Document Title	Generic Structure Template
Document Owner	AUTOSAR
Document Responsibility	AUTOSAR
Document Identification No	202
Document Classification	Standard

Document Status	Final
Part of AUTOSAR Standard	Classic Platform
Part of Standard Release	4.3.0

Document Change History			
Date	**Release**	**Changed by**	**Description**
2016-11-30	4.3.0	AUTOSAR Release Management	• Extend AttributeValuePattern for enumeration • Editorial changes • Control the production of specification documents • Added section on Special Data Group Definitions
2015-07-31	4.2.2	AUTOSAR Release Management	• Update View Approach • Combinations of status values • Update Inline Text Model Element
2014-10-31	4.2.1	AUTOSAR Release Management	• Propagation of LifeCycleState • Editorial changes
2014-03-31	4.1.3	AUTOSAR Release Management	• Update of blueprint topics • Extension of variant handling topics • Editorial changes
2013-10-31	4.1.2	AUTOSAR Release Management	• Editorial changes • Extension of formula language

2013-03-15	4.1.1	AUTOSAR Administration	• Editorial changes including tagged specification items • Support of build action manifest • Support of roles and rights • Added life cycle support • Support of collections and collectable elements
2011-12-22	4.0.3	AUTOSAR Administration	• Editorial changes including tagged specification items • Improvements in UML usage (M3), especially mark obsolete elements • Improved specification of primitives, primitive definition, formula language, category • Improved variant handling and blueprint support • Improved support for instanceRef and arrays • Improved definition of package structures
2009-12-18	4.0.1	AUTOSAR Administration	• Editorial changes • Improvements in variant handling (Package content, composed predefined variants) • Align Formula language with ASAM General Expression Language • Generalized approach for anntoations • Improved aligment with ASAM - FSX • Document the admin.* uml tags. • Support global referenceing and tracing
2010-02-02	3.1.4	AUTOSAR Administration	• restructured the document • support for variant handling • support for abstract structures • documentation support • detailed primitives • general modeling information required to understand other templates

2008-08-13	3.1.1	AUTOSAR Administration	• Legal disclaimer revised • Rename document from "Template Modeling Patterns" to "Generic Structure Template"
2007-12-21	3.0.1	AUTOSAR Administration	• Updated Attributes of Identifiable • Added "Hint to the Users" • Added document identification no • Added document classification
2007-01-24	2.1.15	AUTOSAR Administration	• Legal disclaimer revised • "Advice for users" revised • "Revision Information" added
2006-05-16	2.0	AUTOSAR Administration	Second release

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

Bibliography

[1] Meta Model
AUTOSAR_MMOD_MetaModel

[2] Standardization Template
AUTOSAR_TPS_StandardizationTemplate

[3] XML Schema Production Rules
AUTOSAR_TPS_XMLSchemaProductionRules

[4] Specification of ECU Resource Template
AUTOSAR_TPS_ECUResourceTemplate

[5] System Template
AUTOSAR_TPS_SystemTemplate

[6] Predefined Names in AUTOSAR
AUTOSAR_TR_PredefinedNames

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1 Introduction

This document contains the specification of the AUTOSAR `Generic Structure Template`. Actually, it has been created as a supplement to the formal definition provided by the AUTOSAR meta-model [1]. In other words, this document in addition to the formal specification provides introductory description and rationale for the parts of the AUTOSAR meta-model relevant for almost all AUTOSAR templates.

Nevertheless, the core part of the specification is directly based on the content of the AUTOSAR meta-model. Therefore, this document contains a summary of the main concepts of the AUTOSAR meta-model, see chapters 1.3 and 1.4.

This document provides reference information and is not intended to be read in a sequence. Nevertheless it contains as major aspects:

1. Chapter 3 explains the top level structure which is common to all AUTOSAR templates.
2. Mechanisms used to design AUTOSAR templates:
   (a) Chapter 2 describes an essential aspects of the Autosar Template UML profile which are necessary to understand the AUTOSAR template documents.
   (b) Chapter 4 describes general template classes which are collected similar to the standard library of a compiler.
   (c) Chapter 5 explains abstract classes with abstract relationships. These structures implement **particular concepts** applicable to all Autosar templates. These concepts are applied by specializing these abstract classes and in particular specializing the abstract relationships.
   (d) Chapter 6 explains in general the approach to apply by model transformation (as for example used for Variant handling).
3. Some specific applications of design mechanisms in the MetaModel
   (a) Chapter 7 describes the implementation of variant handling within Autosar templates based on MetaModeling Patterns (as described in 6).
   (b) Chapter 8 describes the documentation support.

1.1 Scope

The scope of this document covers information which is required to understand the AUTOSAR templates and the core mechanisms used to define these templates.

Aspects of UML modeling required to perform the template Modeling tasks are out of the scope of this document.

1.2 Document Conventions

Technical terms are typeset in mono spaced font, e.g. `PortPrototype`. As a general rule, plural forms of technical terms are created by adding "s" to the singular form, e.g. `PortPrototype`s. By this means the document resembles terminology used in the AUTOSAR XML Schema.

This document contains constraints in textual form that are distinguished from the rest of the text by a unique numerical constraint ID, a headline, and the actual constraint text starting after the ⌈ character and terminated by the ⌋ character.

The purpose of these constraints is to literally constrain the interpretation of the AUTOSAR meta-model such that it is possible to detect violations of the standardized behavior implemented in an instance of the meta-model (i.e. on M1 level).

Makers of AUTOSAR tools are encouraged to add the numerical ID of a constraint that corresponds to an M1 modeling issue as part of the diagnostic message issued by the tool.

The attributes of the classes introduced in this document are listed in form of class tables. They have the form shown in the example of the top-level element AUTOSAR:

Class	**AUTOSAR**			
Package	M2::AUTOSARTemplates::AutosarTopLevelStructure			
Note	Root element of an AUTOSAR description, also the root element in corresponding XML documents. **Tags:** xml.globalElement=true			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
adminData	AdminData	0..1	aggr	This represents the administrative data of an Autosar file. **Tags:** xml.sequenceOffset=10
arPackage	ARPackage	*	aggr	This is the top level package in an AUTOSAR model. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variation Point.shortLabel vh.latestBindingTime=blueprintDerivationTime xml.sequenceOffset=30
introductio n	Documentation Block	0..1	aggr	This represents an introduction on the Autosar file. It is intended for example to rpresent disclaimers and legal notes. **Tags:** xml.sequenceOffset=20

Table 1.1: AUTOSAR

The first rows in the table have the following meaning:

Class: The name of the class as defined in the UML model.

Package: The UML package the class is defined in. This is only listed to help locating the class in the overall meta model.

Note: The comment the modeler gave for the class (class note). Stereotypes and UML tags of the class are also denoted here.

Base Classes: If applicable, the list of direct base classes.

The headers in the table have the following meaning:

Attribute: The name of an attribute of the class. Note that AUTOSAR does not distinguish between class attributes and owned association ends.

Type: The type of an attribute of the class.

Mul.: The assigned multiplicity of the attribute, i.e. how many instances of the given data type are associated with the attribute.

Kind: Specifies, whether the attribute is aggregated in the class (`aggr` aggregation), an UML attribute in the class (`attr` primitive attribute), or just referenced by it (`ref` reference). Instance references are also indicated (`iref` instance reference) in this field.

Note: The comment the modeler gave for the class attribute (role note). Stereotypes and UML tags of the class are also denoted here.

Please note that the chapters that start with a letter instead of a numerical value represent the appendix of the document. The purpose of the appendix is to support the explanation of certain aspects of the document and does not represent binding conventions of the standard.

The verbal forms for the expression of obligation specified in [TPS_STDT_00053] shall be used to indicate requirements, see Standardization Template, chapter Support for Traceability ([2]).

The representation of requirements in AUTOSAR documents follows the table specified in [TPS_STDT_00078], see Standardization Template, chapter Support for Traceability ([2]).

1.3 Methodology for Defining Formal Templates

Figure 1.1 illustrates the overall methodology used to define formal templates using System Template as an example. A precise and concise model of the information that needs to be captured in AUTOSAR XML files is provided in [1]

