

Document Title	SW-C and System Modeling Guide
Document Owner	AUTOSAR
Document Responsibility	AUTOSAR
Document Identification No	207
Document Classification	Auxiliary

Document Version	3.0.0
Document Status	Final
Part of Release	4.0
Revision	3

Document Change History			
Date	Version	Changed by	Change Description
02.11.2011	3.0.0	AUTOSAR Administration	<ul style="list-style-type: none"> • Description of “Blueprint” mechanism and its impact on Blueprintable elements in Application Interfaces domain • New Autosar Application Interfaces Package Structure • Keywords handling reformulated according to the Standardization Template specification and the new Application Interfaces Packages Structure • “Units” section enhanced and new “Physical Dimensions” section introduced
24.11.2010	2.1.0	AUTOSAR Administration	<ul style="list-style-type: none"> • Modeling rules optimization for multiple instances. • New description of the standardized Autosar packages structure. • New RTE specification and requirements references introduced.

Document Change History			
Date	Version	Changed by	Change Description
30.11.2009	2.0.0	AUTOSAR Administration	<ul style="list-style-type: none">• Set of modelling rules changed to allow different styles of modelling with respect to clustering and future extensibility.• Set of naming convention rules changed to allow more flexibility in creation of self-explicable names.• Name and number of standardized AR-Packages have changed. Scope of naming convention has been extended accordingly.• Blueprints concept supported as a dedicated AR-Package for Ports• Long Names are now out of scope• Legal disclaimer revised
23.06.2008	1.0.1	AUTOSAR Administration	Legal disclaimer revised
13.12.2007	1.0.0	AUTOSAR Administration	Initial Release

Disclaimer

This specification and the material contained in it, as released by AUTOSAR, is for the purpose of information only. AUTOSAR and the companies that have contributed to it shall not be liable for any use of the specification.

The material contained in this specification is protected by copyright and other types of Intellectual Property Rights. The commercial exploitation of the material contained in this specification requires a license to such Intellectual Property Rights.

This specification may be utilized or reproduced without any modification, in any form or by any means, for informational purposes only.

For any other purpose, no part of the specification may be utilized or reproduced, in any form or by any means, without permission in writing from the publisher.

The AUTOSAR specifications have been developed for automotive applications only. They have neither been developed, nor tested for non-automotive applications.

The word AUTOSAR and the AUTOSAR logo are registered trademarks.

Advice for users

AUTOSAR specifications may contain exemplary items (exemplary reference models, "use cases", and/or references to exemplary technical solutions, devices, processes or software).

Any such exemplary items are contained in the specifications for illustration purposes only, and they themselves are not part of the AUTOSAR Standard. Neither their presence in such specifications, nor any later documentation of AUTOSAR conformance of products actually implementing such exemplary items, imply that intellectual property rights covering such exemplary items are licensed under the same rules as applicable to the AUTOSAR Standard.

Table of Contents

List of Figures	5
List of Tables	6
1 References	7
2 Scope	8
3 How to read this document.....	9
3.1 Conventions used.....	9
3.2 Acronyms and Abbreviations.....	10
4 Requirements traceability	11
5 Modeling Rules.....	13
5.1 Reuse of model element.....	13
5.1.1 Reuse of one interface for multiple ports.....	13
5.1.2 Reuse of one data type for multiple interfaces	14
5.2 Use of multiple ComponentPrototypes	14
5.3 Clustering	15
5.4 Future extensibility	16
6 Naming Convention for AUTOSAR Model Elements.....	18
6.1 General Rules for Short Names	18
6.2 Relation between Model Level and the Implementation Level.....	19
6.2.1 Length Restrictions.....	19
6.2.2 Data Types.....	20
6.2.3 RTE rules of name mapping.....	20
6.2.4 Components and Ports.....	21
6.2.5 Sender Receiver Interfaces and Data Elements	23
6.2.6 Client Server Interfaces, Operations, and Arguments	24
6.3 Usage of Keywords	24
6.3.1 Keyword Composition Semantic Rules	25
6.4 Model Elements.....	29
6.4.1 ARPackage (AR-PACKAGE)	30
6.4.2 SenderReceiverInterface (SENDER-RECEIVER-INTERFACE)	32
6.4.3 VariableDataPrototype (VARIABLE-DATA-PROTOTYPE)	32
6.4.4 ApplicationDataType	34
6.4.5 CompuMethod (COMPU-METHOD)	35
6.4.6 SwComponentType (COMPOSITION-SW-COMPONENT-TYPE)	35
6.4.7 SwComponentPrototype (SW-COMPONENT-PROTOTYPE).....	37
6.4.8 PortPrototype (P-PORT-PROTOTYPE, R-PORT-PROTOTYPE)	38
6.4.9 Units (UNIT)	38
6.4.10 Physical Dimensions	39
6.4.11 Enumerations	39
6.4.12 ClientServerInterface (CLIENT-SERVER-INTERFACE)	41
6.4.13 ParameterInterface (PARAMETER-INTERFACE)	41
6.4.14 ParameterDataPrototype (PARAMETER-DATA-PROTOTYPE)	41
6.4.15 DataConstrs (DATA-CONSTRS).....	42
6.4.16 Blueprintable Elements in Application Interfaces Domain	42
6.4.17 PortPrototypeBlueprint (PORT-PROTOTYPE-BLUEPRINT)	43
6.4.18 Keywords	45

List of Figures

Figure 1: Re-use of PortInterfaces in Ports with variants.	14
Figure 2: Ports of multiple ComponentPrototypes.	15
Figure 3: Components and ports	21
Figure 4: SenderReceiverInterfaces and Data Elements	23
Figure 5: ClientServerInterfaces and Operations	24
Figure 6: AUTOSAR Package structure	31
Figure 7: Example of SwComponentType	37

List of Tables

Table 1 Example of keywords abbreviation of common usage	26
Table 2 Fields	27
Table 3 Category of ARPackages	31

1 References

[1] Template UML Profile and Modeling Guide
AUTOSAR_TemplateModelingGuide.pdf

[2] Specification of RTE Software
AUTOSAR_SWS_RTE.pdf

[3] Software Component Template
AUTOSAR_TPS_SoftwareComponentTemplate.pdf

[4] AUTOSAR Model Persistence Rules for XML
AUTOSAR_TR_XMLPersistenceRules.pdf

[5] MISRA-C: 2004. Guidelines for the use of the C language in critical systems.

[6] Autosar Methodology
AUTOSAR_TR_Methodology.pdf

[7] Generic Structure Template
AUTOSAR_TPS_GenericStructureTemplate.pdf

[8] Requirements on Runtime Environment
AUTOSAR_SRS_RTE.pdf

[9] Standardization Template
AUTOSAR_TPS_StandardizationTemplate.pdf

2 Scope

The limits of my language mean the limits of my world. Ludwig Wittgenstein

This document gives guidelines and conventions on using the AUTOSAR model elements in order to build AUTOSAR systems. It does **not** contain guidelines for the AUTOSAR meta model. This is already covered by [1].

3 How to read this document

All rules are identified by an ID.

The ID starts with "TR_SWMG_" for the Modeling Rules followed by four digits (TR_SWMG_xxxx).

The ID starts with "TR_SWNR_" for the Naming Rules followed by four digits (TR_SWNR_xxxx).

The provided XML examples conform to the AUTOSAR metamodel R4.0

3.1 Conventions used

In requirements, the following specific semantics are used (taken from Request for Comment RFC 2119 from the Internet Engineering Task Force IETF)

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119. Note that the requirement level of the document in which they are used modifies the force of these words.

- **MUST:** This word, or the terms "REQUIRED" or "SHALL", mean that the definition is an absolute requirement of the specification.
- **MUST NOT:** This phrase, or the phrase „SHALL NOT“, means that the definition is an absolute prohibition of the specification.
- **SHOULD:** This word, or the adjective "RECOMMENDED", mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
- **SHOULD NOT:** This phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
- **MAY:** This word, or the adjective „OPTIONAL“, means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation, which does not include a particular option, **MUST** be prepared to interoperate with another implementation, which does include the option, though perhaps with reduced functionality. In the same vein an implementation, which does include a particular option, **MUST** be prepared to interoperate with another implementation, which does not include the option (except, of course, for the feature the option provides.)

3.2 Acronyms and Abbreviations

- API: Application Programming Interface
- AR: AUTOSAR
- CAN: Controller Area Network
- ECU: Electronic Control Unit
- HMI: Human Machine Interface
- MISRA: Motor Industry Software Reliability Association
- RTE: Real Time Environment
- SW-C: Software Component
- WP: Work Package
- XML: eXtensible Markup Language

4 Requirements traceability

Document: AR_RS_SWC_System_Modeling

Requirement	Satisfied by
[RS_SWMG_0001] Distinguish Standardized vs. not standardized model elements of type ARElement	6.4.1 ARPackage:. Reserved to the model elements defined by the AUTOSAR partnership.
[RS_SWMG_0002] Name should reflect the purpose of the model element	6.1, 6.4.2, 6.2.6 covers this requirement only partially.
[RS_SWMG_0005] Easy creation of names	6.2.6
[MG006] Model Elements names shall be self-explanatory	6.1, 6.4.2 , 6.4.4, 6.4.6, 6.4.7, 6.4.8
[RS_SWMG_0007] Distinguish model elements of different model element suppliers of not standardized model elements	5
[RS_SWMG_0010] Model Element Names shall follow semantic rules	6.3.1
[RS_SWMG_0011] Model Element Names are composed by arranging standardized keywords	6.2.6
[RS_SWMG_0012] Semantic of Model Element Names shall allow variable number of keywords	6.3.1
[RS_SWMG_0014] Length restriction for short names of Identifiable	6.1,
[RS_SWMG_0016] Names shall allow to indicate if the value is a direct measurement or a conditioned value	6.2.6 covers this requirement only partially. Values for keywords are needed
[RS_SWMG_0017] Names should follow the ISO 8855 for English naming	6.1 covers this requirement only partially, standard is not mentioned.
[RS_SWMG_0030] Use English as Standard Language for Names	6.1
[RS_SWMG_0031] No Architectural Information in Names	6.4.6, 6.4.7
[RS_SWMG_0034] Usage of Unique Keywords	6.2.6 Keywords are used to compose names
[RS_SWMG_0039] Avoid usage of Trailing underscores	6.1
[RS_SWMG_0040] Avoid sequences of underscores characters	6.1
[RS_SWMG_0041] Do not rely on uppercase/lowercase difference only	6.1.
[RS_SWMG_0048] Easy lookup of names in databases	6.3.1
[RS_SWMG_0049] Support Identifiable already present in the MasterTable	6.4
[RS_SWMG_0054] Provide guidelines how to resolve name conflicts	Whole document.
[RS_SWMG_0052] Definition of Package Structure	6.4.1
[RS_SWMG_0053] Model shall be compliant to the Meta Model	5
[RS_SWMG_0055] Continuous Data Type resolution should be a power of two	5
[RS_SWMG_0056] Standardized model elements shall not contain non standardized elements	4, 6.4.1
[RS_SWMG_0057] Modeling Guide shall support the AUTOSAR methodology	Whole document.
[RS_SWMG_0059] Provide Single Set of Keywords	The standardized keyword list is included in the released Application Interfaces XML file.

