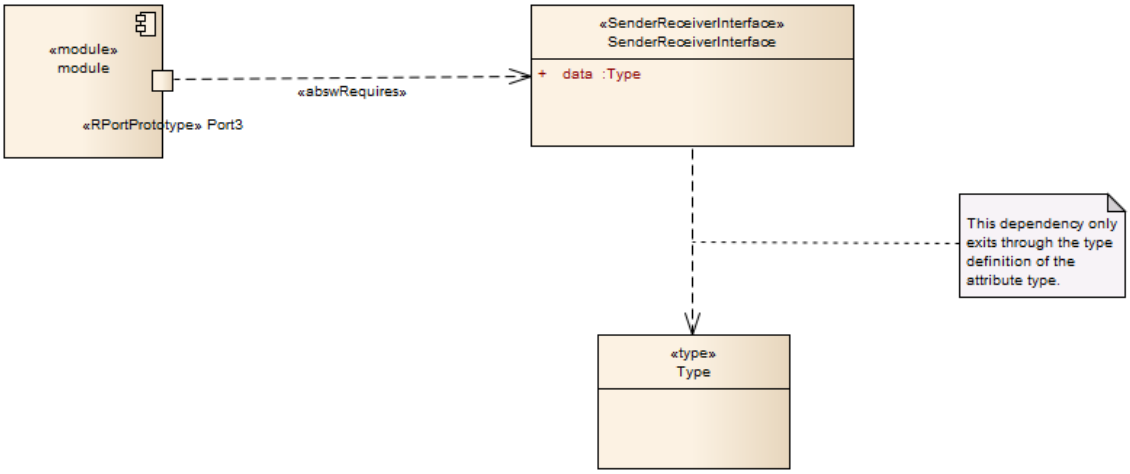


Figure 2.19: Schematic overview of a Sender Receiver Interfaces

[TR_BSWMG_00301] Modeling of SenderReceiverInterfaces ⌈Type of the sending/receiving data shall be modeled as a bsw api type or as a MoS type.⌋

See also chapter 2.8.

[TR_BSWMG_00302] SenderReceiverInterface Data Element ⌈The SenderReceiverInterface class shall contain a public attribute with a reference name to the current sending/receiving Type (e.g. data). The type of the attribute shall be a valid type, see [TR_BSWMG_00301].⌋

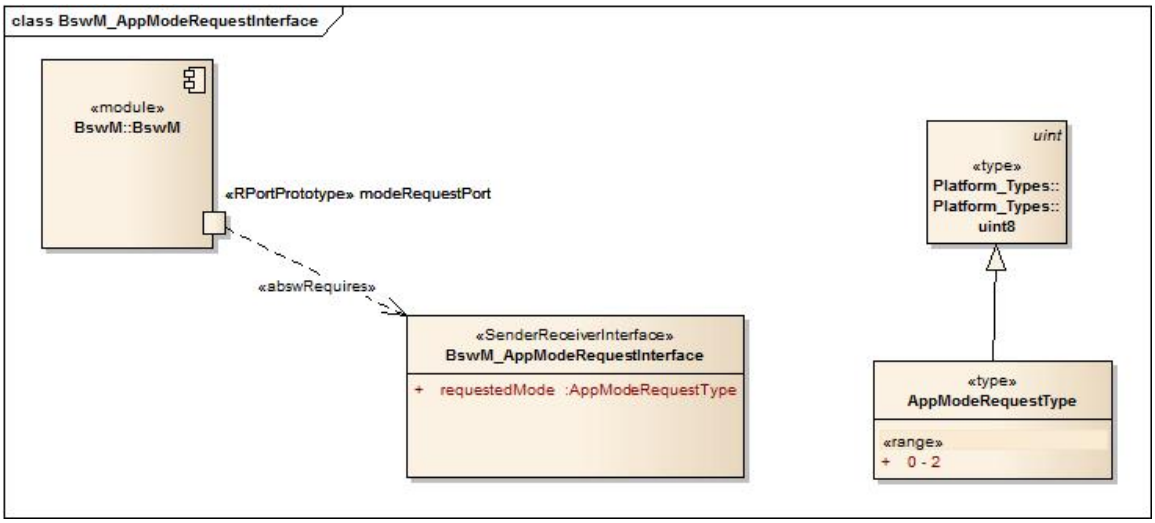


Figure 2.20: Example of a Sender Receiver Interface

[TR_BSWMG_00307] Naming of SenderReceiverInterface Diagrams ⌈For each Sender Receiver Interface a class diagram shall be created. The name of the diagram shall be the name of the Mode Switch Interface.⌋

[TR_BSWMG_00308] Content of SenderReceiverInterface Diagrams ⌈A Sender Receiver Interface diagram shall contain the module, the SenderReceiverInterface and the Type of the sending/receiving data.⌋

2.7.4 Ports (with PortAPIOptions and PortDefinedArgumentValues)

[TR_BSWMG_00100] Modeling of Ports ⌈A port shall be modeled as an UML port having one of the following stereotype ≪RPortPrototype≫, ≪PPortPrototype≫, ≪PRPortPrototype≫. The port shall be provided by the module component.⌋

[TR_BSWMG_00101] Dependency from Port to Port Interface ⌈The port interface, that the port implements, shall be modeled as a dependency of stereotype ≪abswRequires≫ to a ClientServerInterface, a SenderReceiverInterface or a ModeSwitchInterface.⌋

[TR_BSWMG_00118] Modeling of PortAPIOptions ⌈A PortAPIOption shall be modeled as an UML class of stereotype ≪PortAPIOption≫. The class shall be placed in the package <module>/ARInterfaces/<affected interfaces>.⌋

[TR_BSWMG_00119] PortAPIOption Name ⌈The name of the PortAPIOption class shall be composed of the port name followed by underscore followed by literal string “PortAPIOption”, e.g. “Func_PortAPIOption” for a port named “Func”.⌋

[TR_BSWMG_00120] PortAPIOption reference to Port ⌈The ≪PortAPIOption≫ class shall reference its affected port using a dependency with stereotype ≪abswPortRef≫.⌋

[TR_BSWMG_00121] Modeling of PortDefinedArgumentValues ⌈Port Defined Argument Values shall be modeled as attributes of a ≪PortAPIOption≫ class.⌋

[TR_BSWMG_00122] Stereotype of PortDefinedArgumentValues ⌈The attribute representing the Port Defined Argument Value shall have the stereotype ≪PDAV≫.⌋

[TR_BSWMG_00123] Order of PortDefinedArgumentValues ⌈If a port uses more than one Port Defined Argument Values, the attribute order within the ≪PortAPIOption≫ class shall reflect the argument order in the BSW functions associated with the port’s provided ClientServerInterface operations.⌋

[TR_BSWMG_00124] Naming of PortDefinedArgumentValues ⌈The Port Defined Argument Value attribute’s ‘Name’ field shall match the corresponding BSW-functions’ parameter name.⌋

[TR_BSWMG_00125] PortDefinedArgumentValue with fixed Type (non-configurable) ⌈If the Port Defined Argument Value is of a fixed type, i.e. it is not configurable by an EcuC parameter, the attribute's 'Type' field shall reference a valid type that is either modeled as a BSW API type or as an MoS type.⌋

[TR_BSWMG_00126] PortDefinedArgumentValue with configurable Type ⌈If the Port Defined Argument Value's type is configurable by an EcuC parameter, the 'Type' field shall be set to the literal string {DataType}. The curly braces indicate that "DataType" is treated as a place holder for the EcuC-configured type rather than a valid data type itself.⌋

[TR_BSWMG_00128] PortDefinedArgumentValue with Value Configuration by EcuC ⌈If the Port Defined Argument Value's value is configurable by an EcuC parameter, the EcuC configuration dependency shall be expressed by the tagged value `Vh.Value.BlueprintPolicy.DerivationGuide` attached to the attribute.⌋

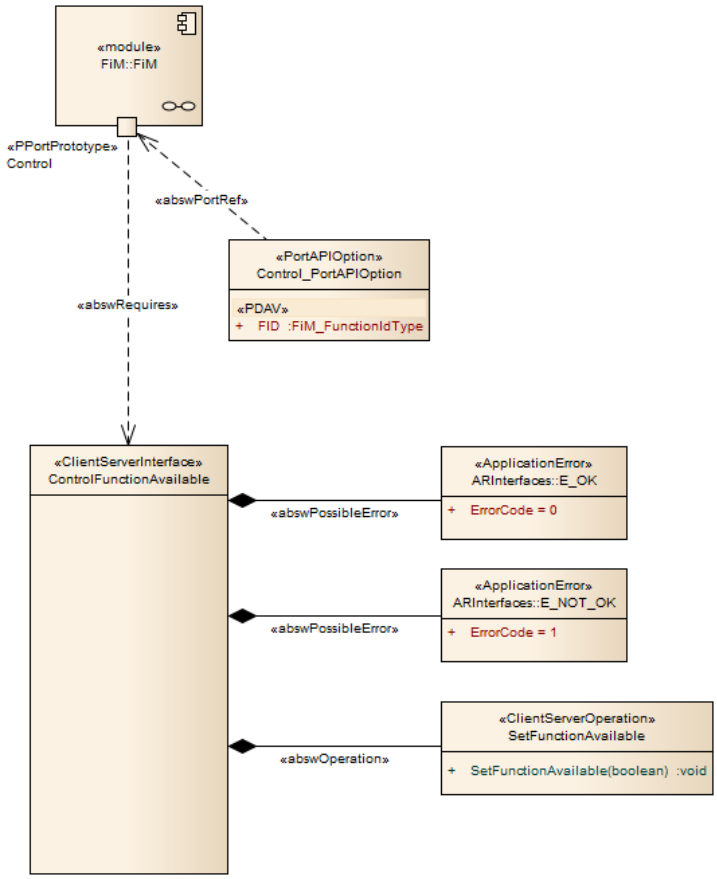


Figure 2.21: PortAPIOption example for module Fim ClientServerInterface ControlFunctionAvailable

2.8 Data Type Definitions

Datatypes in the BSWUMLModel are modelled as an UML Class with a specific stereotype are described in the sections below.

Common modelling patterns for all datatypes are the following:

[TR_BSWMG_00152] SWS Item ID of a Datatype ⌈The tagged value `bsw.swsItemId` is used to specify the SWS Item ID of a datatype.⌋

[TR_BSWMG_00941] Custom SWS Item Title of a Datatype ⌈The tagged value `bsw.swsItemNameForTitle` is used to override the datatype name in the title of the SWS Item representing the datatype.⌋

[TR_BSWMG_00153] Up-traces of a Datatype ⌈The tagged value `bsw.traceRefs` is used to specify up-traces to requirements of a datatype. Multiple requirement IDs have to be separated by a comma.⌋

[TR_BSWMG_00141] Header File Reference of a Datatype ⌈The tagged value `bsw.headerFile` is used to specify the header file where the type is provided.⌋

Additional information on Datatypes used in Service Interfaces

[TR_BSWMG_00400] Modeling of Service Datatypes ⌈Valid stereotypes of datatypes used Service Interfaces are ≪type≫, ≪array≫, ≪pointer≫, and ≪structure≫.⌋

The following listing shows examples of type definitions in the old syntax of modeling / defining types in AUTOSAR R4.0.3 SWS documents.