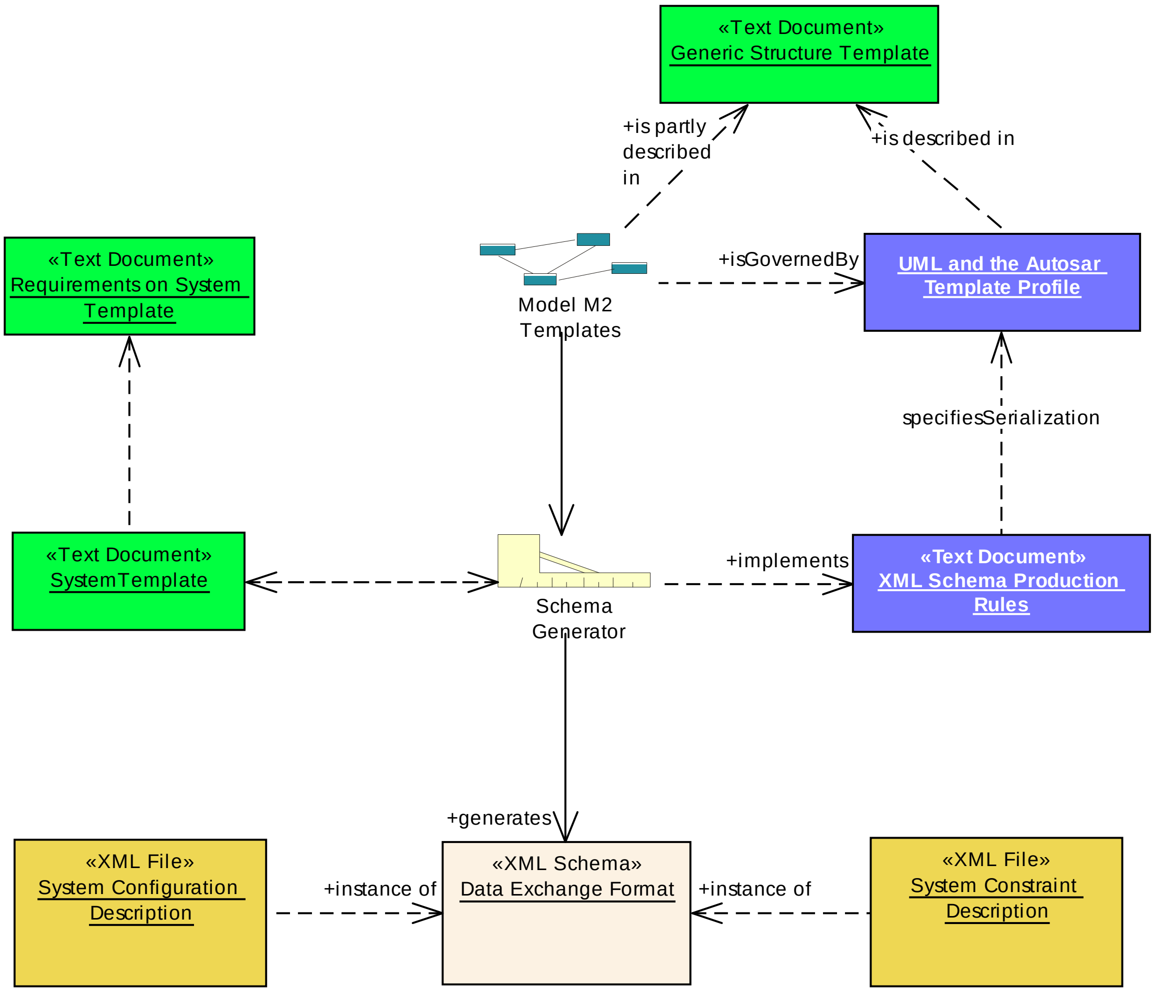


Figure 1.1: Methodology to define templates in AUTOSAR (using SystemTemplate as example

The following documents describe the various aspects of the methodology:

1. The **template document** (in this example `System Template`) describes the information that can be captured in the template, independently from the mapping of this model on XML-technology. It contains an elaborate description of the semantics (the precise meaning) of all the information that can be captured within the relevant parts of the AUTOSAR meta-model.

2. The model called **M2 Templates** in the AUTOSAR meta-model [1] contains the structure of the AUTOSAR templates modeled in UML. The model is annotated using notes which are also represented as class tables in the template documents.

3. The document called **Generic Structure Template** (this document) is represented e.g. as predefined Classes in the meta-model which are incorporated in the generated schema.

4. The **Template UML Profile and Modeling Guide** describes the basic concepts that were applied when creating content of the meta-model. This information is presented in chapter 2.

5. The document called **XML Schema Production Rules** [3] describes how XML is used and how the meta-model designed in the "Software Component Template" should be translated by the "Schema Generator" (MDS) into XML-Schema (XSD) "Data Exchange Format".

   This "formalization strategy" is supposed to be used for all data that is formally described in the meta-model. In particular this document is worth to read in order to understand the mapping of the meta-model and the XML based AUTOSAR template.

6. The **Data Exchange Format** is represented as an XML schema automatically generated out of the AUTOSAR meta-model using the approach and the patterns defined in the **XML Schema Production Rules**. This schema is typically used as input to AUTOSAR tools.

7. The **M1-level descriptions** (in figure 1.1 illustrated as "System configuration description" and "System Constraint Description") are XML files that can be validated against the XML schema and furtheron follow the specifications in the relevant "template document". In other words, the XML files are instances of the schema defining the XML representation of the template.

1.4 Organization of the Meta-Model

Figure 1.2 sketches the overall structure of the meta-model, which formally defines the vocabulary required to describe AUTOSAR software-components. As the diagram points out, other template specifications (e.g. `ECU Resource Template` [4] and `System Template` [5]) also use the same modeling approach in order to define an overall consistent model of AUTOSAR software description.

The dashed arrows in the diagram describe dependencies in terms of import-relationships between the packages within the meta-model. For example, the package `SWComponentTemplate` imports meta-classes defined in the packages `GenericStructure` (described in this document) and `ECUResourceTemplate` [4].

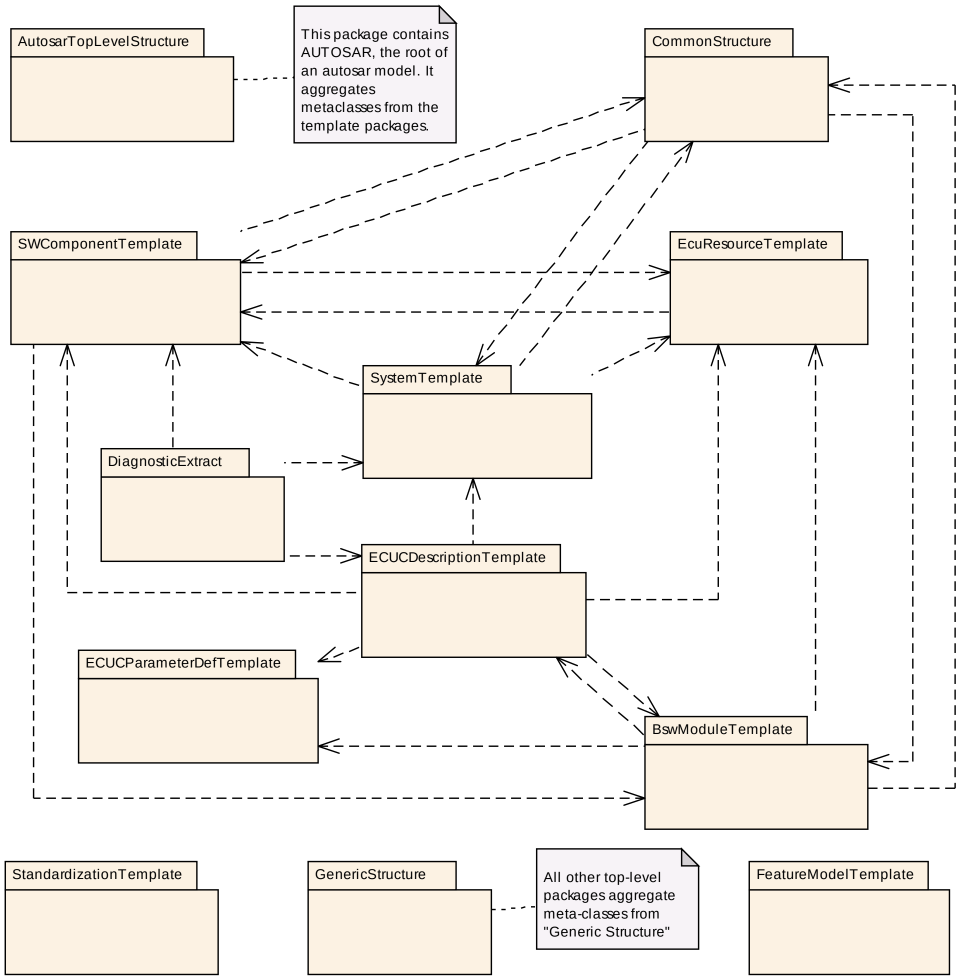


Figure 1.2: Structure of the meta-model

For clarification, please note that the package `GenericStructure` contains some fundamental infrastructure meta-classes and common patterns. As these are used by all other template specification the dependency associations are not depicted in the diagram for the sake of clarity.

2 Usage of UML in AUTOSAR Templates

The AUTOSAR meta-model is defined as an UML model. Therefore basic knowledge of UML is required to understand the AUTOSAR template documents.

2.1 UML Diagrams

The diagrams in the AUTOSAR Template documents are consistent with UML 2.0. The underlying model (the AUTOSAR metamodel) is assumed to be complete even though certain elements might not be shown in a particular diagram to simplify understanding. Nevertheless the class tables show all relevant information.

The coloring of the diagrams is usually explained in the surrounding text. But in general the meta classes in light green color are those which are taken from ASAM/MSR.

Representation of instance refs is shown in Figure 5.9 (see [TPS_GST_00044]).

2.2 The AUTOSAR Meta-Model Hierarchy

The complete meta model hierarchy for AUTOSAR templates is shown in figure 2.1. Unlike the classical four-layer architecture used by OMG, five meta levels are shown. Starting at the lowest, most concrete meta level those are:

- **M0: AUTOSAR objects**
  This is the realization of an AUTOSAR system at work: For example a real ECUs executing a software image containing for instance the windshield wiper control software.

- **M1: AUTOSAR models**
  Models on this meta level are built by the AUTOSAR developers. They may define a software component called "windshield wiper" with a certain set of ports that is connected to another software component and so on. On this level all artifacts required to describe an AUTOSAR system are detailed, including re-usable types as well as specific instances of such types.

  The AUTOSAR software is loaded in to individual ECUs for individual vehicles. This loading means that the M1 Model is instantiated.

  Note that such an AUTOSAR model can be represented using various formats ranging from XML, to C even to PDF.

- **M2: AUTOSAR meta-model**
  On this meta level the vocabulary for AUTOSAR templates is defined. This vocabulary later can be used by developers of AUTOSAR based ECU systems.

  For example it is **defined on M2** that in AUTOSAR we have an entity called "software component" which among others aggregate an entity called "port". This definition ensures that the developer of an AUTOSAR software component can describe his particular component and its ports. This description is called an AUTOSAR model and **resides on M1**.

- **M3: UML profile for AUTOSAR templates**
  The AUTOSAR templates on M2 are built according to the meta-model defined on M3. As discussed before this is UML together with a particular UML profile to better support template modeling work.

  Formally a template on M2 is still an instance of UML, but at the same time the template profile is applied, i.e. that additionally rules set out by the stereotypes in the profile need to be observed. The relevant details of the profile are specified in chapter 2.3 and chapter 2.4.

Note that an AUTOSAR model can be represented using various formats ranging from XML, to C even to PDF. The conversion between these formats is called "transformation", while the fact that an AUTOSAR model follows to the AUTOSAR meta-model is called "instantiation". An AUTOSAR model (M1) is therefore called an instance of **the** AUTOSAR meta-model (M2).