[RS_SWMG_0060] Applicability of Naming Convention	6
RS_SWMG_0061] Naming convention shall be unique	6

5 Modeling Rules

[TR_SWMG_0001] Model shall be compliant to the Meta Model.

[TR_SWMG_0003] Use AR Package concept for SW-C to distinguish different suppliers of SW-C. This helps to trace SW-C supplier in case of errors due to the usage of elements not part of the released AUTOSAR Packages (e.g. the set of data that is in AUTOSAR Release 4.0).

[TR_SWMG_0017] Use AR Package *category* to distinguish what is standardized, according to the provider of the ARPackage, from what is not.

See document [7] for AR Package categories classification.

[TR_SWMG_0004] Each element not defined by the AUTOSAR partnership, shall be included in a AR Package different from the one officially released by AUTOSAR, i.e. the AR Package ShortName shall be changed (e.g. SUPPLIER1) and the category may be changed or not according to AR packages category classification and stakeholder specific standard elements handling.

Recommendations:

- continuous Data Type resolution should be a power of two.

5.1 Reuse of model element

5.1.1 Reuse of one interface for multiple ports

The reuse of interfaces is encouraged.

Example:

The *Temperature* interface is used for the *InsideTemperature* port and *OutsideTemperature* port of a component type.

[TR_SWMG_0011] Do not define different interfaces to implement variants. Define one interface that is independent on the variant and define several ports using this interface which are dependent on the variant.

Using one interface for multiple ports makes variant handling more understandable since the interfaces are not affected by the variant. Ports can be enabled or disabled depending on the selected variant.

Example:

Gasoline spark ignition engine management systems know the concept of a slow path and a fast path for torque intervention. Current diesel systems do not know this distinction.

The following modeling is **not** recommended:

- Define an interface *TorqueInterventionSlow* and an interface *TorqueInterventionFast*.

- Define a port TorqueInterventionSlow with the interface TorqueInterventionSlow and a port TorqueInterventionFast with the interface TorqueInterventionFast.
- In a diesel variant the TorqueInterventionSlow port and interface are ignored.

The following modeling is recommended:

- Define an interface TorqueIntervention1.
- Define a port TorqueInterventionSlow and a port TorqueInterventionFast which both have the interface TorqueIntervention1.
- In a diesel variant the TorqueInterventionSlow port is disabled.

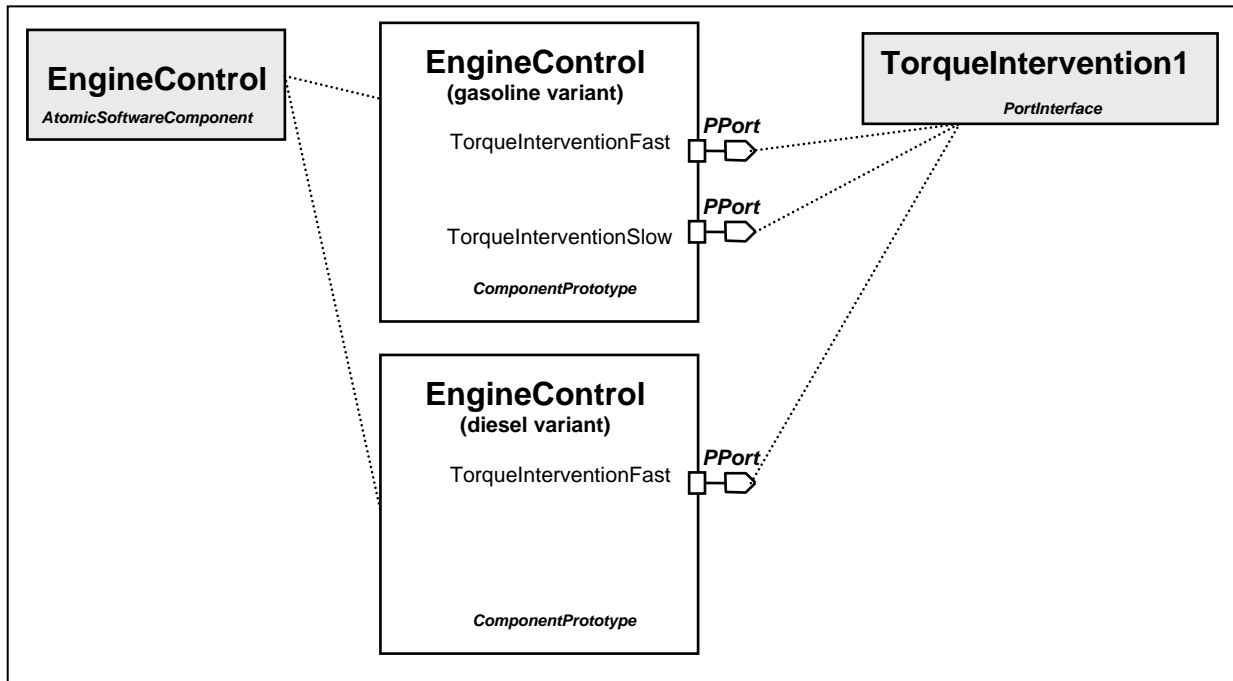


Figure 1: Re-use of PortInterfaces in Ports with variants.

Please note that in the example, as result of variant handling approach, the two ComponentPrototypes are of the same ComponentType.

5.1.2 Reuse of one data type for multiple interfaces

The reuse of data types is encouraged.

Example:

The *Torque* data type is used in the Data Elements of the interfaces *MinimumTorqueAtClutch* and *MaximumTorqueAtClutch*.

5.2 Use of multiple ComponentPrototypes

If the same port P (either RPort or PPort) of multiple ComponentPrototypes A_{1..n} of the same ComponentType is connected to another ComponentPrototype B, the name of the ports should be constructed by concatenating the name of the connected ComponentPrototype A_i and the name of the connected port P.

It is recommended to do the concatenation by means of a preposition (see chapter 6) in the following order:

<Port name>+<Preposition>+[<ComponentPrototype name>]

Example: The “Washer” ComponentType has an RPort “Activation”. There are three ComponentPrototypes of this type: “WasherFront”, “WasherRear”, and “WasherHeadlamp”. The WiperWasherManager ComponentType should have separate PPorts that are connected to the RPorts of the three ComponentPrototypes. These PPorts should have the names “ActivationOfWasherFront”, “ActivationOfWasherRear”, and “ActivationOfWasherHeadlamp”.

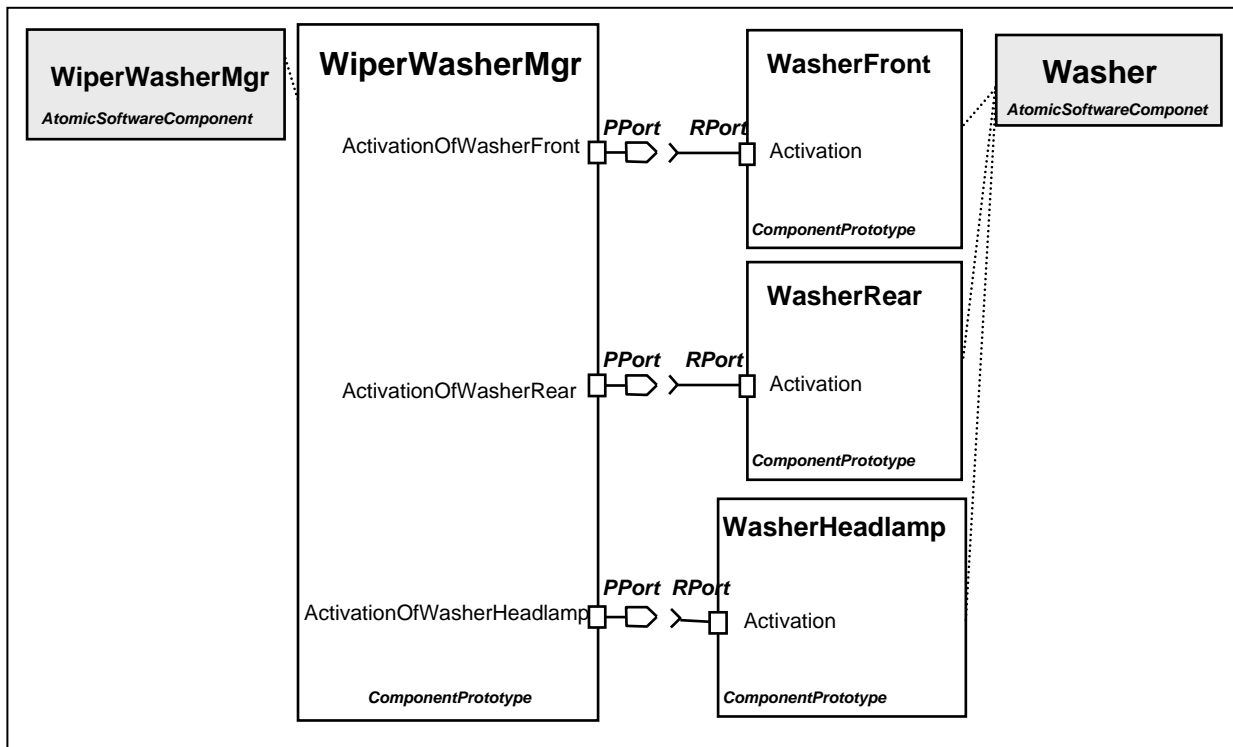


Figure 2: Ports of multiple ComponentPrototypes.

5.3 Clustering

[TR_SWMG_0008] Functional elements that belong together shall also be represented in the model together. The AUTOSAR meta model provides several features to support clustering of model elements. For example, interfaces can contain multiple data elements, record data types and array data types can contain multiple elements. The use of structuring features improves the structure and comprehensibility of the model.

If elements are clustered there is a choice between using three alternatives that have different behaviors and usually fit to different application scenarios:

- A) record data types,
 - elements of a record are transmitted atomically (in one block).
 - elements of record data types can have different data types.