Definition of arrays on arguments of ClientServerOperations:

```
ClientServerInterface Dcm_RequestControlServices
{
PossibleErrors {
  E_NOT_OK = 1,
  };
RequestControl(
  OUT uint8 OutBuffer[<DcmDspRequestControlOutBufferSize>],
  IN uint8 InBuffer[<DcmDspRequestControlInBufferSize>],
  ERR{E_NOT_OK });
}
```

Definition of pointer types:

```
//The data type DataPtr refers to an address and is defined as follows:
uint32* DataLengthPtr;
```

Definition of DataConstraints for simple types:

```
ImplementationDataType Dem_DTCStatusMaskType {
```

```
2     LOWER-LIMIT = 0;
3     UPPER-LIMIT = 255;
4  }
```

2.8.1 Simple Types

[TR_BSWMG_00066] Simple Type Definition ⌈Each simple type definition, i.e. a type definition which is directly derived from another type or which defines a basic type like 'int' shall be modeled as an UML Class with stereotype ≪type≫.⌋

[TR_BSWMG_00067] Simple Types: Base Types vs. Derived Types ⌈A simple type definition shall either define a base type or be derived from another data type definition.⌋

[TR_BSWMG_00068] Simple Types: Base Types are not derived ⌈A base type shall not derive from another data type.⌋

[TR_BSWMG_00069] Simple Types: Variability of Derived Types ⌈Normally, a derived type shall be derived from exactly only one other data type. However, if the type depends on platform or is configuration specific, it may be derived from more than one type.⌋

[TR_BSWMG_00071] Range of Simple Types ⌈If a simple type has a restricted set of ranges, an attribute with stereotype ≪range≫ has to be created for each such range. The name of the attribute specifies the range label and the notes field describes the range.⌋

Example: Name: "0..2^16-1"

Hint: "Name" is the name of the editing field in the EA edit mask.

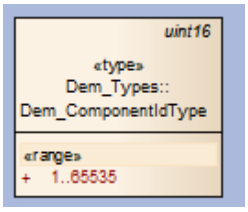


Figure 2.22: Simple type example

[TR_BSWMG_00927] Predefined values of Simple Types ⌈If a simple type has a set of predefined values with special meaning, an attribute without stereotype has to be created for each such value. The Name field of the attribute specifies the label of the value and the Initial Value field specifies the value as number. The Notes field of the attribute may be used to describe the value.⌋

Example: The datatype `float64` has the following predefined values:

- FLOAT64_MIN = 2.2250738585072014e-308
- FLOAT64_MAX = 1.7976931348623157e+308
- FLOAT64_EPSILON = 2.2204460492503131e-16

The following tagged values may be used to tailor the export of a datatype for the Blueprints (in ARXML format). They have no effect on the representation of the datatypes in AUTOSAR SWS documents.

[TR_BSWMG_00913] Tailoring the export of a Datatype ⌈If a datatype shall not be exported to the Blueprints the tagged value `xml.ignore` shall be added – with an arbitrary value. This holds for all Datatypes and is not restricted to Simple Types (see [TR_BSWMG_00066]).⌋

[TR_BSWMG_00914] Tailoring the category of a Simple Type ⌈To override the calculated category of a simple type in the Blueprints the tagged value `xml.category` shall be added with the desired category as value.⌋

[TR_BSWMG_00915] Tailoring the export of a SwBaseType for a Simple Type ⌈To control the export of a simple type as SwBaseType in the Blueprints the tagged value `xml.generateBaseType` shall be added with one of these values:

no export the datatype as ImplementationDataType only (this is the default case)

yes export the datatype as ImplementationDataType and additionally as SwBaseType with the ImplementationDataType referencing the SwBaseType

exclusively export the datatype as SwBaseType only. Do not export the datatype as Specification Item, thus ignoring a potential `bsw.swsItemID` (see [TR_BSWMG_00152]).

⌋

[TR_BSWMG_00909] Tailoring the baseType category of a Simple Type ⌈To set the category of the SwBaseType for a simple type in the Blueprints the tagged value `xml.baseTypeCategory` shall be added with the desired category as value. This tagged value has no effect if no SwBaseType is exported according to [TR_BSWMG_00915].⌋

[TR_BSWMG_00910] Tailoring the baseTypeEncoding of a Simple Type ⌈To set the baseTypeEncoding of the SwBaseType for a simple type in the Blueprints the tagged value `xml.baseTypeEncoding` shall be added with the desired category as value. This tagged value has no effect if no SwBaseType is exported according to [TR_BSWMG_00915].⌋

[TR_BSWMG_00911] Tailoring the baseType nativeDeclaration of a Simple Type ⌈To set the nativeDeclaration of the SwBaseType for a simple type in the Blueprints the tagged value `xml.baseTypeNativeDeclaration` shall be added with the desired

category as value. This tagged value has no effect if no SwBaseType is exported according to [TR_BSWMG_00915].⌋

[TR_BSWMG_00912] Tailoring the baseTypeSize of a Simple Type ⌈To set the baseTypeSize of the SwBaseType for a simple type in the Blueprints the tagged value `xml.baseTypeSize` shall be added with the desired category as value. This tagged value has no effect if no SwBaseType is exported according to [TR_BSWMG_00915].⌋

[TR_BSWMG_00935] Tailoring the byteOrder of a Simple Type ⌈To set the byteOrder of the SwBaseType for a simple type in the Blueprints the tagged value `xml.baseTypeByteOrder` shall be added with the desired byte order as value. This tagged value has no effect if no SwBaseType is exported according to [TR_BSWMG_00915].⌋

[TR_BSWMG_00923] Tailoring the export of a CompuMethod for a DataType ⌈To control the export of a CompuMethod of a DataType in the Blueprints the tagged value `xml.generateCompuMethod` shall be added with one of these values:

yes export a CompuMethod if required (this is the default case)

no export no CompuMethod.

This holds for all Datatypes and is not restricted to Simple Types (see [TR_BSWMG_00066]).⌋

[TR_BSWMG_00924] Tailoring the export of DataConstr for a DataType ⌈To control the export of DataConstr of a DataType in the Blueprints the tagged value `xml.generateDataConstr` shall be added with one of these values:

yes export DataConstr if required (this is the default case)

no export no DataConstr.

This holds for all Datatypes and is not restricted to Simple Types (see [TR_BSWMG_00066]).⌋

[TR_BSWMG_00939] Tailoring the export of References to DataTypes ⌈In case a referenced datatype is not part of the Blueprints export but there shall be a reference exported to this datatype, the datatype shall be tagged with `xml.location`. The value of `xml.location` shall be an absolute shortname path (see [TPS_GST_00169]) leading to the datatype.⌋

Example: The datatype “void” shall not be exported to the Blueprints because it is already defined in AUTOSAR as part of the GeneralDefinitions. Another datatype refers to “void” as its base type and that datatype shall be exported to the Blueprints. In that case, “void” shall be modelled with

- the stereotype ≪`generic_type`≫ (so that is not exported) and
- the tagged value `xml.location = /AUTOSAR/GenDef/BaseTypes/void` (so that it can be referenced by that path).

2.8.2 Enumerations

[TR_BSWMG_00072] Enumeration Definition ⌈Each type definition representing an enumeration shall be modeled as UML Class with stereotype ≪enumeration≫. It shall be placed inside the interface specifying it.⌋

[TR_BSWMG_00073] Enumeration Literal Definition ⌈All possible literals of the enumeration shall be modeled as attributes of this class. The order of the attributes from top to bottom shall represent the order of the enumeration specified.⌋

[TR_BSWMG_00074] Enumeration Literal Details ⌈The following shall be respected for attributes:

- The Name field shall contain the literal name.
- The field “Type” shall be empty.
- The field “Stereotype” shall be empty.
- The field “Scope” shall be “Public”.
- The field “Notes” shall contain the literal description.

⌋

[TR_BSWMG_00075] Enumeration Literal Value ⌈Literals may have a specified value; in this case it shall be placed in the field “Initial Value”.⌋

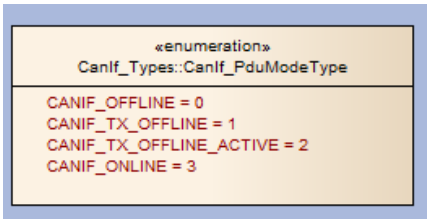


Figure 2.23: Enumeration example

2.8.3 Std_ReturnType Extensions

AUTOSAR defines a standard API return type that is being used throughout the BSW stack. It is also the only return type that can be used in ClientServer type Service Interface Operations.

“Std_ReturnType” is being defined in the SWS Standard Types [3] ([SRS_BSW_00377]). Additionally, two standard values E_OK and E_NOT_OK are defined which should normally be used with Std_ReturnType.

If these two return values are not sufficient, a BSW module is allowed to define additional return values to be used with Std_ReturnType. Such user defined values shall be prefixed with the module prefix and can be in the range 0x02–0x3f.

[TR_BSWMG_00089] Std_ReturnType Extension Definition ⌈The definition of a BSW module specific Std_ReturnType extension shall be modeled as an UML Class with stereotype ≪extra_literals≫.⌋

[TR_BSWMG_00090] Std_ReturnType Extension Name ⌈The UML Class containing the Std_ReturnType extensions shall be named "<Ma>_ReturnType" (*Ma = Module Abbreviation*).⌋

[TR_BSWMG_00091] Std_ReturnType Extension Literal Definition ⌈All BSW module specific possible return type extension literals shall be modeled as attributes of this class. The order of the attributes from top to bottom shall represent the order of the enumeration specified.⌋

[TR_BSWMG_00092] Std_ReturnType Extension Literal Details ⌈The following fields shall be used for specifying the return type extension literals:

- The "Name" field shall contain the Std_ReturnType extension literal name.
- The field "Type" shall be empty.
- The field "Stereotype" shall be empty.
- The field "Scope" shall be "Public".
- The field "Notes" shall contain the description of the custom return value.