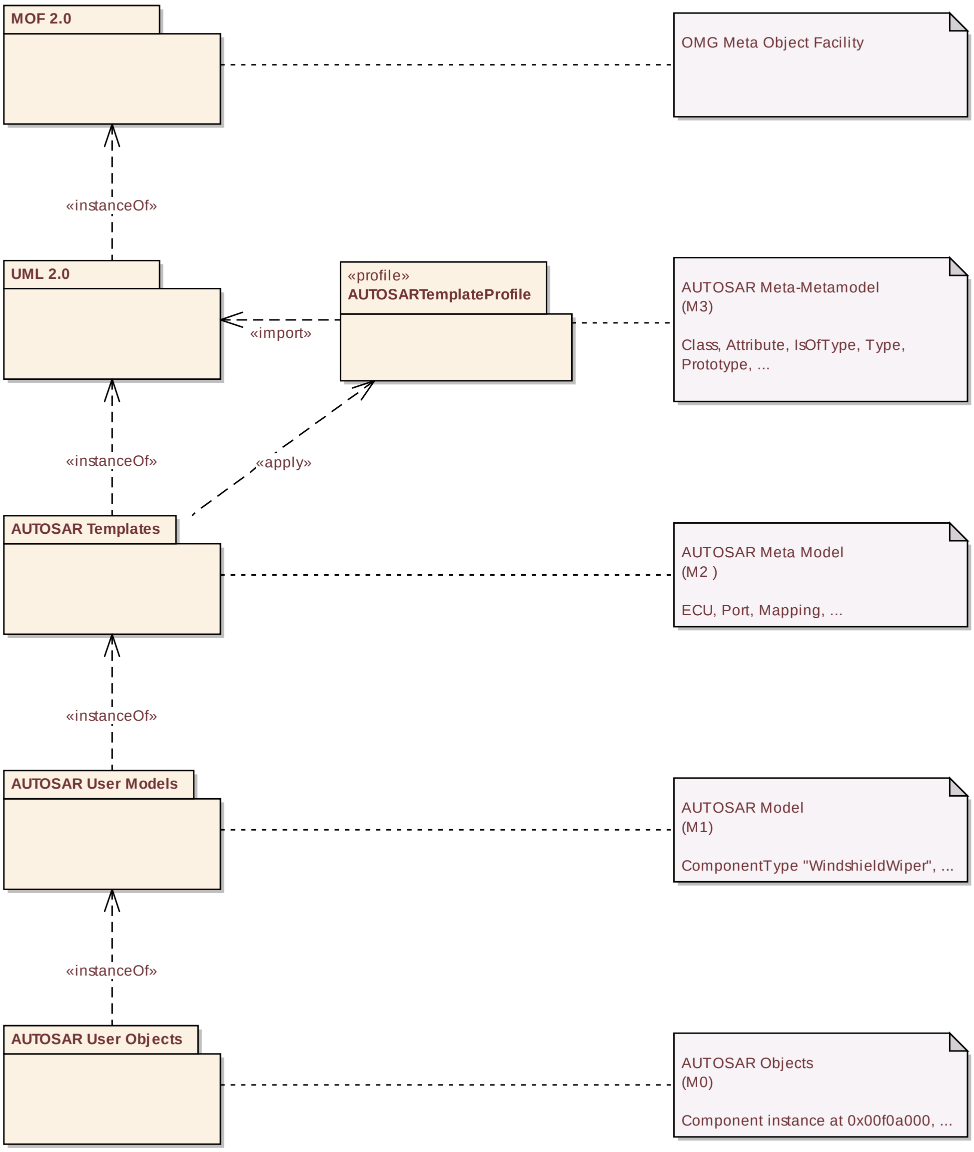


Figure 2.1: Meta Model Hierarchy

2.3 Stereotypes

The AUTOSAR Template Profile uses the following stereotypes[1]:

- **[TPS_GST_00022] ≪`atpAbstract`≫ applicable to relations (associations, aggregations)** ⌈ This indicates that the relationship is abstract. There needs to be specialized relation in every concrete subclass redefining the abstract relation. This stereotype is there to provide a better visualization in the diagrams. The fact that the relation is abstract is modeled by defining the role as “derived” in the model. It is also indicated by a “/” in front of the role name in the diagrams.

[1] the names of these stereotypes start with `atp` which is the abbreviation for **A**utosar **T**emplate **P**rofile

Relations of ≪atpAbstract≫ exist only in the superclass and are not inherited to subclasses. They *need to be redefined* in the subclasses[2]. ⌋*()*

- **[TPS_GST_00023] ≪atpDerived≫ applicable to relations (associations, aggregations)** ⌈ This indicates that the relationship exists in the subclasses by inheritance. It further indicates that in M1 models the relation is calculated (derived) from other information.

  There are two types of calculation:

  - **general**
    indicates that the value is calculated by a method which is described in the note of the abstract relation. For example the atpBase is calculated as the container of the first atpContextElement.
  - **derived union**
    indicates that it is derived as the union of all concrete relations.

  ⌋*()*

  For example, the aggregation from AtpClassifier to AtpFeature with role atpFeature is ≪atpDerived≫, SwComponentType has an atpFeature association **in addition** to component, port etc. This atpFeature is calculated as the union of the concrete features.

  derived union means that for a given component type, its atpFeature property holds its ports AND its contained component prototypes AND its contained connectors. This allows to define the instance reference on abstract level.

  Refer to chapter 5 for further details.

- **[TPS_GST_00024] ≪atpMixed≫ applicable to classes** ⌈

  This is applied to meta-classes only and indicates a mixed content model **without** intermixed text. ⌋*()*

- **[TPS_GST_00025] ≪atpMixedString≫ applicable to classes** ⌈

  This is a mixed content model **with** intermixed text. This is applied to meta-classes only. ⌋*()*

  For more details see chapter 2.3.1.

- **[TPS_GST_00026] ≪atpObject≫ applicable to classes** ⌈

  This is an implicit base class. It can only provide attributes with tagged with xml.attribute=true. ⌋*()*

  For more details see chapter 6.3.3.

- **[TPS_GST_00027] ≪atpSplitable≫ applicable to relations** ⌈ By using the stereotype ≪atpSplitable≫ the meta model can explicitly define how in-

[2] In consequence of such a redefinition the XSD-generator ignores such abstract relations.

stances of the meta model may be distributed over several files. By default all data is stored in one single file. If the ≪atpSplitable≫ is applied, then the associated or aggregated information may be stored in different files. ⌋()

For more details see chapter 2.3.2.

- **[TPS_GST_00028] ≪atpVariation≫ applicable to classes and relations** ⌈ This indicates variant handling. It is applied to meta-classes as well as to associations or aggregations. ⌋()

  For more details see chapter 7.

- **[TPS_GST_00029] ≪atpUriDef≫ applicable to associations** ⌈ This indicates that the essential information is only the full qualified name of the reference.target. This is then used as a whole as identifier for a particular purpose. The association acts as the definition of a kind of "Universal Resource Identifier" in the AUTOSAR model.

  Note that in this case only the full qualified shortName path is important, and not the shortName of the target nor the target itself. The particular semantics and therefore the subsequent processing depends on the individual use case. ⌋()

  Therefore it is not always necessary to really follow the references of stereotype ≪atpUriDef≫. Tools should not warn about dangling references of this stereotype unless explicitly requested by the user respectively the particular use case.

  For example in EcucReferenceDef.destination the reference indicates that valid targets of the EcucReferenceValue must be EcucContainerValues whose definition is derived from the target of EcucReferenceDef.destination. But this can be verified even if the target EcucReferenceDef.destination is not really available.

- **[TPS_GST_00030] ≪instanceRef≫ applicable to dependencies** ⌈ This is used to provide a simplified representation of instance references within diagrams. See chapter 5.1.3 for more details. ⌋()

- **[TPS_GST_00031] ≪isOfType≫ applicable to associations** ⌈ This is used to emphasize the concrete relationship between prototypes (subclasses of AtpPrototype and types (subclasses of AtpType). ⌋()

  This stereotype influences in generation of associations according to chapter 6.3.2[3].

2.3.1 Mixed Content (≪atpMixed≫, ≪atpMixedString≫)

If a meta-class has several attributes (which may include aggregations or references), there are cases in which the “serialized” representation (like XML) in the M1 model

[3]Note that this stereotype is redundant to the fact that such associations need to redefine the role atpType directly or indirectly.

adds semantics to the actual order and to the number of occurrences of the attribute instances. It may be also be required, that the same attribute appears in multiple instances (in M1) which are mixed with other attribute instances. This situation cannot be expressed in UML in a simple way.

In addition, if a model requires to describe documentation-like information, it often will need to mix formal content and text. An example of such a model is a an embedded link in HTML: markup of formal information bits is mixed into regular text, as shown in the following example:

```
[...]meet <a href="/wiki/Runtime" title="Runtime">runtime</a> requirements
of automotive devices[...]
```

This example illustrates that the "mixed content" feature is is well known in the XML world, where it is called mixed content[4].

[TPS_GST_00032] Basic Features of Mixed Content ⌈ The following list indicates the features of mixed content from a modeling point of view. Within a mixed content instance

- a set of formally defined model elements may appear an arbitrary number of times in arbitrary order
- but the actually present order is relevant in terms of semantics of the whole object, and
- In case of ≪atpMixedString≫ unqualified text may be mixed in between any of formally defined elements.

⌋*()*

This mechanism is supported in AUTOSAR through stereotypes

- ≪atpMixedString≫ which allows text between the data elements ([TPS_GST_00025])
- ≪atpMixed≫ which allows any mix of the properties of such a class in any order ([TPS_GST_00024])

The latter stereotype does not allow for mixed-in text, but keeps the definition of order in terms of syntax and semantics.

[TPS_GST_00033] Upper Multiplicity in Mixed content ⌈ A mixed content class will aggregate or reference a number of other classes in a template model. The target multiplicity of those relations are typically 1, since the overall number of occurrences is arbitrary by definition given in [TPS_GST_00032].