B) array data types

- elements of arrays are transmitted atomically (in one block),
- all elements of an array have to use the same data type.

C) interfaces with multiple data elements.

- The data elements of interfaces are transmitted separately.
- Data elements of interfaces can have different data types.

Examples for usage of these three alternatives are:

- To A): use a record data type that includes the
 - status and its value that belong together, e.g. for an actuator
 - wheel dependent information that belong together,
 - axle dependant information that belong together,
 - value(s) and their derivation(s).
- To B): use an array data type
 - sending of dynamic configuration data, e.g. engine full-load curve, or retarder brake torque curve which may change when vehicle is driven, depending on temperature or altitude. This use case is common in commercial vehicles J1939 bus protocol on CAN.
- To C): data that belongs together with independent update times:
 - default for most signals, allows the system configurator most flexibility in scheduling communication.

The advantage to use a record instead of an array data type is that a separate name for each element is used.

5.4 Future extensibility

It is often necessary to adapt and extend model elements to cope with new requirements.

Defining or standardizing elements named “Reserved” (or with other names indicating a project dependent solution) with undefined meaning as placeholders for future extensions would lead to non standardized elements when customization is performed at a project level.

[TR_SWMG_0009] Placeholder model elements with undefined meaning are not allowed.

The following rules ensure forward compatibility of relevant model elements towards new AUTOSAR releases.

[TR_SWMG_0010] If a new application requires the modification of any attribute (Enumeration Values, Enumeration Value Names) of a standardized enumeration data type, the existing data type shall not be changed, but a new enumeration data type shall be created. The name of the new data type shall differ from the name of the original data type only in the sequence number.

[TR_SWMG_0012] If a new application requires the modification of any attribute (Resolution, Physical Limits, Offset, Unit) of a standardized continuous data type, the existing data type shall not be changed, but a new continuous data type shall be created. The name of the new data type shall differ from the name of the original data type only in the sequence number.

[TR_SWMG_0013] If a new application requires the modification of any attribute (number of elements, type of elements) of a standardized array data type, the existing data type shall not be changed, but a new array data type shall be created. The name of the new data type shall differ from the name of the original data type only in the sequence number.

[TR_SWMG_0014] If a new application requires the modification of any attribute (Number of Elements, Elements Name, Elements Type) of a standardized record data type, the existing data type shall not be changed, but a new record data type shall be created. The name of the new data type shall differ from the name of the original data type only in the sequence number.

[TR_SWMG_0015] If a new application requires the modification of any attribute (number of data elements, name of the data elements, type of the data elements) of a standardized sender-receiver interface, the existing interface shall not be changed, but a new sender-receiver interface shall be created. The name of the new interface shall differ from the name of the original interface only in the sequence number.

[TR_SWMG_0016] If a new application requires the modification of any attribute (operation name, number of arguments, argument names, argument data types, argument in/out property) of a standardized client-server interface, the existing interface shall not be changed, but a new interface shall be created. The name of the new interface shall differ from the name of the original interface only in the sequence number.

[TR_SWMG_0019] If a new application requires the modification of the name (shortname) of a standardized PortPrototypeBlueprint, or any change in the referenced elements (port interfaces, application data types, unit) the existing PortPrototypeBlueprint shall not be changed, but a new PortPrototypeBlueprint shall be created. The name (shortname) of the new PortPrototypeBlueprint shall differ from the name of the original PortPrototypeBlueprint only in the sequence number. Changes in the descriptive elements of the PortPrototypeBlueprint (description, longname, introduction) not necessary lead to a new version of the PortPrototypeBlueprint except when the meaning of the original element is modified.

6 Naming Convention for AUTOSAR Model Elements

This section contains naming conventions for AUTOSAR model elements. This naming convention is applicable in any vehicle application domain of AUTOSAR.

[TR_SWNR_0059] The naming convention applies to the following Model Elements:

- SwComponentTypes
- SwComponentPrototypes
- ApplicationDataTypes
- Units
- PhysicalDimensions
- PortInterfaces
- PortPrototypeBlueprints
- PortPrototypes
- DataPrototypes
- CompuMethods
- DataConstrs
- Keywords

The XML code which is shown in the document is compliant to the AUTOSAR xsd of Release 4.0.

6.1 General Rules for Short Names

In this chapter and in the rest of the document from now on, the term “name” refers to “short name” only. Long Names are out of scope.

[TR_SWNR_0001] The language for the names shall be English.

A model element name shows up as a SHORT-NAME in XML in, for example:

```
<SHORT-NAME>MyName</SHORT-NAME>
```

According to the rules for AUTOSAR XML files the short name has the type AR:IDENTIFIER (see document [4]) and is restricted by the following regular expression: $[a-zA-Z][a-zA-Z0-9_]\{0,127\}$

[TR_SWNR_0002] A short name shall be between 1 and 128 characters long, shall begin with an alphabet, and shall consists of alphabets and numbers.

[TR_SWNR_0003] As additional requirement to the MetaModel, underscores are not allowed in the short names.

Rules TR_SWNR_0002 and TR_SWNR_0003 lead to the following regular expression for short names:

```
 $[a-zA-Z][a-zA-Z0-9]\{0,127\}$ 
```

[TR_SWNR_0004] Names shall not differ in capitalization only.

Do not distinguish names only from uppercase/lowercase format since the user can easily mix up names that differ only for capitalization. The following example lists not allowed name differentiation:

Short name 1: DoorLocked

Short name 2: doorLocked

[TR_SWNR_0005] A name must be usable as valid identifier in source code for C, C++ and C-preprocessor.

The rationale behind this rule is, that some of the names are used by code generators, especially the RTE generator, to produce source code symbols. Since it would be difficult to state for each individual name if and in which context it will ever be used by generators, this general restriction is made.

[TR_SWNR_0006] The names of elements shall document their meaning or use.

[TR_SWNR_0007] No prefixes related to the kind of the element shall be used in the name of the model elements covered by this Naming Convention, listed in TR_SWNR_0059.

Reasons for not using prefixes:

- Shorter names, e.g. if it shows up in the RTE API in names as RTE_...
- If we had any prefix for e.g. interfaces, prefixes would have to be defined for all elements (ports, SWCs, data types,...).
- Prefixes can be introduced by code generators for the identifiers of programming language APIs.
- The information, whether some element is a Component, DataType, Interface, etc., is already contained in the structure of the XML file.

6.2 Relation between Model Level and the Implementation Level

This section describes the relation between the model level of AUTOSAR and the implementation level. A “model” in this chapter means an AUTOSAR model, i.e., an instance of the AUTOSAR meta model. “Implementation” means the realization of the model in a programming language, like C. For a more detailed explanation please refers to AUTOSAR Methodology document [6].

6.2.1 Length Restrictions

The RTE Specification [2] contains rules on how to map model-level names to generated names on implementation-level.

For example, an implementation-level name for a sender/receiver implicit write is created as follows:

```
Rte_IWrite_<runnable-entity-name>_<port-name>_<data-element-name>
```

This name is visible to the linker as an external identifier. MISRA [5] rule 1.4 requires that the significant part of such a name shall not exceed 31 chars. Since AUTOSAR

decided to allow a deviation from this rule, the size of the generated name can exceed 31. Taking into account that each single name from the model cannot exceed 128 characters, the name given above could have as much as $10 + 1 + 128 + 1 + 128 + 1 + 128 = 397$ characters.

6.2.2 Data Types

[TR_SWNR_0008] Data type names in an AUTOSAR model shall conform to C/C++ names for typedefs (e.g. they shall not be C keywords).

6.2.3 RTE rules of name mapping

The following RTE requirements describe the mapping from modeling level to implementation level:

- rte_sws_1153
- rte_sws_3837

Such rte_sws rules define the sequence in which model element ShortNames are concatenated to obtain generated function names in the RTE C Code.

Example: ¹

- ShortName of component type: **Wshr**
- ShortName of the component prototype: **WshrFrnt**
- ShortName of runnable entity: **Monr**
- ShortName of provide port: **OutdT**
- ShortName of sender-receiver interface of this port: **T1**
- ShortName the data element: **Val**

Examples of generated function names for rule rte_sws_3837:

Rte_IRead_Monr_OutdT_Val
Rte_IRead_Wshr_Monr_OutdT_Val

¹ The keywords and keyword abbreviations used in this example may not be consistent to the keyword list.