⌋

[TR_BSWMG_00093] Std_ReturnType Extension Literal Value ⌈Custom Std_ReturnType values shall always be defined with a specified unsigned integer value larger than 1 (i.e. `E_NOT_OK`). The integral value shall be placed in the field "Initial Value".⌋

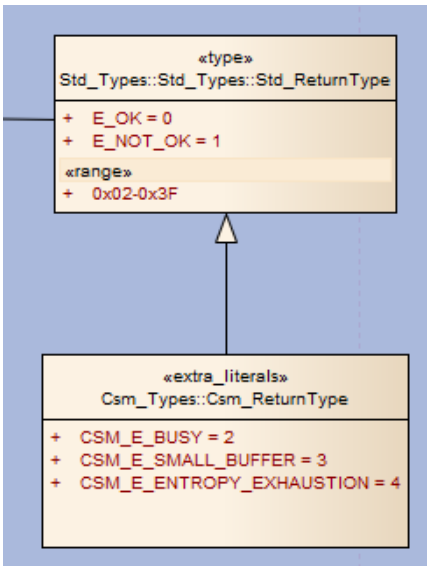


Figure 2.24: Std_ReturnType Extensions example

In case multiple modules of a stack need to extend Std_ReturnType in the same way, there is no need to define the extension separately for each module of the stack. The following modeling shall be applied:

[TR_BSWMG_00173] Generic Std_ReturnType Extension ⌈The generic definition of a Std_ReturnType extension specific to multiple modules shall be modeled as an UML Class with stereotypes ≪extra_literals≫ and ≪generic_type≫.⌋

[TR_BSWMG_00174] Generic Std_ReturnType Extension is no Std_ReturnType Extension ⌈The generic definition of a Std_ReturnType extension is no extension to be used by BSW modules directly. Therefore it shall not be in an realization relationship to any BSW module.⌋

[TR_BSWMG_00175] Users of Generic Std_ReturnType Extension ⌈The definition of a BSW module specific Std_ReturnType extension that has the literals as defined by Generic Std_ReturnType Extension shall be modeled as an UML Class with stereotype ≪extra_literals≫ and derived from that Generic Std_ReturnType Extension. Apart from that it shall be modeled as a usual Std_ReturnType Extension.⌋

Note that Std_ReturnType Extensions derived from a Generic Std_ReturnType Extension may define their own literals as well, in addition to the literals they derive from the Generic Std_ReturnType Extension.

2.8.4 Symbols (#define)

[TR_BSWMG_00928] Symbol Definition ⌈To model symbol definitions (#define in resulting code), a class shall be modeled with the stereotype ≪symbol≫.⌋

[TR_BSWMG_00929] Symbol Basetypes ⌈The optional basetype of a symbol shall be modeled as generalization to the class stereotyped ≪type≫ representing the basetype.⌋

[TR_BSWMG_00948] Value of a Symbol ⌈The value of a symbol definition (be it a numeric value or the description of an unspecified value) is represented by an attribute named “value”. The actual value shall be written into the description field of that attribute.⌋

2.8.5 Arrays

[TR_BSWMG_00403] Array Type Definition ⌈An array type shall be modeled as a class of stereotype ≪array≫. To define the type of the array elements, a generalization relationship to the type shall be created.⌋

[TR_BSWMG_00409] Array Size Definition ⌈The array size shall optionally be specified using the tagged value Vh.ArraySize.⌋

2.8.6 Structures

[TR_BSWMG_00076] Structure Type Definition ⌈Each type definition representing a structure declaration shall be modeled as a UML Class with the stereotype ≪structure≫.⌋

[TR_BSWMG_00077] Structure Member Definition ⌈All members of a structure shall be defined as attributes of this class. The ordering of the attributes shall be the same as expected in the generated table.⌋

[TR_BSWMG_00078] Structure Member Details ⌈The following shall be respected for attributes:

- The “Name” field shall contain the name of the attribute.
- The field “Type” shall select the existing type.
- The field “Scope” shall be “Public”.
- The “Containtment” shall be “Not Specified”.

⌋

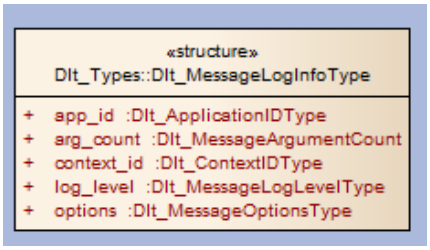


Figure 2.25: Structure example

2.8.7 Unions

[TR_BSWMG_00185] Union Type Definition ⌈Each type definition representing a union declaration shall be modeled as a UML Class with the stereotype ≪union≫.⌋

[TR_BSWMG_00186] Union Member Definition ⌈All members of a union shall be defined as attributes of this class. The ordering of the attributes shall be the same as expected in the generated table.⌋

[TR_BSWMG_00187] Union Member Details ⌈The following shall be respected for attributes:

- The “Name” field shall contain the name of the attribute.
- The field “Type” shall select the existing type.
- The field “Scope” shall be “Public”.

- The “Containtment” shall be “Not Specified”.

⌋

2.8.8 Pointer Types

[TR_BSWMG_00404] Pointer Type Definition ⌈A pointer type shall be modeled as a class of stereotype ≪pointer≫. To define the type of the referenced data, a generalization relationship to the type shall be created.⌋

[TR_BSWMG_00916] Const Pointer Type Definition ⌈A const pointer type shall be modeled exactly as pointer type ([TR_BSWMG_00404]) with the exception that the stereotye ≪constpointer≫ shall be applied.⌋

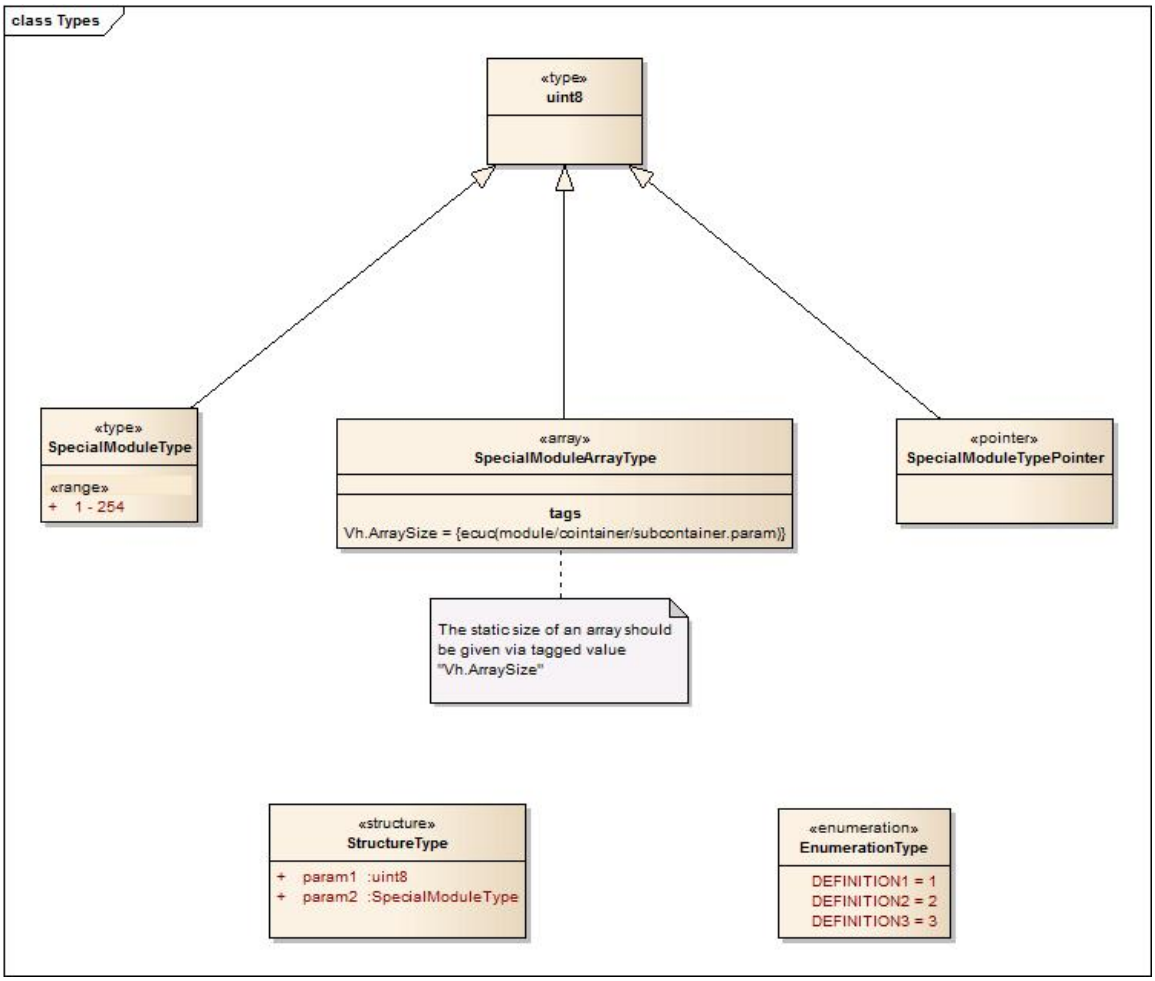


Figure 2.26: Schematic overview of type definitions

2.8.9 Function Pointers

[TR_BSWMG_00188] Function Pointer Type Definition ⌈Each type definition representing a function pointer declaration shall be modeled as a UML Class with the stereotype ≪functionpointer≫.⌋

[TR_BSWMG_00189] Function Pointer Function Definition ⌈The signature of the anonymous function for the function pointer shall be modeled as operation within the UML Class representing the type definition. It shall be named equally to the UML Class name.⌋

[TR_BSWMG_00190] Function Pointer Parameter Definition ⌈Function parameters and return value for Function Pointers are optional and shall be modeled as for API Functions i.e. according to [TR_BSWMG_00020], [TR_BSWMG_00032], [TR_BSWMG_00033], [TR_BSWMG_00021], [TR_BSWMG_00023].⌋

2.8.10 Bitfields

Bitfield types represent an efficient way of encoding a number of independent variables within one type. This is done by breaking down the bitfield type into compartments of individual bit flags or bit ranges containing a series of bits.

One typical application is the implementation of independent boolean variables or “bit flags” (i.e. binary flags); each of these flags takes up one bit in the bitfield, and can be set to true or false independently of all other flags contained in the type.

However, Bitfields are not limited to bit flags: They can also contain one or more groups of bits that can be interpreted as a small-range enumeration type per group (“bit range”).

Both use cases can be mixed and implemented in several instances within the same bitfield type. The definition of the bitfield compartments is done using bitmasks.

The bitfield type can additionally define value literals in order to assign concrete meaning to the masked values.