If, however, multiplicity is different from 1, a required grouping is specified. ⌋*()*

For example if the target multiplicity is 2, always a pair of those objects (not just a single object) must be put into the mixed content, and so on.

[4] http://www.w3schools.com/schema/schema_complex_mixed.asp

Figure 2.2 illustrates how it works. The M1 Model is shown in XML. Please note

1. `MixedContent` can be an arbitrary mix any order of `a b c d e` in any order. The order is semantically important. This is the same significance as if an aggregation of upper multiplicity > 1 is annotated as `{ordered}` in UML[5].

2. `c` is of upper multiplicity $>$ 1 therefore the wrapper for multiplicity is there

3. `e` is legally missing since overall number of occurrences is arbitrary by definition.

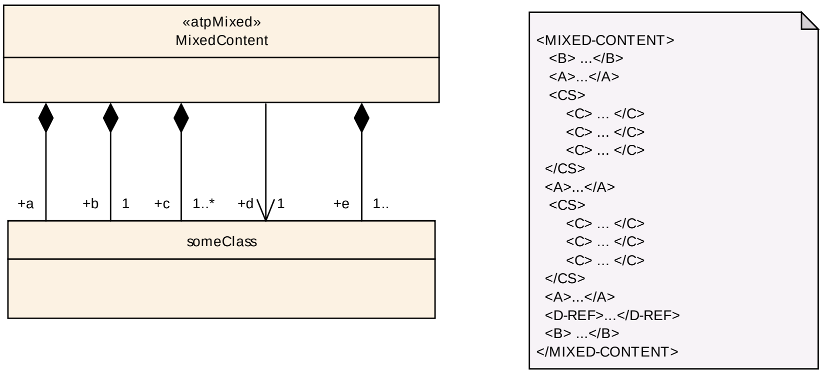


Figure 2.2: Mixed content

[TPS_GST_00045] Inherited properties in mixed content ⌈ Attributes (with `xml.attribute` set to `true`) and inherited properties are **not** part of the mixed content. Note further that in ≪`atpMixedString`≫ there are no inherited properties other than attributes with with `xml.attribute` set to `true`. ⌋ *()*

2.3.2 Splitable Elements (≪**atpSplitable**≫) distributed on Multiple Physical Files

AUTOSAR distinguishes between elements in the model that may be split up over several physical files, and elements that need to be defined together and therefore shall be described completely in exactly one physical file. By default all properties of an element shall be in the same physical file (see [constr_2524]. However for each individual property (attribute, aggregation and reference) the meta model can specify by the stereotype ≪`atpSplitable`≫ that it can be distributed in separate files. These files are merged into one “merged model”.

[constr_2502] Merged model shall be compliant to the meta-model ⌈ A model merged from ≪`atpSplitable`≫ elements shall adhere to the consistency rules of the *pure meta model*. Note that the required lower multiplicities depend on the process phase therefore the AUTOSAR schema sets them mainly to 0. This also applies to the bound model. ⌋ *()*

By introducing splitable elements, AUTOSAR supports

[5]UML it is not possible to denote this annotation for classes.

- Flexible Methodology (e.g. optimizing processes by specific distribution of Information to physical artifacts)
- to add further aspects to an element without changing the original artifact

The semantics of ≪atpSplitable≫ is:

- If the meta model marks an *aggregation*/*attribute* as ≪atpSplitable≫ then the aggregated elements may be described in different physical files (representing partial models).

  [constr_2524] Non splitable elements in one file ⌈ If the *aggregation*/*attribute* is **not** ≪atpSplitable≫, then all aggregated element(s) shall be described in the same physical file as the aggregating element. ⌋*()*

  [TPS_GST_00046] Splitable collections ⌈ If a ≪atpSplitable≫ aggregation is of upper multiplicity > 1 we have a collection of elements. This collection then may be split to different files. The partial models represented by these different files still provide collections contributing to the merged model. Therefore according to [3], the wrapper xml element shall be given in each individual file as well. ⌋*()*

  Note that ≪atpSplitable≫ on ordered collections (relations with upper multiplicity > 1) indicates that the entire collection could be in a partial model.

  [constr_2547] Ordered collections cannot be split into partial models ⌈ Ordered collections which are splitable shall be in one partial model as a whole. In other words: In opposite to unordered collections - which can be distributed between partial models - ordered collections can only be placed as a whole in one of the partial models. Otherwise the merge approach would influence the semantics of the collections. ⌋*()*

- **[constr_2525] Non splitable elements shall not be repeated** ⌈ Properties (namely aggregations and attributes) which are **not** marked as ≪atpSplitable≫ must be all together in one physical file. They must not be repeated in the split files unless they are required for proper merging. ⌋*()*

In order to achieve this, the following is held true in the meta model:

- **[TPS_GST_00047] Identification of Partial Models** ⌈ the ≪atpSplitable≫ property can be unambiguously identified by one of the following properties (decreasing precedence). Such properties must be repeated in the split files.
  - shortName of aggregated element (if upper multiplicity of aggregation is $>$ 1)
  - if the ≪atpSplitable≫ property is subject to variation (see chapter 7), the shortLabel of the VariationPoint needs to be considered as well.
  - Role of aggregation (only for relationships of upper multiplicity equal to 1)

– Role of association shall always evaluate to the full qualified path name (the role name in split key is a value and in case of references yield the full path name).

– additional means, for example `definition` within `EcucParameterValue` or within `EcucContainerValue` of an ECU parameter.

The particular properties are specified explicitly as comma separated list in the UML tag `atp.Splitkey`. ⌋*()*

- **[TPS_GST_00352] Associations in Splitkeys** ⌈ In case an association is part of a split key the absolute representation of the reference value shall be used. In other words, if a `atp.splitkey` refers to an association, then the absolute short name path according to [TPS_GST_00169] of the referenced target shall be used even if it is a relative reference. ⌋*()*

- **[TPS_GST_00048] Splitable up to the Root** ⌈ if an element contains properties marked as ≪`atpSplitable`≫ then all aggregations up to the root element are marked as ≪`atpSplitable`≫. This allows to unambiguously identify split elements in all involved physical files. ⌋*()*

The following pages illustrates how a model can be distributed across multiple files. Figure 2.3 shows the meta model for the example (M2). The merged model is shown in figure 2.4. This diagram also indicates through colors how the elements are distributed across four files (indicated by different colors). Note that in figure 2.4 ≪`atpSplitable`≫ is shown for better understanding even if the diagram shows an M1 artifact (while stereotypes are applied on M2).

Two examples for invalid splitting is given in

- Figure 2.5: `nonSplitDataSpec` is missing.

- Figure 2.6: attribute `a` must be together with the attribute `b` in one file, because these attributes are not splitable. The attribute `a` is also not part of the split key.