6.2.4 Components and Ports

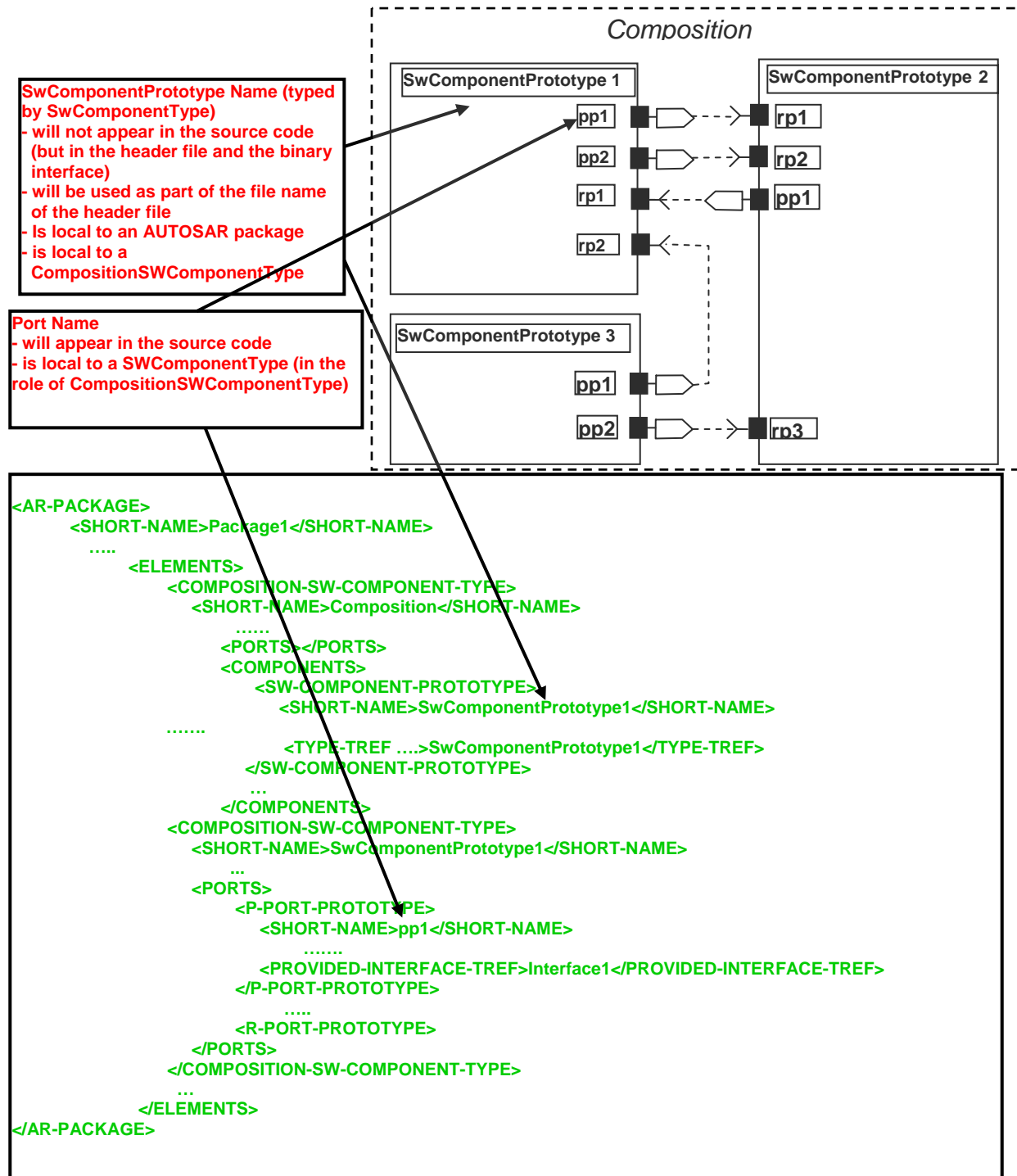


Figure 3: Components and ports

The abstract *SwComponentType* cannot be instantiated, there can only be either a *CompositionSwComponentType*, a *ParameterSwComponentType* or a specialized inherited class of the *AtomicSwComponentType* class. See [3] for more details. Such *AtomicSwComponentTypes* encapsulate the implementation of their functionality and behavior and merely expose well-defined connection points, called *PortPrototypes*, to the outside world.

CompositionSwComponentType, which are SwComponentTypes as well, may be aggregated in further CompositionSwComponentTypes, and their purpose is to allow existing software components aggregation.

In a CompositionSwComponentType the SwComponentTypes are occurring in specific roles which are called *SwComponentPrototypes*.

The figure above shows the scope of Components and Ports names.

SwComponentTypes names are local to an AR-Package therefore within an AR-Package there must not be two SwComponentTypes having the same name, i.e, the short-names shall be unique. This is explicitly required by RTE implementation since RTE generator rejects those configurations where multiple SwComponentTypes have the same short name (see [rte_sws_7190] in [2] for more details)

The same applies for:

- SwComponentPrototypes within a CompositionSwComponentType
- PortPrototypes within a SwComponentType.

See document [3] for detailed information on name space provided by Software Components.

Port names will appear in the RTE APIs, see RTE specifications [2].

The figure also shows that names of connected ports can be different (example: pp2 from Component3 connected to rp3 of Component2).

6.2.5 Sender Receiver Interfaces and Data Elements

Interface Name

- will NOT appear in the source code
- Is local to an AUTOSAR package

Data Element Name

- will appear in the source code
- is local to an interface

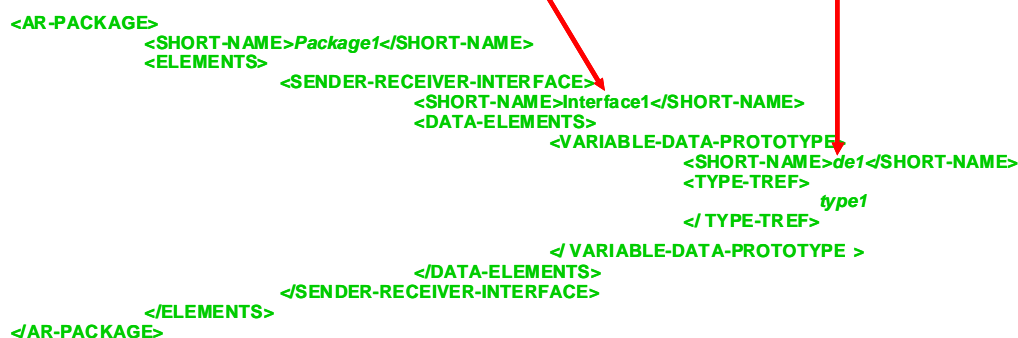


Figure 4: SenderReceiverInterfaces and Data Elements

The figure above shows the scope of SenderReceiverInterfaces and Data Elements names.

Interface names are local to an AR-Package therefore within an AR-Package there must not be two Interfaces having the same name, i.e, the short-names shall be unique.

The same applies for Data Elements i.e. within an Interface, Data Element names shall be unique.

See document [3] for detailed information on name space provided by Sender Receiver Interfaces.

Data Element names will appear in the RTE APIs, see RTE specifications [2].

6.2.6 Client Server Interfaces, Operations, and Arguments

Interface Name

- Will NOT appear in the source code
- is local to an AUTOSAR Package

```

<CLIENT-SERVER-INTERFACE>
  <SHORT-NAME NAME-PATTERN="{anyName}">TrsmRatGear1</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">Transmission: Gear ratio for a given gear</L-4></LONG-NAME>
  <DESC><L-2 L="EN">Returns the gear ratio for a given gear</L-2></DESC>
  <INTRODUCTION>

```

Operation Name

- Will appear in the source code
- is local to an interface

```

</INTRODUCTION>
<IS-SERVICE>false</IS-SERVICE>
<OPERATIONS>
  <CLIENT-SERVER-OPERATION>
    <SHORT-NAME>GetTrsmRatGear</SHORT-NAME>

```

Argument Name

- Will appear in the source code
- is local to an operation

```

  <ARGUMENTS>
    <ARGUMENT-DATA-PROTOTYPE>
      <SHORT-NAME>Gear</SHORT-NAME>
      <TYPE-TREF DEST="APPLICATION-PRIMITIVE-DATA-TYPE"
        BASE="ApplicationDataTypes">Nr4</TYPE-TREF>
      <DIRECTION>IN</DIRECTION>
    </ARGUMENT-DATA-PROTOTYPE>
    <ARGUMENT-DATA-PROTOTYPE>
      <SHORT-NAME>Rat</SHORT-NAME>
      <LONG-NAME><L-4 L="EN">Gear ratio of given gear</L-4></LONG-NAME>
      <DESC><L-2 L="EN">Gear ratio of given gear</L-2></DESC>
      <TYPE-TREF DEST="APPLICATION-PRIMITIVE-DATA-TYPE"
        BASE="ApplicationDataTypes">Fac1</TYPE-TREF>
      <DIRECTION>OUT</DIRECTION>
    </ARGUMENT-DATA-PROTOTYPE>
  </ARGUMENTS>
</CLIENT-SERVER-OPERATION>
</OPERATIONS>
</CLIENT-SERVER-INTERFACE>

```

Figure 5: ClientServerInterfaces and Operations

The figure above shows the scope of ClientServerInterfaces, Operations, and Argument names.

Interface names are local to an AR-Package therefore within an AR-Package there must not be two Interfaces having the same name, i.e, the short-names shall be unique.

The same applies for:

- Operations within a ClientServerInterface.
- Arguments within an Operation.

See document [3] for detailed information on name space provided by Client Server Interfaces.

Data Element names will appear in the RTE APIs, see RTE specifications [2].

6.3 Usage of Keywords

Depending on its role in the component design, short names for component types, ports, port interfaces or data elements can make use of the predefined keywords and their abbreviations, which are described in more detail in 6.3.1. The advantage is, that this results in relatively short names with established meaning.

6.3.1 Keyword Composition Semantic Rules

According to [9] each keyword is described by the following attributes:

- **shortName:** represent the unique name of the keyword, it's **not** involved in name construction
- **longName:** represent the long form of the keyword
- **desc:** represent the definition of the keyword
- **introduction:** verbal description of the use case (*not used at the moment*)
- **abbrName:** specifies the abbreviated name of the keyword and **it's used to build shortNames**
- **classification:** describe the semantic field of the keyword (Mean-Environment-Device, Action-PhysicalType, Condition-Qualifier, Index, Preposition)

If not differently specified in the rest of the document the term **keyword** will refer to the *longName* of the keyword, while the abbreviated name could be referred as "abbrName attribute" or "keyword abbreviation" as well.

Example:

Definition of keyword describing the driver of a vehicle

longName : Driver

abbrName: Drvr

Usecases (shortName of ports using abbrName attribute): DrvrProf, DrvrDoorLockSt [TR_SWNR_0009] No underscores shall be used to separate keyword abbreviations (abbrName attribute) in short names, because the RTE uses them to separate port names from Data Element names. Instead of underscores **capital letters** shall be used to separate the keyword abbreviations.

[TR_SWNR_0010] Short names are composed by concatenating predefined keyword abbreviations (abbrName attribute).

[TR_SWNR_0011] Each keyword shall start with an uppercase letter, or a number, followed by lowercase letters.

[TR_SWNR_0013] A keyword shall be a single English word or a multiplier prefix, such as "kilo", "giga" or "milli". To shorten the names within maximum allowed numbers of characters keyword abbreviations (abbrName attribute) are provided.

[TR_SWNR_0018] A keyword abbreviation (abbrName attribute) shall not be a valid single English word unless the meanings of the keyword and the English word are the same. This avoids potential misunderstanding while reading short names.

The following example is not a valid short name, because non-abbreviated keywords are used: EngineSpd. The correct short name would be: EngSpd.

[TR_SWNR_0016] Keywords (specified longName attribute) and keyword abbreviations (specified abbrName attribute) must be unique. Two different keywords shall not be abbreviated in the same way. Two different abbreviations cannot belong to the same keyword even if the keyword can have multiple meaning.

Examples:

Charge Ch

Channel Ch

Duplicated abbreviation. One of the keyword abbrName shall be changed.

Current Curnt (here intended as adjective)

Current Curr (here intended as noun)

Duplicated keyword. Merge into one by indicating in the definition what multiple meanings it can have.

[TR_SWNR_0017] Some terms of common usage in the automotive environment cannot be expressed by a single English word. In such a case the abbreviation (abbrName) and the keyword (longName) shall be identical.