[TR_BSWMG_00079] Bitfield Type Definition ⌈Each type definition representing a bitfield declaration shall be modeled as a UML Class with the stereotype ≪bitfield≫.⌋

[TR_BSWMG_00080] Bitfield: Bit Flag Definitions ⌈Binary “bit flags” shall be modeled as attributes of the bitfield type using the stereotype ≪bitflag≫.⌋

[TR_BSWMG_00081] Bitfield: Bit Flag Value interpretation ⌈The two possible values of “bit flags” shall always be interpreted as “TRUE” and “FALSE”. In case a binary value shall be interpreted differently, it shall be modeled as a Bit Range (see below).⌋

[TR_BSWMG_00082] Bitfield: Bit Flag Details ⌈The following shall be respected for Bit Flag attributes:

- The “Name” field shall contain the name of the bit flag. (ARXML: Short-Label of CompuScale)
- The field “Type” shall be empty.
- The field “Initial Value” shall contain the bit flag value either in hexadecimal (e.g. 0x10) or in binary (e.g. 0b00010000) representation.
- The field “Stereotype” shall be ≪bitflag≫.
- The field “Alias” shall be empty.
- The field “Scope” shall be “Public”.
- The field “Notes” shall describe the meaning of the bit flag.

⌋

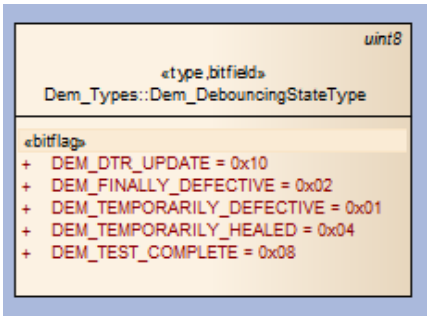


Figure 2.27: Bitfield bitflag example

[TR_BSWMG_00083] Bitfield: Bit Range Definitions ⌈Bit Ranges are continuous bit regions containing one or more bits. Bit Ranges shall be modeled as attributes of the bitfield type using the stereotype ≪bitrange≫.⌋

[TR_BSWMG_00084] Bitfield: Bit Range Details ⌈The following shall be respected for Bit Range attributes:

- The “Name” field shall contain the name of the bit range. (ARXML: Short-Label)
- The field “Type” shall be empty.
- The field “Initial Value” shall contain a bit mask representing the bit range, see below.
- The field “Stereotype” shall be ≪bitrange≫.
- The field “Alias” shall be empty.
- The field “Scope” shall be “Public”.
- The field “Notes” shall describe the meaning of the bit range.

⌋

[TR_BSWMG_00085] Bitfield: Bit Range Mask Value ⌈The size and location of the bits used for the bit range shall be specified as a bitmask using either hexadecimal (e.g. 0x1c) or GCC binary notation, e.g. 0b00011100. This mask value shall be placed in the field “Initial Value”.⌋

[TR_BSWMG_00087] Bitfield: Bit Range Value Definition ⌈A bit range can assume a number of different values. The meaning of these values shall be specified by corresponding ≪`bitflag`≫ attributes that match the mask from the Bit Range Mask Value ([TR_BSWMG_00085]).⌋

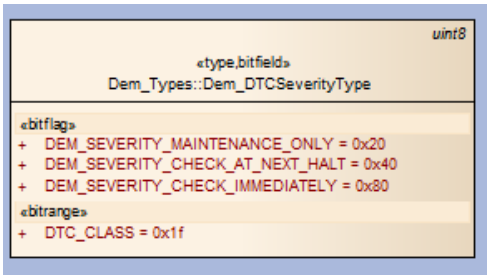


Figure 2.28: Bitfield Bitflag and Bitrange combined example

2.8.11 Implicit Dependencies between Data Types

There are use cases where modeled datatypes implicitly depend on other datatypes.

For example, an enumeration used in an API parameter might define which other datatype to use for another parameter of the API function.
This is an implicit dependency i.e. it is not explicitly modeled which the dependent datatypes are. It is usually only described in prose SWS specification and not modeled explicitly in the BSWUMLModel.

In order to create tables of imported types of a module (see [TR_BSWMG_00098]), implicit dependencies are unfortunate as they cannot be recognized by an automated model processor.

To mitigate this problem, whenever such implicit dependencies occur, they can be made explicit by adding a dependency relation between the two datatypes.

[TR_BSWMG_00933] Make implicit datatype dependencies explicit ⌈In order to explicitly model an otherwise implicit dependency between two datatypes, a dependency relation shall be added from the depending datatype to the dependent datatype. This dependencies shall have the stereotype ≪`dependentType`≫.⌋

2.8.12 References to Data Types

Parameters of API functions as well as datatype members (e.g. structure elements) may reference data types. Usually, those references to datatypes are straight forward cross-references by setting the type (see [TR_BSWMG_00032]).

However, there is need to support cases where the simple reference by type name is not sufficient:

[TR_BSWMG_00905] References to equally named Datatypes ⌈In case a API function parameter or datatype member has a type that cannot be uniquely determined by name (e.g. a datatype that exists in different equally named variants) the reference to the datatype shall be supported by adding the tagged value `bsw.typeRef.aName` at the parameter/type member. The value shall be the `aName` of the referenced datatype, which will uniquely determine the datatype as of [TR_BSWMG_00031].⌋

[TR_BSWMG_00918] References to Datatypes that are not modelled ⌈In case a API function parameter or datatype member has a type that is not part of the BSWUMLModel (e.g. a placeholder for an implementation-defined type) this shall be marked by setting the stereotype ≪`bswNoModeledType`≫ at the parameter/type member.⌋

Rationale for [TR_BSWMG_00918]: Only by setting the stereotpye ≪`bswNoModeledType`≫ it can be clearly distinguished between explicitly setting a datatype that is not modelled or a typographical error.

There is a similar use case to model a datatype derived from a datatype that does not exist in the model. In this case a generalization and a parent datatype as target of that generalization have to be modeled anyway. But the parent datatype shall be marked as being no BSWUML datatype in order to be able to suppress export of that datatype:

[TR_BSWMG_00919] Parent Datatypes that are not modelled ⌈In case a datatype is derived from a parent type that is not part of the BSWUMLModel (e.g. a placeholder for an implementation-defined type) this shall be modelled by creating a class for the parent type with the stereotype ≪`generic_type`≫ and a generalization from the derived datatype to the parent datatype.⌋

Note: It might happen that a datatype reference (e.g. from an operation parameter or a datatype attribute) occurs that points to a ≪`generic_type`≫. Please note that this is not supported per se as ≪`generic_type`≫s are a vehicle to model supertypes / type hierarchies only. In those cases, the stereotype ≪`bswNoModeledType`≫ still has to be added to the referencing element.

2.9 Variability of model elements

Many model elements in the BSW UML Model are configurable since they depend on the configuration of the basis software (EcuC). Therefore, so called “blueprint conditions” have been introduced into BSW model to express e.g. that the existence of ports depends on the existence of specific EcuC parameters.

2.9.1 Examples of defining of variability in AUTOSAR R4.0.3 SWS documents

The following listing shows examples of the old syntax of modeling / defining of variability in AUTOSAR R4.0.3 SWS documents. The variability was defined informal as comments.

Variability in Ports:

```
Service ComM
{
...
  // port present for each channel
  // if ComMModeLimitationEnabled (see ECUC_ComM_00560);
  // there are NC channels;
  ProvidePort ComM_ChannelLimitation CL000;
  ...
  ProvidePort ComM_ChannelLimitation CL<NC-1>;
...
}
```

Variability in provided client server operations:

```
ClientServerInterface Dcm_SecurityAccess
{
...
//Request to application for synchronous comparing key
//(DcmDspSecurityUsePort = USE_SYNCH_CLIENT_SERVER)
CompareKey(IN uint8 Key[<DcmDspSecurityKeySize>],
           ERR{E_NOT_OK, E_COMPARE_KEY_FAILED});

//Request to application for asynchronous comparing key
//(DcmDspSecurityUsePort = USE_ASYNCH_CLIENT_SERVER)
CompareKey(IN uint8 Key[<DcmDspSecurityKeySize>],
           IN Dcm_OpStatusType OpStatus,
           ERR{E_NOT_OK, E_PENDING, E_COMPARE_KEY_FAILED});
}
```

Variability in provided client server operations parameters and types:

```
// ProtInterface type and name
ClientServerInterface Dcm_RoutineServices {
 ...
  // <datatype> dataIn1,..., defines multiple parameters of
  //   a parameterized type
  // uint8* dataInN for the last parameter is a concrete
  //   type defined (not parameterized)

```

```
9    StartFlex(
10         IN <datatype> dataIn1,..., IN uint8 dataInN[( <
               DcmDspRoutineSignalLength of DcmDspStartRoutineInSignal>
               +7)/8],
11         IN Dcm_OpStatusType OpStatus,
12         OUT <datatype> dataOut1,..., OUT uint8 dataOutN[( <
               DcmDspRoutineSignalLength of DcmDspStartRoutineOutSignal>
               +7)/8],
13         INOUT uint16 currentDataLength,
14         OUT Dcm_NegativeResponseCodeType ErrorCode,
15         ERR{E_NOT_OK, DCM_E_PENDING, E_FORCE_RCRRP });
16 ...
17 };
```

Variability in provided interface type:

```
1 ClientServerInterface DataServices:
2
3 Using the concepts of the SW-C template, the interface is defined as
      follows if ClientServer interface is used (DcmDspDataUsePort set to
       USE_DATA_SYNCH_CLIENT_SERVER or USE_DATA_ASYNCH_CLIENT_SERVER):
```

```
1 SenderReceiver DataServices:
2
3 Using the concepts of the SW-C template, the interface is defined as
      follows if SenderReceiver interface is used (DcmDspDataUsePort set
      to USE_DATA_SENDER_RECEIVER):
```

2.9.2 Modeling of variability

[TR_BSWMG_00500] Variability: NamePatterns ⌈If the number of occurrences of a model element is depending on a the occurrences of EcuC containers, the condition shall defined in tagged value `Vh.NamePattern.BlueprintPolicy.DerivationGuide` and the Namepattern shall be defined in tagged value `Vh.NamePattern`.⌋

[TR_BSWMG_00501] Variability: Blueprint Conditions ⌈To define variability of a model element the tagged value `Vh.BlueprintCondition` shall be used.⌋

Variability example of a port:

```
1 Vh.BlueprintCondition:
2   {ecuc(ComM/ComMGeneral.ComMModeLimitationEnabled)} == true
3 Vh.NamePattern.BlueprintPolicy.DerivationGuide:
4   Name = {ecuc(ComM/ComMConfigSet/ComMChannel)}
5 Vh.NamePattern:
6   CL_{Name}
```

[TR_BSWMG_00507] Variability: Configurable reference to Port Interface ⌈If the reference to a port interface is configurable by EcuC the tagged value `Vh.InterfaceRef.BlueprintPolicy.DerivationGuide` shall be used.⌋