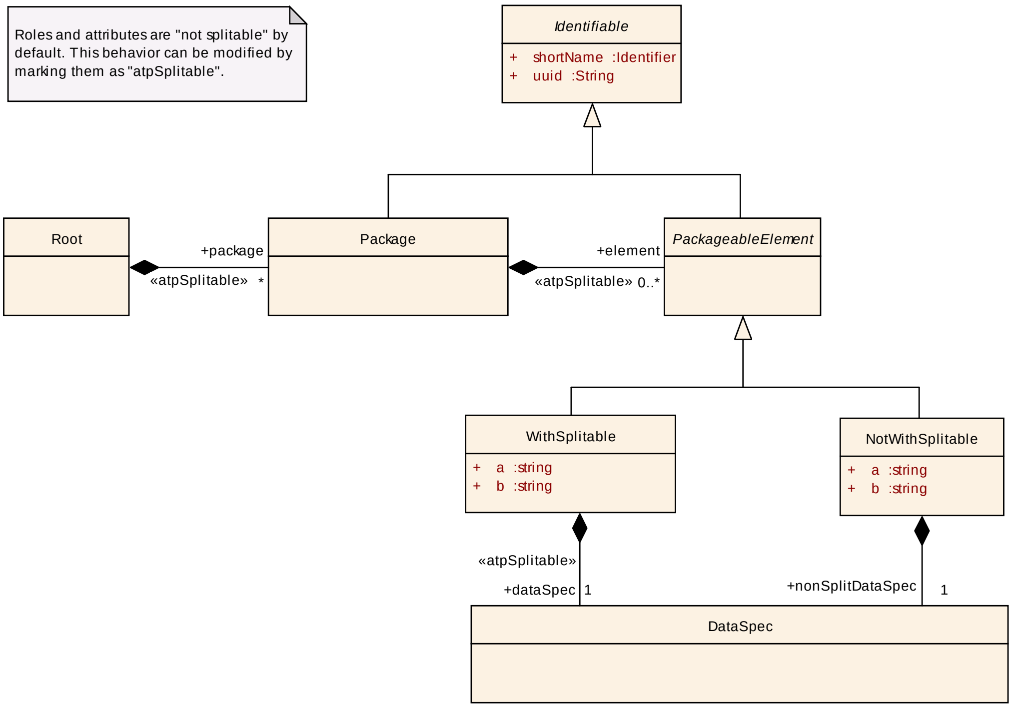


Figure 2.3: Metamodel with splitables

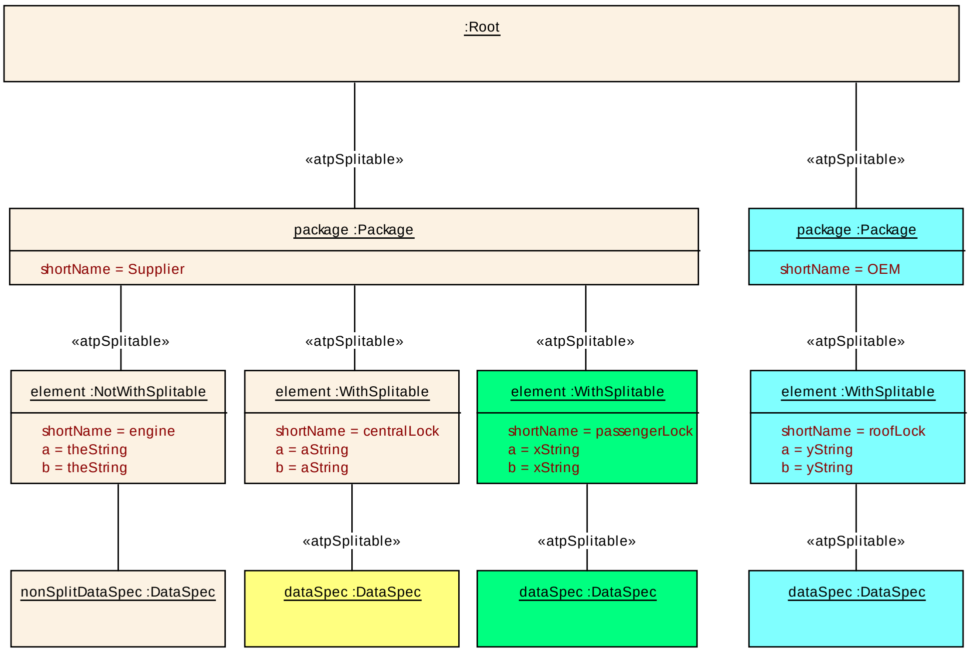


Figure 2.4: Final model after merging

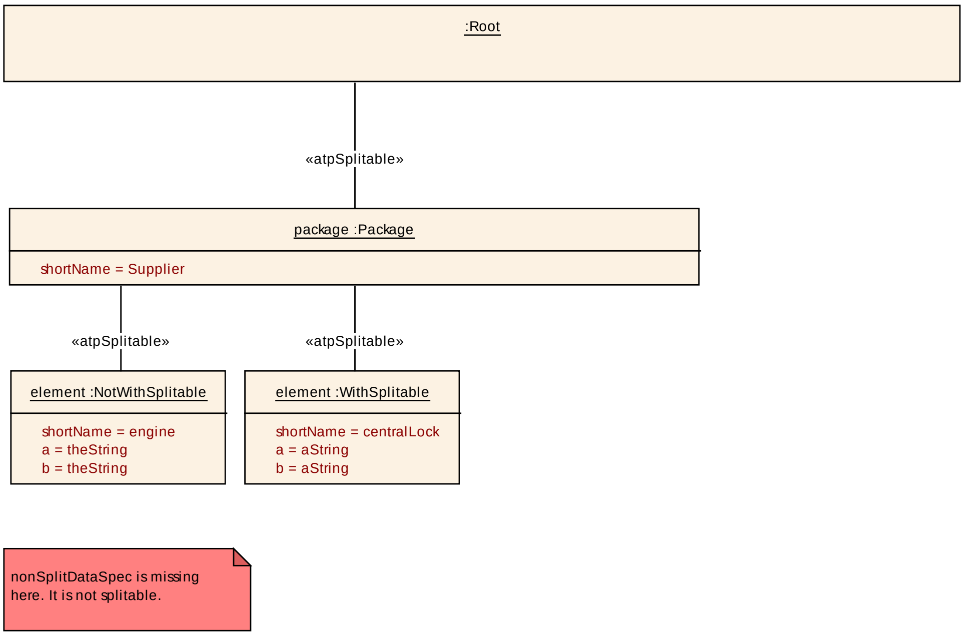


Figure 2.5: Invalid Partial Model (1)

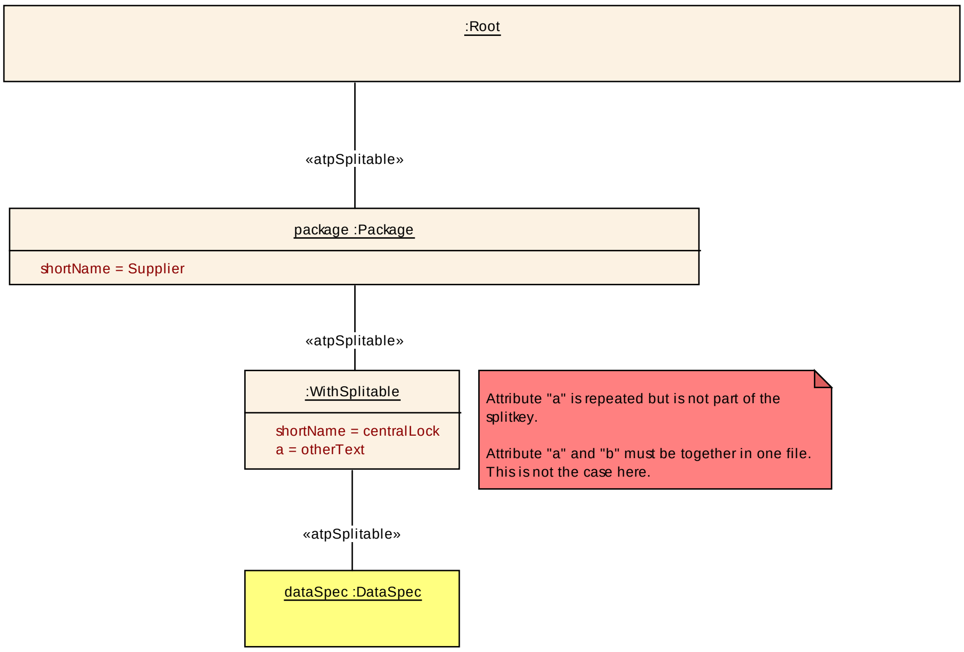


Figure 2.6: Invalid Partial Model (2)

2.4 UML Tags

The AUTOSAR Template Profile uses the following UML tags. Note that only those tags are mentioned here which directly influence the semantic content of the meta model.

[TPS_GST_00364] UML tags are attached to the target end of relations if suitable
⌈

Unless specified differently with the particular UML tag, UML tags are attached to the target end of a relation (association, aggregation). For Dependency and Generalization UML tags are associated with the connector itself (to overcome limitation of UML tool (EA) used in AUTOSAR). ⌋()

- **[TPS_GST_00049] `atp.recommendedPackage`** ⌈
  This tag provides a recommended package name for objects of the given meta class. Thereby it provides a value for `{kind}` in Chapter 3.1. Usually it is the name of the meta class to which the tag is attached. Note that

  – this tag is propagated to subclasses

  – this tag only applies to subclasses of `PackageableElement`

  ⌋()

- **[TPS_GST_00050] `atp.Splitkey`** ⌈
  This specifies the identifying key of ≪`atpSplitable`≫ relations. For more details refer to 2.3.2. The tag specifies a comma separated list of OCL expressions. These expressions can be the foundation of constructing an identifying string.

  For example if in `PhysicalChannel.iSignalTriggering` `atp.Splitkey` is set to "`shortName, variationPoint.shortLabel`", one can generate the following OCL code:

```
context: PhysicalChannel
def: iSignalTriggering_atpSplitkey : String =
     self.iSignalTriggering.shortName.concat(',')
     .concat(self.iSignalTriggering.variationPoint.shortLabel)
```

  ⌋()

[TPS_GST_00297] Tags to denote life cycle information ⌈ AUTOSAR denotes the status with respect to life cycle on entities in UML model by tags with the name `atp.Status*` and `map.Status`. ⌋()

- **[TPS_GST_00051] `atp.Status`** ⌈
  This tag allows to specify the current state of a meta model entity with respect to its life cycle. It is applicable to classes, aggregations, associations and attributes.

  The following values are supported:

  valid This indicates that the related entity is a valid part of the document. This is the default.

  draft This indicates that the related entity is introduced newly in the meta model but still experimental. This information is published but is subject to be changed without backward compatibility management.

  obsolete This indicates that the related entity is obsolete and kept in the meta model for compatibility reasons. If this tag is set, the note shall express the recommended alternative solution.

preliminary This indicates that the related entity is preliminary in the meta model. It is subject to be changed without backwards compatibility management. An AUTOSAR release does not contain such elements. It is intended for AUTOSAR internal development.

removed This indicates that the related entity is still in the meta model for whatever reason (e.g. in context of lifeCycles). It shall not be used and should not even appear in documents. An AUTOSAR release does not contain such elements. It is intended for AUTOSAR internal development.

In M1 use case, such removed elements are not included in an `.arxml` delivery but can be referenced in a `LifeCycleInfoSet` by using the ≪`atpUriDef`≫ attribute of type `Referrable`: `lcObject`, respectively `useInstead`.

shallBecomeMandatory This indicates that the related entity should be mandatory from the semantical perspective and will become mandatory in future. It is yet left optional to avoid backwards compatibility issues. Such elements should be provided whenever possible.

If the tag is not specified, the related entity is a valid part of the current meta model. The tag should be applied to the target end of an association. ⌋*()*

The tag can be applied to the association, if it is intended to be shown in notes within diagrams.

The allowed combinations of status values in classes and aggregations / references are illustrated in table 2.1. There '1' means allowed and '0' means not allowed combinations. The values 'preliminary' and 'shallBecomeMandatory' are not given in this table because they are ony dedicated for AUTOSAR internal development.

	Status of Aggregation / Reference			
Status of Class	draft	valid	obsolete	removed
draft	1	0	1	1
valid	1	1	1	1
obsolete	1	0	1	1
removed	1	0	0	1

Table 2.1: Matrix of allowed status value combinations

Note that [TPS_GST_00051] focuses on M2 entities (meta model) while [TPS_STDT_00064] expresses the same for M1 entities (model).

Note that Listing 11.1 provides these values as AUTOSAR arxml file.