Examples:

Keyword	Keyword Abbreviation	DefinitionEnglish
Engine	Eng	Engine
Abs	Abs	Antilock Braking System

Table 1 Example of keywords abbreviation of common usage

[TR_SWNR_0058] In order to build readable and understandable names, keywords shall be arranged according to semantic rules. Such rules define **Semantic Fields** that must be used in a defined sequence:

Sequence	Semantic Field Name	Description	Rules and Examples
1	<u>Mean-Environment-Device</u>	Physical mean, environment. Define the element subject of Action-PhysicalType .	It shall be a noun. It can be also a compound definition. Abbreviation or acronym cannot end with a digit. Examples for Mean: Fuel Examples for Environment: Air, Ambient Examples for Device: Accelerator, AcceleratorPedal, Engine
2	Action-PhysicalType	Action or physical type conditioning or modifying the Mean-Environment-Device .	The Action shall be a verb. The Physical Type shall be a noun. It can be also a compound. Abbreviation or acronym cannot end with a digit. Examples for Action: Move, Pull, Release, Lock, OpenClose, ShiftUp Examples for Physical Type: Temperature, Speed
3	Condition-Qualifier	Qualifies the Mean-Environment-Device or Action-PhysicalType in terms of data flow, event issuing or expresses a particular condition of the signal in terms of numeric treatment, time validity, precision quality, location.	It shall be a noun or an adjective. It can be also a compound definition. Abbreviation or acronym cannot end with a digit. Examples for Condition: Absolute, Old, New, AbsoluteEstimated, Examples for Qualifier: Request, Command, Status
4	<u>Index</u>	Identifies the signal as part of a logically structured information. Can be used to identify elements multiply instanced (index) or section of information.	It shall be a number, a single character, or an adjective describing the part. When used, it is always the last keyword in the sequence: Examples for Index: BrakeSwitch1
5	<u>Preposition</u>	Used for joining/separating complex naming patterns made by several semantic fields	Example: EngSpd And Posn CoolgReq From Steer TqAct At Clu

Table 2 Fields

All the predefined keywords and their corresponding keyword abbreviations are classified according to the semantic fields. This is specified using the *classification* attribute.

Each keyword can be classified as belonging to more than one semantic field, this is needed to support TR_SWNR_0016.

Semantic fields are concatenated according to the **Sequence** column numbering:

Mean-Environment-Device**Action-PhysicalType****Condition-Qualifier****Index** - this sequence is called **FieldBlock**.

[TR_SWNR_0019] None of the semantic fields are mandatory and semantic fields can be repeated, i.e. names can be built by using an arbitrary number of semantic fields.

[TR_SWNR_0020] Only keywords classified as **Index** shall start with a number. When used, **Index** field is always the last in the field block.

The following examples are valid short names²:

GearAct
MirrMoveCmd
EngSpd
EngSpdMax

Recommendation: if a semantic field contains more than one keyword they either have to be arranged in a natural English order or the most important keyword has to come first.

Example:

BrakePedalStatus

PedalBrake is not recommended, since “brake pedal” is a very well-known English term.

Other examples of compound definitions where not all semantic fields are present:

BrkPedlSwt1
VehBodyAVertBasMeasd
OpenClsReq
AcvDampSts

To increase readability of names, a list of predefined Prepositions is provided within the standardized keyword list.

[TR_SWNR_0034] An arbitrary number of field blocks can be concatenated. However, the number of field blocks should be limited. It is encouraged to separate each field block by adding an appropriate preposition. This leads to the following naming pattern:

Mean-Environment-DeviceAction-PhysicalTypeCondition-
QualifierIndexPrepositionMean-Environment-DeviceAction-
PhysicalTypeCondition-QualifierIndexPreposition ...

Portion of names separated by prepositions are called FieldBlocks:

FieldBlock1Preposition1FieldBlock2Preposition2...FieldBlockN.

The following example shows the usage of prepositions:

EngSpdAtGearTar

² The keywords and keyword abbreviations used in the examples of this chapter may not be consistent to the keyword list

[TR_SWNR_0053] Each FieldBlock shall have a meaning independent of the other FieldBlocks.

Example:

The interface with the description “*Generic interface for total powertrain torque at wheels*” can not be represented by “PtTqAtWhlsTot”. The FieldBlock “WhlsTot” has not the intended meaning, because “Tot” relates to “Tq”. Therefore, one of the possible compliant solutions for the name is “PtTqTotAtWhls”.

[TR_SWNR_0050] If one or more prepositions are used to build a short name the most essential / important element has to be in the FieldBlock1. FieldBlocks that are following are refining the before mentioned FieldBlock.

TR_SWNR_0050 ensures that the names start with most essential information and end with very special details.

Example:

The following interface description: “*Driver request torque limitation if accelerator and brake pedal pressed at the same time and implausibilities have occurred.*” would result in the following name: **DrvrTqLimnReqForBrkAccrPedlImpy1**. The whole interface describes a driver torque limitation request. Therefore, DrvrTqLimnReq is the most important FieldBlock. Hence it is the first FieldBlock.

The following examples show incorrect names:

Naming a PortPrototype: **MaximumEngineSpeed** causes a keyword sequence error: **Condition-Qualifier** keyword cannot precede **Mean-Environment-Device** keyword. The correct sequencing is: **EngineSpeedMaximum**.

6.4 Model Elements

The naming conventions apply to the *ShortName* (*SHORT-NAME*) attribute of the element. The element must be a specialization of *Identifiable*. The elements are referred to by their meta-model name. The names in brackets are the XML element names.

To come to a reasonable naming conventions, for each element the objectives of the convention are described first.

6.4.1 ARPackage (AR-PACKAGE)

An ARPackage creates a name space³. In one system package names have to be unique. Packages can have sub-packages.

The following rules are defined for the standardized package structure:

- ◆ [TR_SWNR_0022] According to [7], chapter 3, below the root an ARPackage with LongName AUTOSAR and ShortName AUTOSAR shall be placed. Everything inside the top-level package AUTOSAR is released by the AUTOSAR partnership (see requirement [RS_SWMG_0001], [RS_SWMG_0056]). The top-level package LongName and ShortName AUTOSAR is reserved by the AUTOSAR partnership and shall not be used elsewhere.
- ◆ [TR_SWNR_0023] Within this ARPackage, “AUTOSAR” packages called (ShortNames) AISpecification, KeywordSets, DataConstrs, PhysicalDimensions, Units, ApplicationDataTypes_Blueprint, CompuMethods_Blueprint, PortInterfaces_Blueprint, PortPrototypeBlueprints_Blueprint, ApplicationDataTypes_Example, BlueprintMappingSets_Example, CompuMethods_Example, PortInterfaces_Example, SwComponentTypes_Example shall be placed.

These rules define the standardized package structure for the defined elements of the M2 [1] modeling level. According to requirement [RS_SWMG_0056] the AUTOSAR package is a reserved name space.

[TR_SWMG_0018] Only elements which are defined by the AUTOSAR partnership shall be added to this name space. These elements shall not be modified (see [7])

³ For a description of the name space concept see [4].

The following figure shows an example for the resulting standardized package structure.

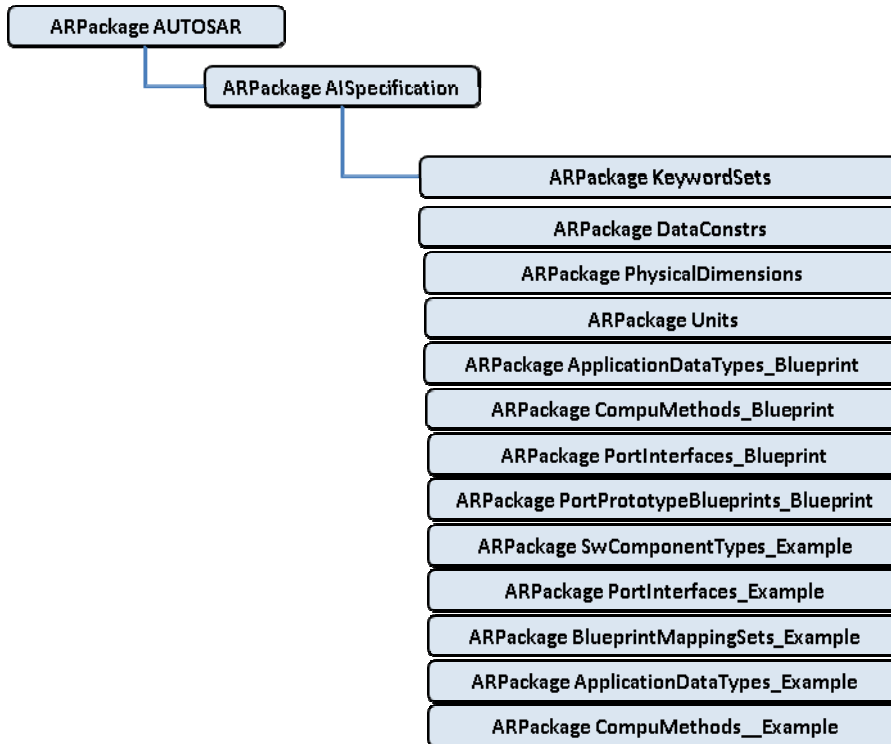


Figure 6: AUTOSAR Package structure

As recommendation, names of non standardized AUTOSAR packages should follow the general rules defined in chapter 6.3.1.

ARPackage AUTOSAR does not have a *category*, while its sub-packages do. In R4.0, categories of the sub-packages are set as follows:

ARPackage	Category
KeywordSets	STANDARD
DataConstrs	STANDARD
PhysicalDimensions	STANDARD
Units	STANDARD
ApplicationDataTypes_Blueprint	BLUEPRINT
CompuMethods_Blueprint	BLUEPRINT
PortInterfaces_Blueprint	BLUEPRINT
PortPrototypeBlueprints_Blueprint	BLUEPRINT
ApplicationDataTypes_Example	EXAMPLE
BlueprintMappingSets_Example	EXAMPLE
CompuMethods_Example	EXAMPLE
PortInterfaces_Example	EXAMPLE
SwComponentTypes_Example	EXAMPLE

Table 3 Category of ARPackages

6.4.2 SenderReceiverInterface (SENDER-RECEIVER-INTERFACE)

[TR_SWNR_0051] The interface name shall end with a sequence number to take into account the future evolution of interfaces.

The rule TR_SWNR_0051 for interfaces is similar to TR_SWNR_0044 for data types.