Configurable interface reference of a port (BswM modeNotificationPort):

```
Vh.InterfaceRef.BlueprintPolicy.DerivationGuide:
  {ecuc(BswM/BswMConfig/BswMArbitration/BswMModeRequestPort/
     BswMModeRequestSource/BswMSwcModeNotification.
     BswMSwcModeNotificationModeDeclarationGroupPrototypeRef)}.parent
```

[TR_BSWMG_00155] Variability: Port Interface with configurable isService attribute ⌈If the value of the isService attribute depends on a EcuC parameter the tagged value `Vh.isService.BlueprintPolicy.DerivationGuide` shall be used. The value of the tagged value shall be set to the blueprint condition referencing the EcuC parameter.⌋

[TR_BSWMG_00917] Variability: Port Interface with configurable class ⌈If the class of a port interface (ClientServerInterface, ModeSwitchInterface, or SenderReceiverInterface) is dependent on EcuC parameters, this shall be modelled by two or more interfaces with their respective stereotypes that are all referenced by the port. The applicability of the interface class shall be modelled with the tagged value `Vh.blueprintCondition` at each of the modelled interfaces.⌋

[TR_BSWMG_00908] Variability: SenderReceiverInterface with configurable data element type ⌈If the datatype of a data element of a SenderReceiverInterface depends on EcuC parameters the tagged value `Vh.TypeRef.BueprintPolicy.DerivationGuide` shall be used to express the dependency.⌋

[TR_BSWMG_00070] Blueprint Conditions for Derived Datatypes ⌈If a type is derived from more than one other data type, the generalization dependency shall have a tagged value `Vh.BlueprintCondition` which specifies the exact conditions for selecting the associated data type. (e.g., `Vh.BlueprintCondition=platform dependent`)⌋

[TR_BSWMG_00503] Blueprint Policies for Datatype CompuMethods ⌈To define blueprint policies for a type's compu method the tagged value `Vh.compuMethod.BlueprintPolicy` with the legal values "not-modifiable", "list", or "single" shall be used.

The blueprint derivation guide shall be described by the tagged value `Vh.compuMethod.BlueprintPolicy.DerivationGuide`.

It is not applicable for blueprint policy not-modifiable.

To explicitly set the maximal and minimal number of elements for a blueprint policy list the tagged values `Vh.compuMethod.BlueprintPolicy.maxElements` and `Vh.compuMethod.BlueprintPolicy.minElements` shall be used.⌋

```
Vh.compuMethod.BlueprintPolicy:
  list
Vh.compuMethod.BlueprintPolicy.maxElements:
  3
Vh.compuMethod.BlueprintPolicy.minElements:
```

```
  1
Vh.compuMethod.BlueprintPolicy.DerivationGuide.1:
  0x00 is locked
Vh.compuMethod.BlueprintPolicy.DerivationGuide.2:
  0x01...0x3F is configuration dependent
Vh.compuMethod.BlueprintPolicy.DerivationGuide.3:
  0x40...0xFF is Reserved by Document
```

[TR_BSWMG_00504] Blueprint Policies for Datatype DataContraints ⌈To define blueprint policies for a type's data constr the tagged value `Vh.dataConstr.lowerLimit.BlueprintPolicy.DerivationGuide` for the lower limit and the tagged value `Vh.dataConstr.upperLimit.BlueprintPolicy.DerivationGuide` for the upper limit shall be used.⌋

[TR_BSWMG_00505] Blueprint Policies for Datatype DataContraints explicit limits ⌈To explicitly set the lower and upper limit the tagged values `Vh.dataConstr.lowerLimit.value` and `Vh.dataConstr.upperLimit.value` shall be used.⌋

[TR_BSWMG_00506] Blueprint Policies for Datatype DataContraints explicit blueprintValues ⌈To explicitly set the lower and upper blueprintValue the tagged values `Vh.dataConstr.lowerLimit.blueprintValue` and `Vh.dataConstr.upperLimit.blueprintValue` shall be used.⌋

```
Vh.dataConstr.lowerLimit.BlueprintPolicy.DerivationGuide:
  For each user, a unique value must be defined at system generation
     time. Maximum number of users is 255. Legal user IDs are in the
     range 0 .. 254;
Vh.dataConstr.lowerLimit.blueprintValue:
  min 0
Vh.dataConstr.lowerLimit.value:
  undefined

Vh.dataConstr.upperLimit.BlueprintPolicy.DerivationGuide:
  For each user, a unique value must be defined at system generation
     time. Maximum number of users is 255. Legal user IDs are in the
     range 0 .. 254;
Vh.dataConstr.upperLimit.blueprintValue:
  max 254
Vh.dataConstr.upperLimit.value:
  undefined
```

[TR_BSWMG_00411] Configurable literals for Enumeration Types ⌈For each BlueprintCondition delivering names of literals an attribute have to be defined. The name of the attribute has to be the namepattern e.g. "ResetMode".⌋

[TR_BSWMG_00412] Configurable literals for Enumeration Types ⌈The BlueprintCondition delivering names of literals an attribute have to be defined on the attribute using the tagged value `Vh.BlueprintCondition`.⌋

[TR_BSWMG_00413] Configurable literals for Enumeration Types ⌈The value of configurable literals shall be defined on the attribute using the tagged value `Vh.BlueprintValue`. The value field shall be set to the variable used in tagged value `Vh.BlueprintValue`.⌋

Example of configurable literals for an enumeration type (EcuM_ShutdownModeType): The literals of this data type is a union of configured EcuMResetModes and EcuMSleepModes. Therefor two attribute have to be modeled containing the condition to get the literals names and the condition to get the IDs for the literals.

```
Attribute name: {ResetMode}
Attribute value: {ResetModeId}

Vh.BlueprintCondition:
  ResetMode = {ecuc(EcuM/EcuMConfiguration/EcuMFlexConfiguration/
      EcuMResetMode.SHORT-NAME)}
Vh.BlueprintValue:
  ResetModeId = {256 + ecuc(EcuM/EcuMConfiguration/
      EcuMFlexConfiguration/EcuMResetMode.EcuMResetModeId)}
```

```
Attribute name: {SleepMode}
Attribute value : {SleepModeId}

Vh.BlueprintCondition:
  SleepMode = {ecuc(EcuM/EcuMConfiguration/EcuMCommonConfiguration/
      EcuMSleepMode.SHORT-NAME)}
Vh.BlueprintValue:
  SleepModeId = {ecuc(EcuM/EcuMConfiguration/EcuMCommonConfiguration/
      EcuMSleepMode.EcuMSleepModeId)}
```

[TR_BSWMG_00907] Variable Bitflags in Bitfields ⌈Bitflags in Bitfields might be subject to variability. In this case the stereotype ≪`variablebitflag`≫ shall be applied to the attribute representing the bitflag instead of ≪`bitflag`≫. The variable name and value of this bitflag may be set via the respective tagged values `Vh.AttributeName` and `Vh.AttributeValue`.⌋

Note: Changes to modeling of variability

The tagged values defined in this section now describe legacy-notation of variability in the BSW UML Model.

They are still widely in use and supported by the model processing. However, at some point in the future that notation will be marked as deprecated and eventually removed from the model and from this modeling guide entirely.

Instead, the new notation, as decribed below ([TR_BSWMG_00934]), will be used exclusively.

[TR_BSWMG_00934] Variability of model elements expressed in ARMQL ⌈To express the variability of a model element using the ARMQL notation (as defined in [4] Chapter 4.11) the required ARMQL-statements shall be appended to the “Notes” field of the element following the keyword `@FORMAL_BLUEPRINT_GENERATOR!`. All text after that keyword is interpreted as ARMQL statements.⌋

Example note to an element with ARMQL:

```
... the element's desription...

@FORMAL_BLUEPRINT_GENERATOR!
FOR
  element : ECV.subEltList("MyModule");
LET
  Name       = element.shortname();
  Applicable = element.subElt("IsAppl").value();
WHERE
  Applicable;
```

2.10 Modeling of Error classification

[TR_BSWMG_00165] ErrorClassification model location ⌈All additional elements of error classification modeling shall be placed in a package "ErrorClassification". This packages shall be a child package of the module package.⌋

[TR_BSWMG_00166] Modeling of ErrorSets ⌈For each kind of errors a module uses a class stereotyped ≪ErrorSet≫ shall be created and aggregated by the module component. The classes shall be named after the kind of errors they represent:

- Development Errors
- Runtime Errors

⌋

Note: Only the error sets that are actually used by the module shall be modeled.

[TR_BSWMG_00167] SWS Item ID of an ErrorSet ⌈The tagged value `bsw.swsItemId` is used to specify the SWS Item ID of an error set.⌋

[TR_BSWMG_00168] Up-traces of an ErrorSet ⌈The tagged value `bsw.traceRefs` is used to specify up-traces to requirements for an error set. Multiple requirement IDs have to be separated by a comma.⌋

[TR_BSWMG_00169] Modeling of DevelopmentErrors ⌈A Development Error shall be modeled as class stereotyped ≪DevelopmentError≫ aggregated at the ≪ErrorSet≫ named "DevelopmentErrors" (see [TR_BSWMG_00166]).⌋

[TR_BSWMG_00170] Modeling of RuntimeErrors ⌈A Runtime Error shall be modeled as class stereotyped ≪RuntimeError≫ aggregated at the ≪ErrorSet≫ named "RuntimeErrors" (see [TR_BSWMG_00166]).⌋

[TR_BSWMG_00172] Specific Modeling of Errors in ErrorSets ⌈Any Error modeled as in [TR_BSWMG_00169] and [TR_BSWMG_00170] shall be named after the desired

error name. It shall contain an attribute ErrorCode, which shall have the initial value set to the desired error value. The description of the class shall be the desired error description.⌋

2.11 Modeling of Life Cycle information

AUTOSAR introduced the possibility to attach life-cycle-related information to all (`Referrable`) specification elements with the Life Cycle Concept in R4.1.1. In a nutshell, a LifeCycleInfo element can be created for a specification element to document its life cycle state - see [4] Chapter 12.3.2.