- **[TPS_GST_00295]** **`atp.StatusRevisionBegin`** ⌈
  This tag indicates the AUTOSAR-Revision from which on the status denoted in `atp.Status` is viable. This corresponds to the `periodBegin` as specified in [TPS_GST_00244]. ⌋*()*

- **[TPS_GST_00296]** **atp.StatusRevisionEnd** ⌈
This tag indicates the AUTOSAR-Revision from which on the status denoted in atp.Status is viable. This corresponds to the periodEnd as specified in [TPS_GST_00244]. ⌋*()*

- **[TPS_GST_00274]** **atp.StatusComment** ⌈ This represents a short note about the current status according to [TPS_GST_00051]. It is primarily applied to status values other than "valid". ⌋*()*

- **[TPS_GST_00362]** **map.Status** ⌈ This tag allows the definition of a life cycle for upstream mappings. The values of this tagged value are linked to the values of atp.status [TPS_GST_00051]. ⌋*()*

[TPS_GST_00370] **atp.EnumerationValue** ⌈ This tag allows the definition of EnumerationValue(s). They shall not overlap each other in the context of one meta class stereotyped "enumeration". ⌋*()*

[TPS_GST_00371] Tag to control the production of specification documents ⌈ UML-Tags with the name mmt.* control the production of specification documents. ⌋*()*

- **[TPS_GST_00372]** **mmt.RestrictToStandards** ⌈ The usage of this tag controls the appearance of model elements in generated artifacts with respect to the mentioned standard. If mmt.RestrictToStandards is applied to a model element then this model element shall appear only in the generated artifacts of the standard identified by the value of mmt.RestrictToStandards. The value of mmt.RestrictToStandards can contain a comma separated list with one or more of the following values "CP", "AP", "FO", "TC", "TA". The comma may be succeeded by white-space. ⌋*()*

  The meta models of adaptive platform and classic platform are be maintained in a common model. This allows reuse of existing meta-classes. Some meta-classes will have attributes, aggregations or references that are mutually exclusive for the respective standards, i.e the attributes relevant form the classic platform shall only appear in generated artifacts for the classic platform and vice versa.

- **[TPS_GST_00353]** **mmt.templateTable** ⌈
This tag is used to associate templates with the given variation Point. The value is a white space separated list of templates denoted by names according to [TR_PDN_00003]. In particular it is the abbrName defined by a Keyword of classification DocumentAbbreviation in set "DocumentAbbreviations" specified in [6] (e.g. SWCT).

  mmt.templateTable tag is applied to any package which objects contributing to the meta model.

  mmt.templateTable applies transitively to all sub-packages of the package in which it is defined. Nevertheless sub-packages may override the value provided by mmt.templateTable on ancestor packages. ⌋*()*

[TPS_GST_00298] Tags to denote Variant Handling Properties ⌈UML- Tags with the name vh.* relate to the variant handling. ⌋*()*

- **[TPS_GST_00052]** **`vh.latestBindingTime`** ⌈
This tag controls the binding time of variant handling. ⌋*()*

  For more details see chapter 7.6 [TPS_GST_00182].

[TPS_GST_00291] UML-tags for Configuration of XML schema production ⌈ UML-Tags with the name `xml.*` relate to the XML serialization of AUTOSAR models. They basically do not influence the semantics of an M1 model, but ensure that the XML serialization can be controlled by the meta model.

They also provide means to tweak the schema such that backwards compatibility of the schema can be ensured while the meta model evolves.

For more details how to apply these tags and about the impact of these tags, refer to chapter "4 Configuration of XML schema production" in [3]. ⌋*()*

- **[TPS_GST_00053]** **`xml.xsd.*` etc.** ⌈
These tags allow to define details of primitive types by using XSD restrictions. Even if it is specified by means of a technology specific definition it applies to the meta model independently of the storage technology. ⌋*()*

- **[TPS_GST_00054]** **`xml.xsd.customType`** ⌈
This tag is applicable to a ≪`primitive`≫. It specifies the name of the `xsd:simpleType` which represents the primitive type. ⌋*()*

- **[TPS_GST_00055]** **`xml.attribute`** ⌈
determines if the UML-attribute is serialized as an XML attribute. This tag allows to control the XML serialization and is not relevant for the semantics of an M1 model. ⌋*()*

- **[TPS_GST_00056]** **`xml.attributeRef`** ⌈
determines if the UML-attribute is serialized as a reference to a global XML attribute. If set to `true` serializes the property as a reference to a global attribute. Applicable only if `xml.attribute` is set to `true`.

  The name of the referenced attribute is specified in `xml.name`. The namespace prefix of the referenced attribute is specified in `xml.nsPrefix`. ⌋*()*

- **[TPS_GST_00057]** **`xml.enforceMinMultiplicity`** ⌈
If true, enforce minimum multiplicity; otherwise, it is "0". In order to allow for transmitting partial information, the minimum multiplicity is not enforced by default in the standardized schema. ⌋*()*

- **[TPS_GST_00058]** **`xml.enforceMaxMultiplicity`** ⌈
If true, enforce maximum multiplicity; otherwise, it is "unbounded". By default `xml.enforceMaxMultiplicity` is true. ⌋*()*

- **[TPS_GST_00059]** **`xml.globalElement`** ⌈
If true, a global `xsd:element` is created for the tagged class. This `xsd:element` can be used as the root element of an instance of the schema. This tag needs to be explicitly defined in the AUTOSAR meta-model. Usually only the meta-class AUTOSAR is represented by a globally defined XML element. ⌋*()*

- **[TPS_GST_00060]** **`xml.mds.type`** ⌈
determines the data type for a primitive if this is a primitive type generated by the meta model tool. Major example for such a generated type is given by `REFERRABLE-SUBTYPES-ENUM`. This tag shall be applied to a ≪`primitive`≫ which then acts as a proxy to the type denoted in `xml.mds.type`. ⌋*()*

- **[TPS_GST_00061]** **`xml.name`** ⌈
Provides the name of a schema fragment (element, attribute, group, etc.) that represents the role or class.

  If not explicitly defined in the AUTOSAR meta model, then this value is calculated as explained in [3]. ⌋*()*

- **[TPS_GST_00062]** **`xml.nsPrefix`** ⌈
This tag may be applied to

  attribute determines the name space prefix for properties with `xml.attributeRef` set to `true`

  package determines the name space prefix used for the schema based on this package.

  ⌋*()*

- **[TPS_GST_00063]** **`xml.nsUri`** ⌈
determines the name space URI used for the schema based on this package. The format of the name space URI is defined in [3]. If not explicitly defined in the AUTOSAR meta model, then this value is implicitly specified as explained in [3]. ⌋*()*

- **[TPS_GST_00064]** **`xml.roleElement`**, **`xml.roleWrapperElement`**, **`xml.typeElement`**, **`xml.typeWrapperElement`** ⌈
These tags allow to control the XML serialization, in particular the creation of XML-Elements and are not relevant for the semantics of an M1 model. For more details see [3]. ⌋*()*

- **[TPS_GST_00065]** **`xml.sequenceOffset`** ⌈
Determines the sequence in which the properties are serialized in XML. If this tag is missing, the properties are serialized in alphabetical order. This sequence is relevant for easier maintenance of the XML artifacts but are not relevant for the semantics of an M1 Model. ⌋*()*[6]

- **[TPS_GST_00066]** **`xml.systemIdentifier`** ⌈
Determines the System identifier which should be used in instances dedicated to this schema. If not explicitly defined in the AUTOSAR meta model, then this value is implicitly specified as explained in [3]. ⌋*()*

[TPS_GST_00292] Adminstrative UML Tags ⌈ For document administration of the meta model, the UML tags with the name pattern `admin.*` are applied to a particular package (for example `M2::AUTOSAR Templates::ReadMe`). If

[6] If the sequence is relevant, this is denoted as {ordered} mutltiplicity in the model.

this package is referenced in the configuration files of the Meta Model Tool the values are forwarded to the generated artifacts (e.g. MMOD_XMLSchema or MOD_ECUConfigurationParameters).

In addition to the UML tags the disclaimer for the generated artifacts is taken from the package note of this package.⌋*()*

The following UML tags apply:

- **[TPS_GST_00067]** **`admin.documentClassification`** ⌈
  Denotes the classification of the meta-model (Standard resp. Auxiliary) ⌋*()*
- **[TPS_GST_00068]** **`admin.documentIdentificationNo`** ⌈
  This represents the AUTOSAR document number. ⌋*()*
- **[TPS_GST_00069]** **`admin.documentOwner`** ⌈
  This denotes the maintainer of the meta-model. ⌋*()*
- **[TPS_GST_00070]** **`admin.documentResponsibility`** ⌈
  This denotes the responsible authority of the meta-model. ⌋*()*
- **[TPS_GST_00071]** **`admin.documentStatus`** ⌈
  This denotes the status of the meta-model. ⌋*()*
- **[TPS_GST_00072]** **`admin.documentTitle`** ⌈
  This denotes the title assigned to the meta-model. ⌋*()*
- **[TPS_GST_00073]** **`admin.documentVersion`** ⌈
  This denotes the official version of the meta-model. Note that the document version is not related to the `admin.partOfRelease` so a version number like 3.1.12 doesn't necessarily refer to the R3.1 branch of AUTOSAR. ⌋*()*
- **[TPS_GST_00074]** **`admin.partOfRelease`** ⌈
  This denotes the AUTOSAR release in which the meta-model is published. Note that this tag is necessary as it's being used by the tooling in order to control the details of various generators such as:
  - the insertion of hardwired `xsd:simpleType` named `REF` for AUTOSAR release less than 4.0.
  - the processing of primitives according to Chapter 6.3.1.
  - structural differences of artifacts (e.g. classtables) among the AUTOSAR releases.