Example:

```
<SENDER-RECEIVER-INTERFACE>
  <SHORT-NAME NAME-PATTERN="{anyName}">BattU1</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">Battery Voltage</L-4></LONG-NAME>
  <DESC><L-2 L="EN">This interface provides the actual voltage level as measured at the
    battery.</L-2></DESC>
  <IS-SERVICE>false</IS-SERVICE>
  <DATA-ELEMENTS>
    <VARIABLE-DATA-PROTOTYPE>
      <SHORT-NAME>BattU</SHORT-NAME>
      <TYPE-TREF DEST="APPLICATION-PRIMITIVE-DATA-TYPE"
        BASE="ApplicationDataTypes">U1</TYPE-TREF>
    </VARIABLE-DATA-PROTOTYPE>
  </DATA-ELEMENTS>
</SENDER-RECEIVER-INTERFACE>
```

Recommendations:

A SenderReceiverInterface should be a reusable element. The name should be independent of its concrete usage by components and ports and should only reflect its general purpose.

To allow reuse, the communication path (the indication of source or destination of ports using the interface) should not be encoded in the interface name.

The following short names are bad examples for interface names:

YawRateStdByEsc

YawRateStdBySecCtrlrYawRate

The interface name in this example shall be “YawRate1” and reused by two ports whose names could be “YawRateStdByEsc” and “YawRateStdBySecCtrlrYawRate”.

6.4.3 VariableDataPrototype (VARIABLE-DATA-PROTOTYPE)

Objectives:

- Should only be significant relative to the SenderReceiverInterface.
- Shall be a unique name per SenderReceiverInterface.

Rules:

- [TR_SWNR_0026] The name shall reflect the content of the data. If no sensible name for the data element can be found and the interface is used to indicate a data transfer, it is recommended to use the name `Val` (abbreviation of `Value`).

Example:

```
<VARIABLE-DATA-PROTOTYPE>
  <SHORT-NAME>Val</SHORT-NAME>
  <TYPE-TREF DEST="APPLICATION-PRIMITIVE-DATA-TYPE"
    BASE="ApplicationDataTypes">T1</TYPE-TREF>
</VARIABLE-DATA-PROTOTYPE>
```

- [TR_SWNR_0027] If the data element prototype contains no value information, but an operation, the name shall reflect the operation that is driven by the data element prototype.

Example: `Cls` (abbreviation of `Close`).

If no sensible name for the data element prototype can be found and the interface is used to indicate an operation, the name `Oper` (abbreviation of `Operation`) should be used.

- [TR_SWNR_0029] If the `SenderReceiverInterface` contains more than one data element prototype denoting the same operation, a “Mean-Environment-Device” keyword must be used to differentiate the operations. (Here “operation” is not used in the sense of `ClientServerInterface` operations, but as an operation or action which is triggered by a `SenderReceiver` communication. “Operation” is also not identical to the semantic field “Action”.)

Example:

<code>UserTransmit</code>	<code>UsrTx</code>
<code>TelegramTransmit</code>	<code>TelgrmTx</code>
<code>ExteriorLightDisplay</code>	<code>ExtrLiDisp</code>
<code>ParkingLightDisplay</code>	<code>PrkgLiDisp</code>

Remark: In the last two examples all keywords are classified as “Mean-Environment-Device” so they can be arranged in any order

Recommendations:

- Repeating the name of the enclosing interface in the name of the data element is allowed, but not recommended. Repetition of the name would result in redundant information and would reflect negatively in RTE generated function names (see chapter 6.2.3 for an example of distribution of information between interface name and data element name).

6.4.4 ApplicationDataType

The following classes are subclasses of the class ApplicationDataType in the AUTOSAR meta model. Therefore, the naming convention applies also to these classes:

ApplicationPrimitiveDataType (APPLICATION-PRIMITIVE-DATA-TYPE)
ApplicationRecordDataType (APPLICATION-RECORD-DATA-TYPE)
ApplicationArrayDataType (APPLICATION-ARRAY-DATA-TYPE)

Rules:

- [TR_SWNR_0056] The name shall reflect the meaning of the type.
- [TR_SWNR_0057] No prefixes, such as “t_” shall be used in the type name.
- [TR_SWNR_0055] No numbers shall be used in an ApplicationArrayDataType name to specify its length.
- [TR_SWNR_0044] The data type name shall end with a sequence number to take into account the future evolution. This rule shall also be applied to distinguish data types, which represent the same physical entity, but with different ranges or resolution i.e. names of such data types shall differ only for the sequence number.

Example:

Temperature1	T1
Temperature2	T2
Temperature3	T3

The rules TR_SWNR_0044 ensures the reusability of the data types.

- [TR_SWNR_0048] To allow reuse, the communication path shall not be encoded in the data type name.

Example XML:

```
<APPLICATION-PRIMITIVE-DATA-TYPE>
  <SHORT-NAME NAME-PATTERN="{anyName}">U1</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">Voltage 1</L-4></LONG-NAME>
  <DESC><L-2 L="EN">Generic data type for voltage</L-2></DESC>
  <CATEGORY>VALUE</CATEGORY>
  <SW-DATA-DEF-PROPS>
    <SW-DATA-DEF-PROPS-VARIANTS>
      <SW-DATA-DEF-PROPS-CONDITIONAL>
        <SW-CALIBRATION-ACCESS>READ-ONLY</SW-CALIBRATION-ACCESS>
        <COMPU-METHOD-REF DEST="COMPU-METHOD" BASE="CompuMethods">U1</COMPU-METHOD-REF>
        <DATA-CONSTR-REF DEST="DATA-CONSTR" BASE="DataConstrs">U1</DATA-CONSTR-REF>
        <SW-INTENDED-RESOLUTION>0.1</SW-INTENDED-RESOLUTION>
        <UNIT-REF DEST="UNIT" BASE="Units">Volt</UNIT-REF>
      </SW-DATA-DEF-PROPS-CONDITIONAL>
    </SW-DATA-DEF-PROPS-VARIANTS>
  </SW-DATA-DEF-PROPS>
</APPLICATION-PRIMITIVE-DATA-TYPE>
```

6.4.5 CompuMethod (COMPU-METHOD)

COMPU-METHOD shortnames elements fulfill naming convention rules.

Example:

```
<COMPU-METHOD>
  <SHORT-NAME NAME-PATTERN="{anyName}">U1</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">Voltage 1</L-4></LONG-NAME>
  <DESC><L-2 L="EN">Generic data type for voltage</L-2></DESC>
  <CATEGORY>LINEAR</CATEGORY>
  <UNIT-REF DEST="UNIT" BASE="Units">Volt</UNIT-REF>
  <COMPU-PHYS-TO-INTERNAL>
    <COMPU-SCALES>
      <COMPU-SCALE>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">25.2</UPPER-LIMIT>
        <COMPU-RATIONAL-COEFFS>
          <COMPU-NUMERATOR>
            <V>0</V>
            <V>1</V>
          </COMPU-NUMERATOR>
          <COMPU-DENOMINATOR>
            <V>0.1</V>
          </COMPU-DENOMINATOR>
        </COMPU-RATIONAL-COEFFS>
      </COMPU-SCALE>
    </COMPU-SCALES>
  </COMPU-PHYS-TO-INTERNAL>
</COMPU-METHOD>
```

6.4.6 SwComponentType (COMPOSITION-SW-COMPONENT-TYPE)

The naming convention applies to the following subclasses of the class SwComponentType:

ApplicationSwComponentType
CompositionSwComponentType
SensorActuatorSwComponentType
ParameterSwComponentType

Objectives:

- Avoid name clashes within the package
- Classification of components
- Not for component prototypes (see 6.4.7)

Rules

- [TR_SWNR_0035] Using a prefix to indicate the application domain (such as powertrain, body, chassis) of the SwComponentType is **not** allowed.

Recommendations:

- Use a noun or concatenation of nouns.

Example

SensorSpeed

SnsrSpd

- The name should be understandable.

Examples

VehicleSpeed

VehSpd

VehicleMotionDemand

VehMtnDmd

WiperWasher

WiprWshr

Example (to shorten the example, some lines have been removed):

```

<COMPOSITION-SW-COMPONENT-TYPE>
  <SHORT-NAME>KeyPad</SHORT-NAME>
  <PORTS>
    <P-PORT-PROTOTYPE>
      <SHORT-NAME>DrvrDoorKeyPad</SHORT-NAME>
      <LONG-NAME><L-4 L="EN">Driver Door Keypad</L-4></LONG-NAME>
      <DESC><L-2 L="EN">Request to activate central locking master from the driver
        door key pad</L-2></DESC>
      <PROVIDED-INTERFACE-TREF DEST="SENDER-RECEIVER-INTERFACE"
        BASE="PortInterfaces_Blueprint">LockgCenReq1</PROVIDED-INTERFACE-TREF>
    </P-PORT-PROTOTYPE>
    ...some ports skipped
    <P-PORT-PROTOTYPE>
      <SHORT-NAME>KeyPadOfLidRe</SHORT-NAME>
      <LONG-NAME><L-4 L="EN">Rear Lid Keypad</L-4></LONG-NAME>
      <DESC><L-2 L="EN">Request to activate central locking master on the rear
        lid from lid key pad</L-2></DESC>
      <PROVIDED-INTERFACE-TREF DEST="SENDER-RECEIVER-INTERFACE"
        BASE="PortInterfaces_Blueprint">LockgCenReq1</PROVIDED-INTERFACE-TREF>
    </P-PORT-PROTOTYPE>
  </PORTS>
  <COMPONENTS>
    <SW-COMPONENT-PROTOTYPE>
      <SHORT-NAME>KeyPadMgr</SHORT-NAME>
      <LONG-NAME><L-4 L="EN">KeyPadManager</L-4></LONG-NAME>
      <DESC><L-2 L="EN">Key Pad Manager</L-2></DESC>
      <TYPE-TREF DEST="COMPOSITION-SW-COMPONENT-TYPE"
        BASE="SwComponentTypes_Example">KeyPadMgr</TYPE-TREF>
    </SW-COMPONENT-PROTOTYPE>
  </COMPONENTS>
  <CONNECTORS>
    <DELEGATION-SW-CONNECTOR>
      <SHORT-NAME>delcon_0</SHORT-NAME>
      <INNER-PORT-IREF>
        <P-PORT-IN-COMPOSITION-INSTANCE-REF>
          <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PROTOTYPE"
            BASE="SwComponentTypes_Example">KeyPad/KeyPadMgr</CONTEXT-COMPONENT-REF>
          <TARGET-P-PORT-REF DEST="P-PORT-PROTOTYPE"
            BASE="SwComponentTypes_Example">KeyPadMgr/DrvrDoorKeyPad</TARGET-P-PORT-REF>
        </P-PORT-IN-COMPOSITION-INSTANCE-REF>
      </INNER-PORT-IREF>
      <OUTER-PORT-REF DEST="P-PORT-PROTOTYPE"
        BASE="SwComponentTypes_Example">KeyPad/DrvrDoorKeyPad</OUTER-PORT-REF>
    </DELEGATION-SW-CONNECTOR>
    ...some delegation ports skipped
  </CONNECTORS>
</COMPOSITION-SW-COMPONENT-TYPE>
    
```