[TR_BSWMG_00700] Model elements that support life cycle information ⌈In the BSW model the following modeling elements shall be able to have life cycle information:

- API Functions
- datatypes
- ports
- port interfaces
- ModeDeclarationGroups
- imported-types-lists
- mandatory-interfaces-lists
- optional-interfaces-lists
- error-classification-sets

⌋

[TR_BSWMG_00702] Tagged values for life cycle information on model elements ⌈The following tagged values can be used to document life cycle information of a model element (see [TR_BSWMG_00700]):

`atp.Status` A value from the official AUTOSAR lifecycle definitions [5]

`atp.StatusUseInstead` (optional) SWS Item ID(s) of the element(s) replacing this “obsolete” model element

`atp.StatusReplaces` (optional) SWS Item ID(s) of the “obsolete” or “removed” element(s) this model element replaces

`bsw.swsItemPreviousIds` (optional) list of previous SWS Item ID(s) of this model element

⌋

Imported-types-lists, mandatory-interfaces-lists, and optional-interfaces-lists do not have a corresponding model element where to add tagged values representing lifecycle-information to. This is mitigated by modified tagged values:

[TR_BSWMG_00703] Valid tagged values for life cycle information on Imported Types of a module ⌈The following tagged values can be used to document life cycle information on Imported Types of a module: All tagged values listed in [TR_BSWMG_00702] prefixed by `bsw.importedTypes..`⌋

[TR_BSWMG_00704] Valid tagged values for life cycle information on Mandatory Interfaces of a module ⌈The following tagged values can be used to document life cycle information on Mandatory Interfaces of a module: All tagged values listed in [TR_BSWMG_00702] prefixed by `bsw.mandatory..`⌋

[TR_BSWMG_00705] Valid tagged values for life cycle information on Optional Interfaces of a module ⌈The following tagged values can be used to document life cycle information on Optional Interfaces of a module: All tagged values listed in [TR_BSWMG_00702] prefixed by `bsw.optional..`⌋

Use cases of the Life Cycle concept in the BSWUMLModel

- An existing model element is set to **obsolete**. In this case, the tagged value `atp.Status=obsolete` shall be applied to the model element.
- A model element is added as **draft**. In this case, the model element shall be added with the tagged value `atp.Status=draft`.
- A model element is replaced by a new version that has the status **draft**. In this case, the original model element shall get the tagged value `atp.Status=obsolete` and the new model element shall be added with the tagged value `atp.Status=draft`.

  Note that the new model element shall get a new SWS Item ID to avoid SWS Item duplicates as long as both model elements are still in present in an AUTOSAR Release. As guidance to the reader of the specification, the following statement shall be added to the description of the new model element: *"Replaces [<original SWS Item ID>]."*

  Further, in order to maintain unique identifiers among the model elements, the original model element shall receive a unique anchor name by applying the tagged value `aName=<name>_obs`.

Example for the 3rd usecase:
The type `Eth_ModeType` (`SWS_Eth_00158`) shall be replaced by a new version due to the introduction of a new concept in AUTOSAR. The following steps need to by performed:

- Add a tagged value `aName=Eth_ModeType_obs` to `Eth_ModeType`.

- Add a tagged value `atp.Status=obsolete` to `Eth_ModeType`.
- Create the desired new version of the datatype, also named `Eth_ModeType`.
- Add a tagged value `atp.Status=draft` to the new `Eth_ModeType`.
- Set a new SWS Item ID to the new `Eth_ModeType` by adding a tagged value `bsw.swsItemId=SWS_Eth_91008`.
- Add to the description of the new `Eth_ModeType`: *"Replaces [SWS_Eth_00158]."*

2.12 Diagrams

2.12.1 Header File Modeling

[TR_BSWMG_00600] Header File Diagram ⌈The module package shall contain a *header file diagram* (Enterprise Architect: UML Component Diagram).⌋

[TR_BSWMG_00601] Naming of Header File Diagram ⌈The name of the header file diagram shall be the name of the *module component* followed by "_header", e.g. "FrTp_header".⌋

[TR_BSWMG_00602] Header and Source Code Artifacts ⌈Document artifacts shall be declared either as header or source file using the stereotypes ≪`header`≫ and ≪`source`≫.⌋

[TR_BSWMG_00603] Document Artifact Location ⌈Document artifacts shall be placed in the module package of the defining BSW module.⌋

[TR_BSWMG_00604] Include Dependency of Document Artifacts ⌈Document artifacts can include other artifacts using a dependency with stereotype ≪`include`≫. With the additional stereotype ≪`optional`≫, optional inclusion can be expressed.⌋

[TR_BSWMG_00605] Optional Include Dependency of Document Artifacts ⌈Optional inclusion can be expressed by specifying the additional stereotype ≪`optional`≫ on an include dependency.⌋

2.12.2 Sequence Diagrams

[TR_BSWMG_00901] Usage of Sequence Diagrams ⌈For modeling interactions of different modules, sequence diagrams shall be used.⌋

[TR_BSWMG_00902] Location of Sequence Diagrams ⌈All sequence diagrams shall be placed within the "Interaction Views" package.⌋

2.12.3 State Machine Diagrams

[TR_BSWMG_00801] Usage of State Machine Diagrams ⌈For modeling state dependencies within and between elements, state machine diagrams shall be used.⌋

[TR_BSWMG_00920] Location of State Machine Diagrams ⌈All state machine diagrams shall be placed within the “Documentation Drawings” package.⌋

2.12.4 Specification Diagrams

Specification diagrams are distinguished from the other modeled diagrams by their purpose to provide actual *specification* instead of having illustrative nature.

That purpose imposes the following requirements upon a specification diagram:

1. It is a specification item i.e. it shall have an SWS Item Id and optionally further metadata of an SWS Item.
2. It shall be included in AUTOSAR’s change documentation. Hence, it needs to be possible to track semantical changes to the diagram and to filter out layout changes to the diagram (e.g. only moving diagram elements shall not be considered a semantical change).

Note that the following UML diagram types are currently supported as specification diagrams:

- Sequence charts
- State diagrams
- Activity diagrams

[TR_BSWMG_00942] Root element of a specification diagram ⌈A specification diagram shall be modeled with one UML element as **root element** depending on the diagram type:

- for Sequence charts: root shall be an Interaction
- for State diagrams: root shall be an StateMachine
- Activity diagrams: root shall be an Activity

The root element shall have the stereotype ≪`asipSpecItem`≫ and shall contain the diagram.⌋

[TR_BSWMG_00943] Naming of specification diagrams ⌈The root element (see [TR_BSWMG_00942]) of a specification diagram shall have the intended name with the prefix “SPEC_”. The name of the contained diagram is not restricted.⌋

[TR_BSWMG_00944] Self-contained modeling of specification diagrams ⌈Specification diagrams shall be modeled in a self-contained way: All elements shown

in the diagram shall be contained in the root element (see [TR_BSWMG_00942]). Conversely, all elements contained in the root element shall be included in the diagram.⌋

Rationale for [TR_BSWMG_00944]: This restriction enables model processing tools to distinguish semantical changes to the diagram from layout changes.

[TR_BSWMG_00945] SWS Item information of specification diagrams ⌈The SWS Item information of a specification diagram is set via the following tagged values at the root element (see [TR_BSWMG_00942]):

- `asipID` for the SWS Item ID
- `asipTitle` for the SWS Item title
- `asipUptraces` for up-traces to requirements (comma-separated list).

⌋

[TR_BSWMG_00946] Description of specification diagrams ⌈In case further explanation is needed at a specification diagram a description (one paragraph) can be appended by using the tagged value `asipDescription` at the root element (see [TR_BSWMG_00942]).⌋

[TR_BSWMG_00947] Life cycle information of specification diagrams ⌈Life cycle information of specification diagrams is set via the following tagged values at the root element (see [TR_BSWMG_00942]):

- `asipState` for the life cycle state
- `asipUseInstead` to link to SWS Item(s) replacing this “obsolete” SWS Item (comma-separated list)
- `asipReplaces` to link to “obsolete” SWS Item(s) replaced by this SWS Item (comma-separated list)
- `asipPreviousIDs` to list previous SWS Item Ids (comma-separated list).

⌋

A Stereotypes and Tagged Values defined for the BSWUMLModel

Stereotype	Applicable to [UML model element]	Specified in
abswMapping	dependency	[TR_BSWMG_00111]
abswModeType	composition	[TR_BSWMG_00205]
abswOperation	composition	[TR_BSWMG_00104]
abswPortRef	dependency	[TR_BSWMG_00120]
abswPossibleError	composition	[TR_BSWMG_00109]
abswPossibleErrorRef	dependency	[TR_BSWMG_00110]
abswRequires	dependency	[TR_BSWMG_00101]
ApplicationError	class	[TR_BSWMG_00108]
array	class	[TR_BSWMG_00403]
asipSpecItem	activity, interaction, state machine	[TR_BSWMG_00942]
bitfield	class	[TR_BSWMG_00079]
bitflag	attribute	[TR_BSWMG_00080]
bitrange	attribute	[TR_BSWMG_00083]
bswNoModeledType	parameter, attribute	[TR_BSWMG_00918]
callback	operation	[TR_BSWMG_00157]
callout	operation	[TR_BSWMG_00016]
ClientServerInterface	class	[TR_BSWMG_00102]
ClientServerOperation	class	[TR_BSWMG_00103]
configurable	dependency	[TR_BSWMG_00059]
constpointer	class	[TR_BSWMG_00916]
dependentType	dependency	[TR_BSWMG_00933]
derived_generic_interface	interface	[TR_BSWMG_00134]
DevelopmentError	class	[TR_BSWMG_00169]
enumeration	class	[TR_BSWMG_00072]
ErrorSet	class	[TR_BSWMG_00166]
extra_literals	class	[TR_BSWMG_00089]
function	operation	[TR_BSWMG_00016]
function_blueprint	operation	[TR_BSWMG_00133]
functionpointer	class	[TR_BSWMG_00188]
generic_interface	interface	[TR_BSWMG_00061]
generic_type	class	[TR_BSWMG_00919]
header	artifact	[TR_BSWMG_00602]
interface	interface	[TR_BSWMG_00012]
mandatory	dependency	[TR_BSWMG_00043]
ModeDeclaration	class	[TR_BSWMG_00204]
ModeDeclarationGroup	class	[TR_BSWMG_00203]
ModeSwitchInterface	class	[TR_BSWMG_00102]
module	component	[TR_BSWMG_00003]
multiple	parameter	[TR_BSWMG_00130]
mutualexcl	parameter	[TR_BSWMG_00131]



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Stereotype	Applicable to [UML model element]	Specified in
optional	dependency, parameter	[TR_BSWMG_00046], [TR_BSWMG_00129]
PDAV	attribute	[TR_BSWMG_00122]
pointer	class	[TR_BSWMG_00404]
PortAPIOption	class	[TR_BSWMG_00118]
PPortPrototype	port	[TR_BSWMG_00100]
PRPortPrototype	port	[TR_BSWMG_00100]
range	attribute	[TR_BSWMG_00071]
realize	realization	[TR_BSWMG_00015]
RPortPrototype	port	[TR_BSWMG_00100]
RuntimeError	class	[TR_BSWMG_00170]
scheduled_function	operation	[TR_BSWMG_00037]
SenderReceiverInterface	class	[TR_BSWMG_00102]
source	artifact	[TR_BSWMG_00602]
structure	class	[TR_BSWMG_00076]
symbol	class	[TR_BSWMG_00928]
type	class	[TR_BSWMG_00066]
union	class	[TR_BSWMG_00185]
use	dependency	[TR_BSWMG_00921]
variablebitflag	attribute	[TR_BSWMG_00907]