  ⌋*()*
- **[TPS_GST_00075]** **`admin.releaseDate`** ⌈
  This denotes the date of the AUTOSAR release in which the meta-model is published ⌋*()*

- **[TPS_GST_00076] `admin.revision`** ⌈
  denotes the particular revision of the AUTOSAR release in which the meta-model is published. ⌋*()*

[TPS_GST_00299] Tags to specify Upstream Mapping ⌈ UML-Tags with the name `map.{template}.*` relate to the description of upstream mapping. Upstream mapping describes if and how entities (M1 or M2) in artifacts crated latter in the methodology (also called downstream) relate to entities created earlier (also called upstream). ⌋*()*

- **[TPS_GST_00301] Placeholder `{template}` in Upstream Mapping Specification Tags** ⌈ This denotes the applicable upstream template, in which the mapping will be listed. These names follow [TR_PDN_00003]. In particular it is the `abbrName` defined by a `Keyword` of `classification` `DocumentAbbreviation` in set "DocumentAbbreviations" specified in [6] (e.g. `SWCT`). ⌋*()*
- **[TPS_GST_00300] `map.{template}.desc`** ⌈ This provides a description of the mapped entity. ⌋*()*
- **[TPS_GST_00302] `map.{template}.m2element`** ⌈ This denotes the reference to M2 entity, e.g. `SystemSignal.length` ⌋*()*
- **[TPS_GST_00303] `map.{template}.rule`** ⌈ This gives textual description how to transform the data, e.g. 1:1 mapping ⌋*()*
- **[TPS_GST_00304] `map.{template}.type`** ⌈ This represents the mapping quality. The following values apply:

  local no mapping needed since parameter local to BSW

  partial some data can be automatically mapped but not all

  full all data can be mapped automatically

  ⌋*()*

[TPS_GST_00363] map.Id ⌈ This tag allows the unique identification of a given upstream mapping for the purpose of tracing. ⌋*()*

3 Autosar Top Level Structure

AUTOSAR uses a common top level structure for all AUTOSAR templates. This approach leaves maximum flexibility to design the artifacts in the AUTOSAR methodology. Figure 3.1 illustrates the AUTOSAR top level structure.

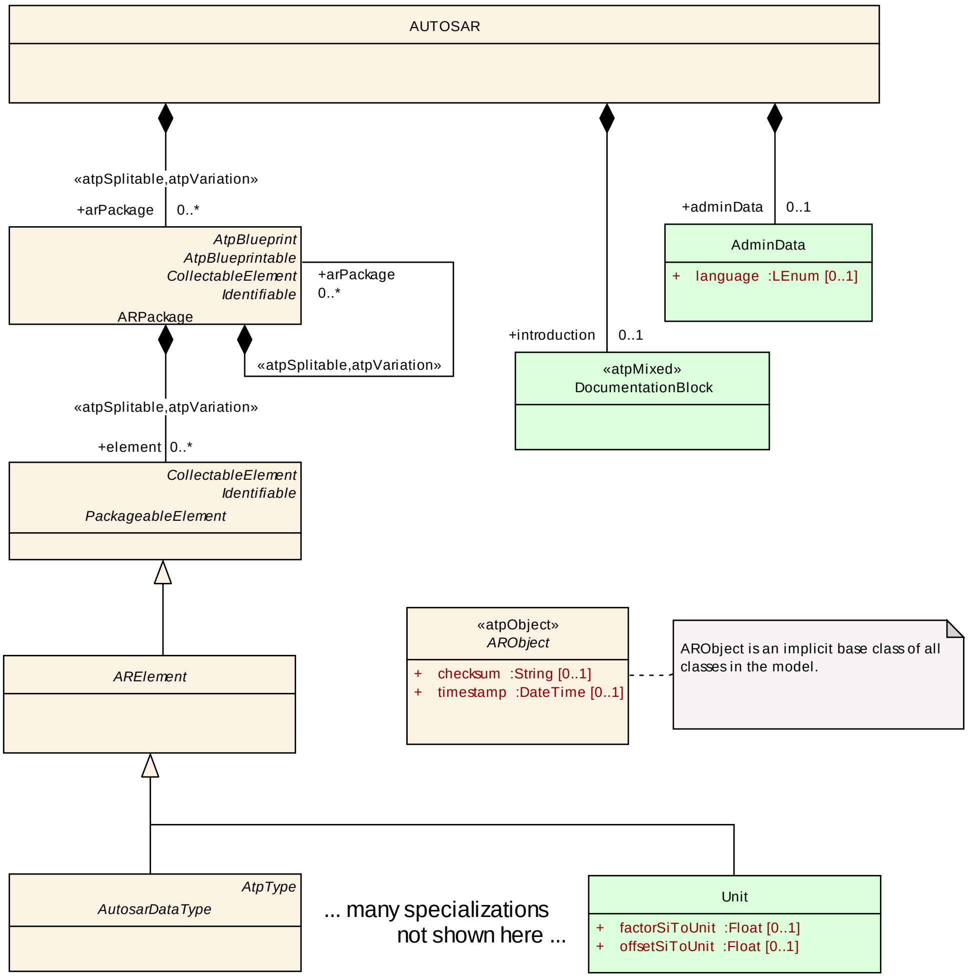


Figure 3.1: Top level structure of AUTOSAR templates

[TPS_GST_00077] Top-Level Structure of an AUTOSAR Model ⌈ The meta-class `AUTOSAR` is the root of all templates. `AUTOSAR` contains multiple `ARPackage`s as `arPackage`. ⌋*()*

`ARPackage` can be arbitrarily nested. These packages contain `PackageableElement`s which represent particular autonomous entities of AUTOSAR templates. The most prominent specialization of this is `ARElement` (see Chapter 4.2).

Note that all[1] AUTOSAR meta-classes inherit from `ARObject` (see Chapter 4.1).

[TPS_GST_00078] AUTOSAR top level AdminData ⌈ The top level structure also contains `AdminData` which specifies two major aspects of an AUTOSAR artifact:

[1] Obviously `ARObject` dos not inherit from itself.

- change management information specified as DocRevision
- language status of the document

⌋()

For more details see Chapter 4.4).

[TPS_GST_00079] Language Status of an Artifact ⌈ The language status of the artifact specifies:

1. the "master" language of the document specified in the attribute language in the top level AdminData.
2. the additional languages which are in the document. This is specified as usedLanguages which is a MultiLanguagePlainText which serves as a list of languages used in the document.

⌋()

For more details on the multi language approach see Chapter 8.6. The following example illustrates the top-level structure of an ARXML file. This file is maintained in English as well as in German. English is the master language.

Listing 3.1: Top-Level Structure of an ARXML file

```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xmlns="http://autosar.org/schema/r4.0"
      xsi:schemaLocation="http://autosar.org/schema/r4.0 AUTOSAR_4-1-3.xsd"
         >
  <ADMIN-DATA>
    <LANGUAGE>EN</LANGUAGE>
    <USED-LANGUAGES>
      <L-10 L="EN" xml:space="default">English</L-10>
      <L-10 L="DE" xml:space="default">German</L-10>
    </USED-LANGUAGES>
  </ADMIN-DATA>
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>demo</SHORT-NAME>
      <ELEMENTS>
        <!--
          autosar elements here
        -->
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

Class	**AUTOSAR**			
Package	M2::AUTOSARTemplates::AutosarTopLevelStructure			
Note	Root element of an AUTOSAR description, also the root element in corresponding XML documents. **Tags:** xml.globalElement=true			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
adminData	AdminData	0..1	aggr	This represents the administrative data of an Autosar file. **Tags:** xml.sequenceOffset=10
arPackage	ARPackage	*	aggr	This is the top level package in an AUTOSAR model. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variation Point.shortLabel vh.latestBindingTime=blueprintDerivationTime xml.sequenceOffset=30
introductio n	Documentation Block	0..1	aggr	This represents an introduction on the Autosar file. It is intended for example to rpresent disclaimers and legal notes. **Tags:** xml.sequenceOffset=20

Table 3.1: AUTOSAR

An AUTOSAR artifact is organized in `ARPackage`s which contains so called `PackageableElement`s elements. These are defined on its own nature, they exist independently from each other and are used by associations. For example a computation method is defined on its own. It is used by data definitions through a reference.

For more details about `ARPackage` please refer to Chapter 4.2.

3.1 Identifying M1 elements in packages

Packages are are used to organize AUTOSAR M1 models. AUTOSAR Gbr itself publishes M1 models as part of the released standard. In order to clearly identifying such model elements, the following rules apply:

- **[TPS_GST_00080] Package Structure for AUTOSAR delivered Models** ⌈ Model elements standardized by AUTOSAR and delivered as ARXML live in a top-level Package of which the `shortName` is `AUTOSAR`.

  This means that data elements which are defined by an OEM or supplier should **not** live in a top level package named `AUTOSAR`. ⌋*()*

  [TPS_GST_00081] Pattern for AUTOSAR delivered Models ⌈ The package structure of AUTOSAR delivered models follow the pattern:

```
/AUTOSAR
    /{module}                                        -- identify the spec
       /{kind}s[_Blueprint | _Example]               -- identify the kind
                                                     --         of object
```

⌋()

Note that AUTOSAR typically delivers Blueprints. For more details see [TPS_STDT_00067].

An example structure is

```
/AUTOSAR
    /ComM
       /ApplicationDataTypes_Blueprint        [BLUEPRINT]
       /BswModuleEntrys_Blueprint             [BLUEPRINT]
       /CompuMethods_Blueprint                [BLUEPRINT]
       /DataConstrs_Blueprint                 [BLUEPRINT]
       /DataTypeMappingSets_Blueprint         [BLUEPRINT]
       /Documentations                        [STANDARD]
       /ImplementationDataTypes_Blueprint     [BLUEPRINT]
       /ImplementationDataTypes               [STANDARD]
       /ModeDeclarationGroups_Blueprint       [BLUEPRINT]
       /SwcBswMappings_Blueprint              [BLUEPRINT]
       /SwComponentTypes_Blueprint            [BLUEPRINT]
       /BswModuleDescriptions_Blueprint       [BLUEPRINT]
```

In this example, there is a package with blueprints for implementation data types as well as for implementation data types which are finally implemented as STANDARD.

Another example is

```
/AUTOSAR
    /AISpecification
       /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]
```

This example shows a use case which provides STANDARD, BLUEPRINT and EXAMPLE.

[TPS_GST_00082] Package Structure for ECUC parameter definitions ⌈
Note that that for compatibility reasons, the ECUC package structure is kept in AUTOSAR 4.0 as