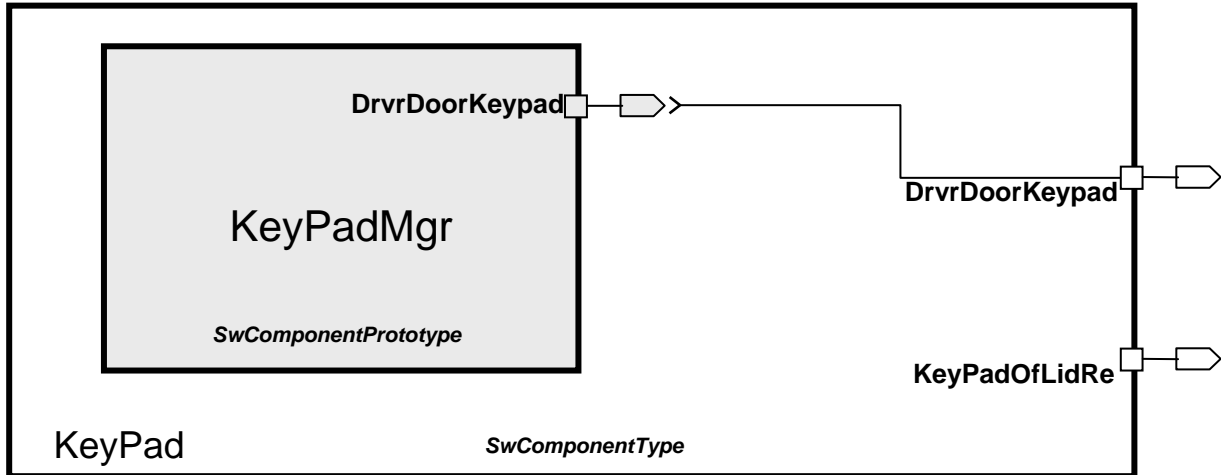


Figure 7: Example of SwComponentType

6.4.7 SwComponentPrototype (SW-COMPONENT-PROTOTYPE)

Objectives of naming conventions for component prototypes (which are the instances of each component type):

- avoid name clashes within the composition
- classification of components

These names are not used within the API to the RTE.

Rules:

- [TR_SWNR_0036] Using a prefix to indicate the application domain (such as powertrain, body, chassis) of the SwComponentPrototype is not allowed.

Recommendations:

- The name should be understandable. In case a composition contains more than one instance of the same component type, the prototype name should reflect the role of this specific instance in the composition. An example on how to name multiple SwComponentPrototypes is given in section 5.2.

Example: DoorLe, DoorRi

Example:

```
<SW-COMPONENT-PROTOTYPE>
  <SHORT-NAME>MgrOfMirrAdjAutReqByUsr</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">ManagerOfMirrorAdjustmentAutomaticRequestByUser</L-4></LONG-NAME>
  <DESC><L-2 L="EN">Component treating the Automatic mirror movement
    requests - memory recall. </L-2></DESC>
  <TYPE-TREF DEST="COMPOSITION-SW-COMPONENT-TYPE"
    BASE="SwComponentTypes">MgrOfMirrAdjAutReqByUsr</TYPE-TREF>
</SW-COMPONENT-PROTOTYPE>
```

6.4.8 PortPrototype (P-PORT-PROTOTYPE, R-PORT-PROTOTYPE)

Objectives:

- should only be significant relative to the SW component (e.g. left, right etc.)
- unique name per component

PortPrototypes can be connected as long as they are typed with compatible PortInterfaces. Please refer to document [3] for such compatibility rules.

Rules:

- [TR_SWNR_0037] The PortPrototype shall indicate the operation or data that is provided/required by the port
- [TR_SWNR_0052] Port names shall not contain sequence numbers.

Example:

Short-Name: EmgyLockg

```
<R-PORT-PROTOTYPE>
  <SHORT-NAME>EmgyLockg</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">Emergency Locking</L-4></LONG-NAME>
  <DESC><L-2 L="EN">User request for emergency locking in case of danger.</L-2></DESC>
  <REQUIRED-INTERFACE-TREF DEST="SENDER-RECEIVER-INTERFACE"
    BASE="PortInterfaces">LockUnlckReq1</REQUIRED-INTERFACE-TREF>
</R-PORT-PROTOTYPE>
```

6.4.9 Units (UNIT)

Objectives:

- Shall be unique.

Rules:

- [TR_SWNR_0040] If the unit is a formula containing “x to the power of 2” the short name shall contain “Sq^d” (abbreviation of keyword “Squared”).
- [TR_SWNR_0041] If the unit is a formula containing “x to the power of 3” the short name shall contain “Cub^d” (abbreviation of keyword “Cubed”).
- [TR_SWNR_0042] If the unit is a formula containing “x to the power of *number* >3” the short name shall contain ToPwrOf<number> .
- [TR_SWNR_0043] If the unit is a formula containing a division the short name shall contain “Per”

Examples:

```
<UNIT>
  <SHORT-NAME>NwtPerMtr</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">Newton Per Meter</L-4></LONG-NAME>
  <DESC><L-2 L="EN">surface tension (derived from SI units)</L-2></DESC>
  <DISPLAY-NAME>N/m</DISPLAY-NAME>
  <FACTOR-SI-TO-UNIT>1</FACTOR-SI-TO-UNIT>
  <PHYSICAL-DIMENSION-REF DEST="PHYSICAL-DIMENSION"
    BASE="PhysicalDimensions">M1TiNeg2</PHYSICAL-DIMENSION-REF>
</UNIT>
```

```
<UNIT>
  <SHORT-NAME>MtrPerSecCubd</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">Meter Per Second Cubed</L-4></LONG-NAME>
  <DESC><L-2 L="EN">jerk (derived from SI units), also called jolt (esp. in British
English), surge or lurch, is the rate of change of acceleration; more precisely, the
derivative of acceleration with respect to time, the second derivative of velocity, or the
third derivative of displacement.</L-2></DESC>
  <DISPLAY-NAME>m/s^3</DISPLAY-NAME>
  <FACTOR-SI-TO-UNIT>1</FACTOR-SI-TO-UNIT>
  <PHYSICAL-DIMENSION-REF DEST="PHYSICAL-DIMENSION"
    BASE="PhysicalDimensions">Len1TiNeg3</PHYSICAL-DIMENSION-REF>
</UNIT>
```

6.4.10 Physical Dimensions

Physical Dimensions are used to entirely describe and classify elements inside the Units Package. Each unit's physical dimension is represented as generic combination of one or more base physical quantities: electrical current, luminous intensity, time, mass, amount of substance, thermodynamic temperature, length or no-dimension, with specific exponents.

Physical Dimensions Shortnames are built using a sequence of base physical quantities keyword abbreviations followed by numbers as exponents ("Neg" keyword abbreviation shall be used for negative number). Space character is not allowed inside shortname.

Following the same base physical quantities sequence, Physical Dimensions Longnames are built using keywords (instead of abbreviations), numbers as exponents (minus sign for negative numbers is mandatory), and space between each physical quantity's keyword and its exponent

Example:

Unit: Nm/s *Physical Dimension:* [L]²[M]¹[T]⁻³

Shortname: NwtMtrPerSec

Longname: Newton Meter Per Second

```
<PHYSICAL-DIMENSION>
  <SHORT-NAME>Len2M1TiNeg3</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">Length 2 Mass 1 Time -3</L-4></LONG-NAME>
  <LENGTH-EXP>2</LENGTH-EXP>
  <MASS-EXP>1</MASS-EXP>
  <TIME-EXP>-3</TIME-EXP>
</PHYSICAL-DIMENSION>
```

6.4.11 Enumerations

There is no explicit support for enumeration types in the metamodel. Enumerations are modeled by using a DataType and a CompuMethod.

Example:

```
<APPLICATION-PRIMITIVE-DATA-TYPE>
  <SHORT-NAME NAME-PATTERN="{anyName}">UsrReqForWipg1</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">User Request For Wiping</L-4></LONG-NAME>
  <DESC><L-2 L="EN">It represents the selection of the interval time or the speed of the
wiper requested by the user. The exact timings and wipe speeds are not standardized and need
therefore to be parameterized.</L-2></DESC>
  <CATEGORY>VALUE</CATEGORY>
  <SW-DATA-DEF-PROPS>
    <SW-DATA-DEF-PROPS-VARIANTS>
      <SW-DATA-DEF-PROPS-CONDITIONAL>
        <SW-CALIBRATION-ACCESS>READ-ONLY</SW-CALIBRATION-ACCESS>
        <COMPU-METHOD-REF DEST="COMPU-METHOD" BASE="CompuMethods">UsrReqForWipg1</COMPU-
METHOD-REF>
        <DATA-CONSTR-REF DEST="DATA-CONSTR" BASE="DataConstrs">UsrReqForWipg1</DATA-CONSTR-
REF>
      </SW-DATA-DEF-PROPS-CONDITIONAL>
    </SW-DATA-DEF-PROPS-VARIANTS>
  </SW-DATA-DEF-PROPS>
</APPLICATION-PRIMITIVE-DATA-TYPE>
```

```
<COMPU-METHOD>
  <SHORT-NAME NAME-PATTERN="{anyName}">UsrReqForWipg1</SHORT-NAME>
  <LONG-NAME><L-4 L="EN">User Request For Wiping</L-4></LONG-NAME>
  <CATEGORY>TEXTTABLE</CATEGORY>
  <COMPU-INTERNAL-TO-PHYS>
    <COMPU-SCALES>
      <COMPU-SCALE>
        <DESC><L-2 L="EN">4 = UsrReqForWipgSpdHi</L-2></DESC>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">4</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">4</UPPER-LIMIT>
        <COMPU-CONST><VT>UsrReqForWipgSpdHi</VT></COMPU-CONST>
      </COMPU-SCALE>
      <COMPU-SCALE>
        <DESC><L-2 L="EN">2 = UsrReqForWipgIntl</L-2></DESC>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">2</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">2</UPPER-LIMIT>
        <COMPU-CONST><VT>UsrReqForWipgIntl</VT></COMPU-CONST>
      </COMPU-SCALE>
      <COMPU-SCALE>
        <DESC><L-2 L="EN">3 = UsrReqForWipgSpdLo</L-2></DESC>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">3</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">3</UPPER-LIMIT>
        <COMPU-CONST><VT>UsrReqForWipgSpdLo</VT></COMPU-CONST>
      </COMPU-SCALE>
      <COMPU-SCALE>
        <DESC><L-2 L="EN">0 = UsrReqForWipgOff</L-2></DESC>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">0</UPPER-LIMIT>
        <COMPU-CONST><VT>UsrReqForWipgOff</VT></COMPU-CONST>
      </COMPU-SCALE>
      <COMPU-SCALE>
        <DESC><L-2 L="EN">1 = WipgStrikeSngReqByUsr</L-2></DESC>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">1</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">1</UPPER-LIMIT>
        <COMPU-CONST><VT>WipgStrikeSngReqByUsr</VT></COMPU-CONST>
      </COMPU-SCALE>
    </COMPU-SCALES>
  </COMPU-INTERNAL-TO-PHYS>
</COMPU-METHOD>
```