Table A.1: Stereotypes used in the BSWUMLModel

Tagged Value	Applicable to [BSWUML model element][2]	Specified in
aName	named bsw element	[TR_BSWMG_00031]
asipDescription	specification diagram root	[TR_BSWMG_00946]
asipID	specification diagram root	[TR_BSWMG_00945]
asipPreviousIDs	specification diagram root	[TR_BSWMG_00947]
asipReplaces	specification diagram root	[TR_BSWMG_00947]
asipState	specification diagram root	[TR_BSWMG_00947]
asipTitle	specification diagram root	[TR_BSWMG_00945]
asipUptraces	specification diagram root	[TR_BSWMG_00945]
asipUseInstead	specification diagram root	[TR_BSWMG_00947]
atp.Status	specification element	[TR_BSWMG_00702]
atp.StatusReplaces	specification element	[TR_BSWMG_00702]
atp.StatusUseInstead	specification element	[TR_BSWMG_00702]
bsw.calltype	configurable-dependency	[TR_BSWMG_00903]
bsw.entryKind	configurable-dependency	[TR_BSWMG_00904]
bsw.extendsModule	module	[TR_BSWMG_00184]
bsw.externalSpecification	API function, datatype	[TR_BSWMG_00930]
bsw.headerFile	API function, datatype	[TR_BSWMG_00140], [TR_BSWMG_00141]

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[2]For the definition of the terms used here, please see Table Table A.3.

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Tagged Value	Applicable to [BSWUML model element][1]	Specified in
bsw.importedTypes.atp.Status	module	[TR_BSWMG_00703]
bsw.importedTypes.atp.StatusReplaces	module	[TR_BSWMG_00703]
bsw.importedTypes.atp.StatusUseInstead	module	[TR_BSWMG_00703]
bsw.importedTypes.swsItemId	module	[TR_BSWMG_00098]
bsw.importedTypes.swsItemPreviousIds	module	[TR_BSWMG_00098]
bsw.importedTypes.traceRefs	module	[TR_BSWMG_00099]
bsw.isService	port interface	[TR_BSWMG_00154]
bsw.lastUsedServiceId	module	[TR_BSWMG_00937]
bsw.lastUsedSwsItemId	module	[TR_BSWMG_00936]
bsw.mandatory.atp.Status	module	[TR_BSWMG_00704]
bsw.mandatory.atp.StatusReplaces	module	[TR_BSWMG_00704]
bsw.mandatory.atp.StatusUseInstead	module	[TR_BSWMG_00704]
bsw.mandatory.swsItemId	module	[TR_BSWMG_00094]
bsw.mandatory.swsItemPreviousIds	module	[TR_BSWMG_00094]
bsw.mandatory.traceRefs	module	[TR_BSWMG_00095]
bsw.moduleId	module	[TR_BSWMG_00036]
bsw.moduleLongName	module	[TR_BSWMG_00931]
bsw.optional.atp.Status	module	[TR_BSWMG_00705]
bsw.optional.atp.StatusReplaces	module	[TR_BSWMG_00705]
bsw.optional.atp.StatusUseInstead	module	[TR_BSWMG_00705]
bsw.optional.swsItemId	module	[TR_BSWMG_00096]
bsw.optional.swsItemPreviousIds	module	[TR_BSWMG_00096]
bsw.optional.traceRefs	module	[TR_BSWMG_00097]
bsw.sequenceOffset	see [TR_BSWMG_00926]	[TR_BSWMG_00925]
bsw.swsItemId	specification element	[TR_BSWMG_00150], [TR_BSWMG_00152], [TR_BSWMG_00167]
bsw.swsItemNameForTitle	API function, datatype, port, port interface	[TR_BSWMG_00940], [TR_BSWMG_00941]
bsw.swsItemPreviousIds	specification element	[TR_BSWMG_00702]
bsw.traceRefs	specification element	[TR_BSWMG_00151], [TR_BSWMG_00153], [TR_BSWMG_00168]
bsw.typeRef.aName	operation parameter, datatype member	[TR_BSWMG_00905]
Reentrant	API function	[TR_BSWMG_00025]
ServiceID	API function	[TR_BSWMG_00024]
ServiceIDGroup	API function	[TR_BSWMG_00938]
Synchronous	API function	[TR_BSWMG_00026]
Synchronous.comment	API function	[TR_BSWMG_00906]
Vh.ArraySize	datatype	[TR_BSWMG_00409]
Vh.AttributeName	bitfield flag	[TR_BSWMG_00907]
Vh.AttributeValue	bitfield flag	[TR_BSWMG_00907]
Vh.BlueprintCondition	named bsw element	[TR_BSWMG_00501]
Vh.BlueprintValue	datatype member	[TR_BSWMG_00413]

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[1] For the definition of the terms used here, please see Table Table A.3.

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Tagged Value	Applicable to [BSWUML model element][1]	Specified in
Vh.compuMethod.BlueprintPolicy	datatype	[TR_BSWMG_00503]
Vh.compuMethod.BlueprintPolicy.DerivationGuide	datatype	[TR_BSWMG_00503]
Vh.compuMethod.BlueprintPolicy.maxElements	datatype	[TR_BSWMG_00503]
Vh.compuMethod.BlueprintPolicy.minElements	datatype	[TR_BSWMG_00503]
Vh.dataConstr.lowerLimit.BlueprintPolicy.DerivationGuide	datatype	[TR_BSWMG_00504]
Vh.dataConstr.lowerLimit.blueprintValue	datatype	[TR_BSWMG_00506]
Vh.dataConstr.lowerLimit.value	datatype	[TR_BSWMG_00505]
Vh.dataConstr.upperLimit.BlueprintPolicy.DerivationGuide	datatype	[TR_BSWMG_00504]
Vh.dataConstr.upperLimit.blueprintValue	datatype	[TR_BSWMG_00506]
Vh.dataConstr.upperLimit.value	datatype	[TR_BSWMG_00505]
Vh.InterfaceRef.BlueprintPolicy.DerivationGuide	port	[TR_BSWMG_00507]
Vh.isService.BlueprintPolicy.DerivationGuide	port interface	[TR_BSWMG_00155]
Vh.NamePattern	named bsw element	[TR_BSWMG_00500]
Vh.NamePattern.BlueprintPolicy.DerivationGuide	named bsw element	[TR_BSWMG_00500]
Vh.TypeRef.BueprintPolicy.DerivationGuide	sender receiver data element	[TR_BSWMG_00908]
Vh.Value.BlueprintPolicy.DerivationGuide	named bsw element	[TR_BSWMG_00128]
xml.baseTypeByteOrder	datatype	[TR_BSWMG_00935]
xml.baseTypeCategory	datatype	[TR_BSWMG_00909]
xml.baseTypeEncoding	datatype	[TR_BSWMG_00910]
xml.baseTypeNativeDeclaration	datatype	[TR_BSWMG_00911]
xml.baseTypeSize	datatype	[TR_BSWMG_00912]
xml.category	datatype	[TR_BSWMG_00914]
xml.generateBaseType	datatype	[TR_BSWMG_00915]
xml.generateCompuMethod	datatype	[TR_BSWMG_00923]
xml.generateDataConstr	datatype	[TR_BSWMG_00924]
xml.location	datatype	[TR_BSWMG_00939]
xml.ignore	named bsw element	[TR_BSWMG_00913]

Table A.2: Tagged Values used in the BSWUMLModel

The following table (Table A.3 “Definitions of terms for BSWUML model elements”) serves as legend for the second column in Table A.2 “Tagged Values used in the BSWUMLModel”.

Term for BSWUML model elements	Actual UML model elements
module	component with stereotype ≪module≫, see [TR_BSWMG_00003]
API function	operation of an interface, see [TR_BSWMG_00016]
operation parameter	parameter within an operation
configurable-dependency	dependency from a module to an interface with stereotype ≪configurable≫, see [TR_BSWMG_00059]
datatype	class representing a BSW datatype of either stereotype: • ≪array≫ ([TR_BSWMG_00403]) • ≪bitfield≫ ([TR_BSWMG_00079]) • ≪constpointer≫ ([TR_BSWMG_00916]) • ≪enumeration≫ ([TR_BSWMG_00072]) • ≪extra_literals≫ ([TR_BSWMG_00089]) • ≪functionpointer≫ ([TR_BSWMG_00188]) • ≪pointer≫ ([TR_BSWMG_00404]) • ≪structure≫ ([TR_BSWMG_00076]) • ≪symbol≫ ([TR_BSWMG_00928]) • ≪type≫ ([TR_BSWMG_00066]) • ≪union≫ ([TR_BSWMG_00185])
datatype member	attribute within a datatype
bitfield flag	attribute with stereotype ≪bitflag≫ with a datatype with stereotype ≪bitfield≫, see [TR_BSWMG_00080]
port	port of a module, see [TR_BSWMG_00100]
port interface	class representing a ClientServerInterface, SenderReceiverInterface, or ModeSwitchInterface, see [TR_BSWMG_00102]
sender receiver data element	attribute within a SenderReceiverInterface, see [TR_BSWMG_00302]
specification diagram root	a root element of a specification diagram (see [TR_BSWMG_00942]); one of • activity • interaction • state machine
specification element	any BSWUML model element that corresponds to a specification item: • API functions • datatypes • ports • port interfaces • ModeDeclarationGroups ([TR_BSWMG_00203]) • imported-types-lists ([TR_BSWMG_00098]) • mandatory-interfaces-lists ([TR_BSWMG_00094]) • optional-interfaces-lists ([TR_BSWMG_00096]) • error-classification-sets ([TR_BSWMG_00166])
named BSWUML element	any named model element dependent on modules with the exception of error classification elements

Table A.3: Definitions of terms for BSWUML model elements

B History of Specification Items

B.1 Specification Item History of this Document according to AUTOSAR R26-11

B.1.1 Added Specification Items in R26-11

Number	Heading
[TR_BSWMG_00942]	Root element of a specification diagram
[TR_BSWMG_00943]	Naming of specification diagrams
[TR_BSWMG_00944]	Self-contained modeling of specification diagrams
[TR_BSWMG_00945]	SWS Item information of specification diagrams
[TR_BSWMG_00946]	Description of specification diagrams
[TR_BSWMG_00947]	Life cycle information of specification diagrams
[TR_BSWMG_00948]	Value of a Symbol

Table B.1: Added Specification Items in R26-11

B.1.2 Changed Specification Items in R26-11

Number	Heading
[TR_BSWMG_00179]	Override Generic Interface Properties
[TR_BSWMG_00180]	Override Derived Generic Interface Properties
[TR_BSWMG_00702]	Tagged values for life cycle information on model elements
[TR_BSWMG_00917]	Variability: Port Interface with configurable class

Table B.2: Changed Specification Items in R26-11

B.1.3 Deleted Specification Items in R26-11

none

B.2 Specification Item History of this Document according to AUTOSAR R25-11

B.2.1 Added Specification Items in R25-11

Number	Heading
[TR_BSWMG_00936]	Tracking the latest used SWS-ID of the module
[TR_BSWMG_00937]	Tracking the latest used Service-ID of the module
[TR_BSWMG_00938]	Service ID Groups
[TR_BSWMG_00939]	Tailoring the export of References to DataTypes
[TR_BSWMG_00940]	Custom SWS Item Title of an API Function
[TR_BSWMG_00941]	Custom SWS Item Title of a Datatype

Table B.3: Added Specification Items in R25-11

B.2.2 Changed Specification Items in R25-11

Number	Heading
[TR_BSWMG_00024]	Service ID of an API Function

Table B.4: Changed Specification Items in R25-11

B.2.3 Deleted Specification Items in R25-11

none

B.3 Specification Item History of this Document according to AUTOSAR R24-11

B.3.1 Added Specification Items in R24-11

Number	Heading
[TR_BSWMG_00930]	Model elements with an external specification
[TR_BSWMG_00931]	BSW Module Name
[TR_BSWMG_00932]	ClientServerOperation intentionally not mapped to an API Function
[TR_BSWMG_00933]	Make implicit datatype dependencies explicit
[TR_BSWMG_00934]	Variability of model elements expressed in ARMQL

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Number	Heading
[TR_BSWMG_00935]	Tailoring the byteOrder of a Simple Type

Table B.5: Added Specification Items in R24-11

B.3.2 Changed Specification Items in R24-11

Number	Heading
[TR_BSWMG_00002]	Naming of BSW Module Packages
[TR_BSWMG_00004]	Naming of BSW Module components
[TR_BSWMG_00036]	BSW Module ID
[TR_BSWMG_00094]	SWS Item ID of the Mandatory Interfaces table of the module
[TR_BSWMG_00095]	Up-traces of the Mandatory Interfaces table of the module
[TR_BSWMG_00096]	SWS Item ID of the Optional Interfaces table of the module
[TR_BSWMG_00097]	Up-traces of the Optional Interfaces table of the module
[TR_BSWMG_00098]	SWS Item ID of the Imported Types table of the module
[TR_BSWMG_00099]	Up-traces of the Imported Types table of the module
[TR_BSWMG_00111]	Mapping ClientServerOperations to API Functions
[TR_BSWMG_00166]	Modeling of ErrorSets
[TR_BSWMG_00172]	Specific Modeling of Errors in ErrorSets
[TR_BSWMG_00400]	Modeling of Service Datatypes
[TR_BSWMG_00500]	Variability: NamePatterns
[TR_BSWMG_00501]	Variability: Blueprint Conditions
[TR_BSWMG_00503]	Blueprint Policies for Datatype CompuMethods
[TR_BSWMG_00702]	Tagged values for life cycle information on model elements
[TR_BSWMG_00915]	Tailoring the export of a SwBaseType for a Simple Type
[TR_BSWMG_00926]	Restriction on explicit ordering of model elements

Table B.6: Changed Specification Items in R24-11

B.3.3 Deleted Specification Items in R24-11

Number	Heading
[TR_BSWMG_00027]	Mandatory pointers for API Function Output Parameters
[TR_BSWMG_00044]	Mandatory Dependencies
[TR_BSWMG_00045]	Naming of Mandatory Usage Collections
[TR_BSWMG_00047]	Optional Dependencies

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Number	Heading
[TR_BSWMG_00048]	Naming of Optional Usage Collections
[TR_BSWMG_00127]	PortDefinedArgumentValue with Type Configuration by EcuC
[TR_BSWMG_00171]	Modeling of TransientFaults
[TR_BSWMG_00502]	Variability: Multiple Conditions
[TR_BSWMG_00701]	LifeCycleInfo information in model elements

Table B.7: Deleted Specification Items in R24-11

B.4 Specification Item History of this Document according to AUTOSAR R23-11

B.4.1 Added Specification Items in R23-11

Number	Heading
[TR_BSWMG_00922]	API Function Return Value Links
[TR_BSWMG_00923]	Tailoring the export of a CompuMethod for a DataType
[TR_BSWMG_00924]	Tailoring the export of DataConstr for a DataType
[TR_BSWMG_00925]	Explicit ordering of model elements
[TR_BSWMG_00926]	Restriction on explicit ordering of model elements
[TR_BSWMG_00927]	Predefined values of Simple Types
[TR_BSWMG_00928]	Symbol Definition
[TR_BSWMG_00929]	Symbol Basetypes

Table B.8: Added Specification Items in R23-11

B.4.2 Changed Specification Items in R23-11

Number	Heading
[TR_BSWMG_00024]	Service ID of an API Function
[TR_BSWMG_00025]	Reentrancy value of an API Function
[TR_BSWMG_00026]	Synchronicity value of an API Function
[TR_BSWMG_00074]	Enumeration Literal Details
[TR_BSWMG_00082]	Bitfield: Bit Flag Details
[TR_BSWMG_00084]	Bitfield: Bit Range Details
[TR_BSWMG_00092]	Std_ReturnType Extension Literal Details

Table B.9: Changed Specification Items in R23-11

B.4.3 Deleted Specification Items in R23-11

none

B.5 Specification Item History of this Document according to AUTOSAR R22-11

B.5.1 Added Specification Items in R22-11

Number	Heading
[TR_BSWMG_00703]	Valid tagged values for life cycle information on Imported Types of a module
[TR_BSWMG_00704]	Valid tagged values for life cycle information on Mandatory Interfaces of a module
[TR_BSWMG_00705]	Valid tagged values for life cycle information on Optional Interfaces of a module
[TR_BSWMG_00903]	Overriding the calltype of a Configurable Generic Interface
[TR_BSWMG_00904]	Overriding the entryKind of a Configurable Callback
[TR_BSWMG_00905]	References to equally named Datatypes
[TR_BSWMG_00906]	Comment on synchronicity of an API Function
[TR_BSWMG_00907]	Variable Bitflags in Bitfields
[TR_BSWMG_00908]	Variability: SenderReceiverInterface with configurable data element type
[TR_BSWMG_00909]	Tailoring the baseType category of a Simple Type
[TR_BSWMG_00910]	Tailoring the baseTypeEncoding of a Simple Type
[TR_BSWMG_00911]	Tailoring the baseType nativeDeclaration of a Simple Type
[TR_BSWMG_00912]	Tailoring the baseTypeSize of a Simple Type
[TR_BSWMG_00913]	Tailoring the export of a Datatype
[TR_BSWMG_00914]	Tailoring the category of a Simple Type
[TR_BSWMG_00915]	Tailoring the export of a SwBaseType for a Simple Type
[TR_BSWMG_00916]	Const Pointer Type Definition
[TR_BSWMG_00917]	Variability: Port Interface with configurable class
[TR_BSWMG_00918]	References to Datatypes that are not modelled
[TR_BSWMG_00919]	Parent Datatypes that are not modelled
[TR_BSWMG_00920]	Location of State Machine Diagrams
[TR_BSWMG_00921]	Illustrating a module's usage of an interface

Table B.10: Added Specification Items in R22-11

B.5.2 Changed Specification Items in R22-11

Number	Heading
[TR_BSWMG_00031]	Alternative Anchor Name
[TR_BSWMG_00087]	Bitfield: Bit Range Value Definition
[TR_BSWMG_00700]	Model elements that support life cycle information
[TR_BSWMG_00702]	Valid tagged values for life cycle information on model elements
[TR_BSWMG_00902]	Location of Sequence Diagrams

Table B.11: Changed Specification Items in R22-11

B.5.3 Deleted Specification Items in R22-11

Number	Heading
[TR_BSWMG_00053]	Callback Blueprint interface subpackage location
[TR_BSWMG_00086]	Bitfield: Bit Mask and Bit Range Order
[TR_BSWMG_00088]	Bitfield: Bit Range Value Details

Table B.12: Deleted Specification Items in R22-11

B.6 Specification Item History of this Document according to AUTOSAR R21-11

B.6.1 Added Specification Items in R21-11

Number	Heading
[TR_BSWMG_00176]	Modeling of tagged values as tagged value notes
[TR_BSWMG_00177]	Generic Interface model location
[TR_BSWMG_00178]	Override the Derived Generic Interface Name
[TR_BSWMG_00179]	Override Generic Interface Properties
[TR_BSWMG_00180]	Override Derived Generic Interface Properties
[TR_BSWMG_00181]	Re-use existing interfaces as much as possible
[TR_BSWMG_00182]	Illustrating purpose of Virtual Interfaces
[TR_BSWMG_00183]	BSW Module Extensions
[TR_BSWMG_00184]	Explicit modeling of BSW Module Extensions
[TR_BSWMG_00185]	Union Type Definition
[TR_BSWMG_00186]	Union Member Definition
[TR_BSWMG_00187]	Union Member Details

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Number	Heading
[TR_BSWMG_00188]	Function Pointer Type Definition
[TR_BSWMG_00189]	Function Pointer Function Definition
[TR_BSWMG_00190]	Function Pointer Parameter Definition
[TR_BSWMG_00308]	MoS SenderReceiverInterface

Table B.13: Added Specification Items in R21-11

B.6.2 Changed Specification Items in R21-11

Number	Heading
[TR_BSWMG_00050]	Callback Generic Interface Name
[TR_BSWMG_00062]	Derived Generic Interface Name
[TR_BSWMG_00132]	Generic Interface is abstract
[TR_BSWMG_00133]	Generic Interface Function Definition
[TR_BSWMG_00134]	Derived Generic Interface
[TR_BSWMG_00156]	Derived Generic Interface contains no function

Table B.14: Changed Specification Items in R21-11

B.6.3 Deleted Specification Items in R21-11

Number	Heading
[TR_BSWMG_00029]	Naming of Virtual Interface
[TR_BSWMG_00039]	Virtual Interface Multiplicity
[TR_BSWMG_00040]	Virtual Interface Location
[TR_BSWMG_00042]	No Mixed Usage of Function Interfaces and Virtual Interfaces
[TR_BSWMG_00052]	Callback Blueprint interface model location
[TR_BSWMG_00063]	Provider Naming Scheme
[TR_BSWMG_00064]	User Naming Scheme
[TR_BSWMG_00065]	User-Configurable Naming Scheme
[TR_BSWMG_0308]	MoS SenderReceiverInterface

Table B.15: Deleted Specification Items in R21-11