6.4.12 ClientServerInterface (CLIENT-SERVER-INTERFACE)

While modeling a ClientServerInterface, names for the following attributes shall be also defined:

- OperationPrototype
- ArgumentPrototype

Rules:

- [TR_SWNR_0062] The interface name shall end with a sequence number to take into account the future evolution of interfaces.
- The name of OperationPrototype attribute shall follow rule TR_SWNR_0029 in place for VariableDataPrototype (see 6.4.3)
- The name of ArgumentPrototype attribute shall follow all the rules in place for VariableDataPrototype (see 6.4.3)

Recommendations:

- A ClientServerInterface should be a reusable element. The name of interface should be independent of its concrete usage by components and ports and should only reflect its general purpose.
- To allow reuse, the communication path (the indication of source or destination of ports using the interface) shall not be encoded in the interface name.
- The name of ArgumentPrototype attribute should follow all the recommendation in place for VariableDataPrototype (see 6.4.3)
- The name of OperationPrototype attribute should start with a keyword classified as “Action / Physical Type”

Example for OperationPrototype:

Short-Name: SetEveSts

6.4.13 ParameterInterface (PARAMETER-INTERFACE)

To this model element, same rules and recommendations as for SenderReceiverInterface (see chapter 6.4.2) apply.

6.4.14 ParameterDataPrototype (PARAMETER-DATA-PROTOTYPE)

Objectives:

- Should only be significant relative to the ParameterInterface.
- Shall be a unique name per ParameterInterface.

To this model element, same rules and recommendations as for VariableDataPrototype (see chapter 6.4.3) apply.

6.4.15 DataConstrs (DATA-CONSTRS)

DATA-CONSTRS shortname elements fullfill naming convention rules..

Example:

```
<DATA-CONSTR>
  <SHORT-NAME>Flg1</SHORT-NAME>
  <DATA-CONSTR-RULES>
    <DATA-CONSTR-RULE>
      <PHYS-CONSTRS>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">1</UPPER-LIMIT>
      </PHYS-CONSTRS>
    </DATA-CONSTR-RULE>
  </DATA-CONSTR-RULES>
</DATA-CONSTR>
```

6.4.16 Blueprintable Elements in Application Interfaces Domain

AUTOSAR metamodel provides and supports mechanism to allow users to create and expand model elements starting from a well defined model elements base. Its goal is to provide the possibility of deriving elements with enhancing features and attributes that can be used in different contexts (e.g series projects).(for more details and for a complete definition of Blueprint mechanism and meta model UML classes at each AUTOSAR level, please refer to [9])

This blueprint mechanism is mainly based on three entities :

- *Blueprint:*
acts as the predefinition of the element. Basically it follows the same structure as the derived elements.
- *Blueprinted Element:*
acts as the element which was derived from the Blueprint. These elements are derived from blueprints mainly by copy and refine. This "refine" may add further attribute values'
- *Blueprint Mapping:*
acts as a reference between blueprints and their derived elements. The main purpose of this blueprint mapping is the ability to validate for each derived elements that they conform the the blueprint.

Focusing on the Application Interfaces domain the goal is to promote the reuse of model elements outside the scope of SwComponentType.

Blueprintable elements are collected into a sort of stand alone elements library from which derived elements (for example PortPrototypes) can be created, refined and plugged into SWComponentsProtoTypes.

Blueprintable elements have no impact on the AUTOSAR RTE level (impact covered by derive prototype elements)

There are four different types of Blueprintable elements in the Application Interface domain. They are collected into four different packages categorized as BLUEPRINT:

- ApplicationDataTypes
- CompuMethods
- PortInterfaces
- PortPrototypeBlueprints

Special attention will be payed now to PortPrototypeBlueprint elements since the following considerations are also valid for other blueprintable elements.

6.4.17 PortPrototypeBlueprint (PORT-PROTOTYPE-BLUEPRINT)

For the scope of this document a PortPrototypeBlueprint has the following characteristics:

- It is an ARElement and does therefore not require any element other than an ARPackage as context. It is therefore not necessary to involve “auxiliary” model elements into the definition of a standardized “application interface” for the mere purpose of conforming to the AUTOSAR meta-model.
- The structure of the created PortPrototype is indistinguishable from a PortPrototype created without taking a PortPrototypeBlueprint as a blueprint. A PortPrototypeBlueprint can be taken as the blueprint for as many PortPrototypes as required.
- It can only be used for the standardization of “application interfaces”. A PortPrototypeBlueprint does not play any role in the formal description of any SwComponentType or related model artifacts. To be sure, the existence of a PortPrototypeBlueprint has no impact on the AUTOSAR RTE.
- Derived PortPrototypes may have more attribute than the PortPrototypeBlueprint
- The attributes of derived PortPrototypes are copied from the PortPrototypeBlueprint with one exception, the attribute ***namePattern*** that may not be copied.

The attribute ***namePattern*** represents the pattern which shall be used to build the shortName of the derived elements (in this case *PortPrototypes*).

This allows to change the shortName of a portprototype derived from a PortPrototypeBlueprint according to predefined rules.

The complete syntax used by the ***namePattern*** attribute is defined in [9] and it will not be reported here in detail.

Nevertheless since this syntax nearly leads to any possible solution for building shortNames it's strongly suggested that it's used to stick with rules for PortPrototype shortNames defined in this documents.

Even if no obligatory pattern is defined and the value of the attribute is 'anyName', the following use cases and relative syntax usage are strongly recommended:

- Use case 1: signal used once (one portprototype):
<ShortName>
- Use case 2: signal used twice or more (two or more portprototypes):
<ShortName>{<Keyword>}0..n

Where <ShortName> represents the shortName built using the whole set of rules previously described in this document.

```

<AR-PACKAGE>
  <SHORT-NAME>PortPrototypeBlueprints_Blueprint</SHORT-NAME>
  <CATEGORY>BLUEPRINT</CATEGORY>
  <REFERENCE-BASES>
    <REFERENCE-BASE>
      <SHORT-LABEL>PortInterfaces</SHORT-LABEL>
      <IS-DEFAULT>>false</IS-DEFAULT>
      <IS-GLOBAL>>false</IS-GLOBAL>
      <BASE-IS-THIS-PACKAGE>>false</BASE-IS-THIS-PACKAGE>
      <PACKAGE-REF DEST="AR-
PACKAGE"/>/AUTOSAR/AISpecification/PortInterfaces_Blueprint</PACKAGE-REF>
    </REFERENCE-BASE>
  </REFERENCE-BASES>
  <ELEMENTS>
    .
    .
    .
    <PORT-PROTOTYPE-BLUEPRINT>
      <SHORT-NAME NAME-PATTERN="{anyName}" >DrvPrProf</SHORT-NAME>
      <LONG-NAME><L-4 L="EN">Driver Profile</L-4></LONG-NAME>
      <DESC><L-2 L="EN">Status of current selected personalization profile from profile
manager. It is a common profile selectable from transponder, remote key, keyless access, Human
Machine Interface (HMI),...</L-2></DESC>

      <INTERFACE-REF DEST="SENDER-RECEIVER-INTERFACE"
        BASE="PortInterfaces">ProfPenSts1</INTERFACE-REF>
    </PORT-PROTOTYPE-BLUEPRINT>
    .
    .
    .
  </ELEMENTS>
</AR-PACKAGE>

```

6.4.18 Keywords

Keywords, which represent a set of basic elements for short names construction, are collected into one package, named KeywordSets, and categorized as STANDARD. Rules for using keywords and their abbreviated names (in the role of abbrName attribute) in shortnames construction are described in chapter 6.3.1.

Example :

```

<AR-PACKAGE>
  <SHORT-NAME>KeywordSets</SHORT-NAME>
  <CATEGORY>STANDARD</CATEGORY>
  <ELEMENTS>
    <KEYWORD-SET>
      <SHORT-NAME>KeywordList</SHORT-NAME>
      <LONG-NAME><L-4 L="EN">AUTOSAR Keywords and Keywords Abbreviations</L-4></LONG-NAME>
      <KEYWORDS>
        <KEYWORD>
          <SHORT-NAME>Idx0</SHORT-NAME>
          <LONG-NAME><L-4 L="EN">0</L-4></LONG-NAME>
          <DESC><L-2 L="EN">Index 0. This keyword is used to express the number zero
            in form of an index</L-2></DESC>
          <ABBR-NAME>0</ABBR-NAME>
          <CLASSIFICATIONS>
            <CLASSIFICATION>Index</CLASSIFICATION>
          </CLASSIFICATIONS>
        </KEYWORD>
        .
        .
        .
        <KEYWORD>
          <SHORT-NAME>Abs</SHORT-NAME>
          <LONG-NAME><L-4 L="EN">Abs</L-4></LONG-NAME>
          <DESC><L-2 L="EN">antilock braking system</L-2></DESC>
          <ABBR-NAME>Abs</ABBR-NAME>
          <CLASSIFICATIONS>
            <CLASSIFICATION>Mean-Environment-Device</CLASSIFICATION>
          </CLASSIFICATIONS>
        </KEYWORD>
        <KEYWORD>
          <SHORT-NAME>Abslt</SHORT-NAME>
          <LONG-NAME><L-4 L="EN">Absolute</L-4></LONG-NAME>
          <DESC><L-2 L="EN">Absolute value</L-2></DESC>
          <ABBR-NAME>Abslt</ABBR-NAME>
          <CLASSIFICATIONS>
            <CLASSIFICATION>Condition-Qualifier</CLASSIFICATION>
          </CLASSIFICATIONS>
        </KEYWORD>
        .
        .
      </KEYWORDS>
    </KEYWORD-SET>
  </ELEMENTS>
</AR-PACKAGE>

```