```
/AUTOSAR
      /EcucDefs
```

⌋*()*

- **[TPS_GST_00083] Pattern for AUTOSAR defined Model Elements** ⌈ Model elements for which AUTOSAR specification already defines a standardized name (such as platform types) shall live in a package path according to the following pattern:

  `/AUTOSAR_{module}[_{postfix}]/{kind}s` ⌋*()*

In these given patterns, the following placeholders apply:

- **[TPS_GST_00017] `{module}` denotes a Module Designator** ⌈ The module designator is one of
  - the module, library etc. (as API service prefix according to [7] (e.g. `CanIf`, `Ifx`, `Compiler`)
  - the `abbrName` defined by a `Keyword` of `classification` `ModuleDesignator` in set "VirtualModules" specified in [6] (e.g. `AISpecification`).

  ⌋*()*
- **[TPS_GST_00084] `{postfix}` denotes the particular implementation** ⌈ If and only if multiple implementations of the BSW Module appear in the same system the a postfix is added to the package structure. ⌋*()*
- **[TPS_GST_00085] `{kind}` denotes the kind of element** ⌈ The value is the name of a subclass of `ARElement` with an appended plural-'s'. The particular package names are specified for each `ARElement` using the UML tag `atp.recommendedPackage` (see [TPS_GST_00049]) and shown as such in the class tables (e.g. `BswModuleDescriptions` derived from `BswModuleDescription`. ⌋*()*

[TPS_GST_00086] Category of `ARPackage` ⌈ Packages have a `category` indicating if the elements in this package are used for reference purposes or if they are used for processing. The standardized values are `STANDARD`, `BLUEPRINT`, `EXAMPLE`. ⌋*()*

- **[TPS_GST_00087] `BLUEPRINT`** ⌈
  Elements in such a package act as a kind of “blueprint” for real objects.

  This applies in particular to objects such as `PortInterface` which are not modeled particularly to be a “blueprint” but still are specializations of `AtpBlueprint` respectively `AtpBlueprintable`. ⌋*()*

For example, an authoring tool provides the such predefined `PortInterface` as a kind of toolbox from which the definitions can be copied to a real project.

Model elements in such packages may be only defined partially. Therefore particular semantic constraints may apply. See [TPS_STDT_00002] in [2] for more details.

[constr_2501] Blueprint of blueprints are not supported ⌈ Note that objects modeled particularly as a "blueprint" (e.g. `PortPrototypeBlueprint`) also live in a package of category `BLUEPRINT`. Strictly speaking this means that they can be "blueprints" of "blueprints". This indirection is not intended and not supported. ⌋*()*

- **[TPS_GST_00088] `STANDARD`** ⌈
  Elements which are standardized by the submitter of the related top level package and can be used as is for processing (e.g. ECU Parameter definitions). ⌋*()*

  Note that this also allows to represent stakeholder specific standard elements since `STANDARD` is not limited to AUTOSAR internal application.

- **[TPS_GST_00196] `ICS`** ⌈
  Elements which form an Implementation Conformance Statement. ⌋*()*

  [constr_4055] ICS may not contain blueprints ⌈ Since an Implementation Conformance Statement always describes a set of one or more fully configured software modules, a package with category `ICS` it is not allowed to contain subpackages at any level which have the category `BLUEPRINT`. ⌋*()*

  [constr_2573] ICS shall not reference examples ⌈ ICS is like a productive Model and therefore shall not reference to an `EXAMPLE`. Such a reference would be useless since the target needs to be ignored in the ICS. ⌋*()*

  For more details on the content of an Implementation Conformance Statement refer to [8].

- **[TPS_GST_00089] `EXAMPLE`** ⌈
  Elements in `EXAMPLE` package illustrate how to apply for example Elements defined in `STANDARD` or `BLUEPRINT` packages. Elements in `EXAMPLE` packages shall be ignored by generators etc. ⌋*()*

[TPS_GST_00090] Non Standardized Category of `ARPackage` ⌈ Model elements which do not fall in to one of these categories should live in a package with a `category` mutually agreed between the stakeholders. It is also possible to have no `category` at all in this case. ⌋*()*

[constr_2515] Avoid conflicting package categories ⌈ Note that it is in the responsibility of the stakeholders to ensure that no conflicting category occurs. ⌋*()*

It is possible to maintain a reference from a blueprint to the "actual" objects which were derived from this blueprint. The meta-class `BlueprintMappingSet` can be used for this. Particular compatibility rules may be applicable and defined in the appropriate templates. For more details refer to [2].

Class	**BlueprintMappingSet**			
Package	M2::AUTOSARTemplates::StandardizationTemplate::BlueprintMapping			
Note	This represents a container of mappings between "actual" model elements and the "blueprint" that has been taken for their creation. **Tags:** atp.recommendedPackage=BlueprintMappingSets			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
blueprintMap	AtpBlueprintMapping	*	aggr	This represents a particular blueprint map in the set.

Table 3.2: BlueprintMappingSet

3.2 The role of ARPackage, ARElement and Identifiable et. al.

The AUTOSAR meta model uses some abstract classes which represent various abilities with respect of model organization. A synopsis of the same is provided in Figure 3.2.

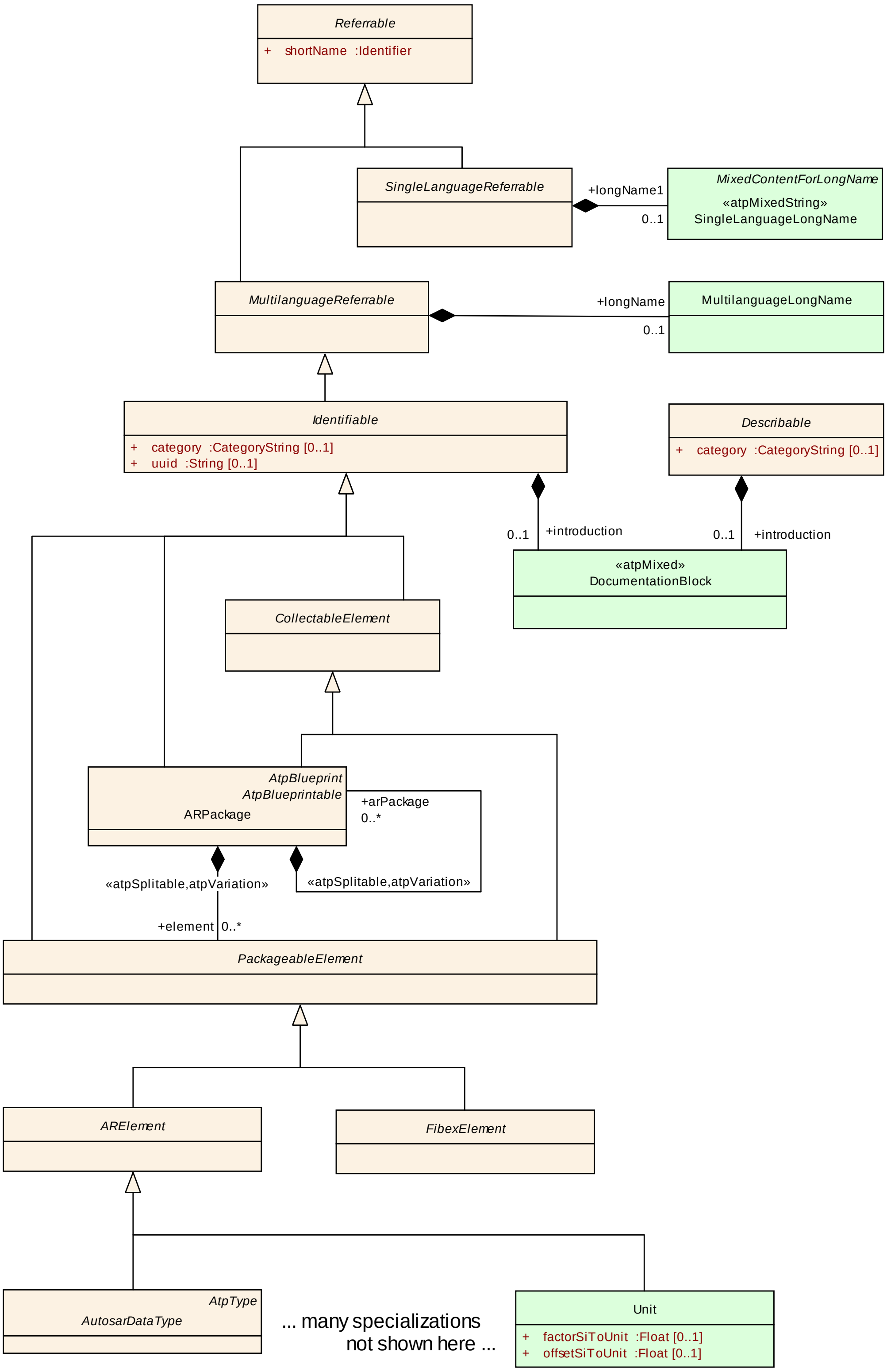


Figure 3.2: Synopsis of model organization classes

About `Referrable`:

- `Referrable` is an abstract meta class which has a `shortName` acting as a target for references. `Referrable` is mainly used for reference targets with a small footprint such as Sdg. Referrable is specialized in SingleLanguageReferrable/MultilanguageReferrables.

- Specialization s of SingleLanguageReferrable are applicable as elements which are embedded in a text which is already part of a multilingual object (so called inline elements as described in Chapter 8.2.8).
- Specializations of MultilanguageReferrables apply to multilingual objects which should have a relatively small footprint such as DefList, Traceable.

About Describable:

- Describable is an abstract meta class which represents the ability to provide a description but not being Referrable or Identifiable. It is mentioned here for completeness.

About Identifiable:

- Identifiable is an abstract class which inherits from MultilanguageReferrable. This is used to identify the essential objects in an AUTOSAR model. Related to Referrable it provides further means to identify the element such as desc. Obviously anything which can be identified shall also be referable. Therefore, Identifiable is a specialization of Referrable.
- Nested Identifiables establish a **hierarchical name space**.

  Note that if Referrable would contain further Referrables it would **not** be a hierarchical name space because name spaces are established by Identifiable only[2].

  See chapter 4.3.1 for more details.
- arPackage in AUTOSAR is the top-most Identifiable in an AUTOSAR model. This top-level ARPackage is the root of the name space hierarchy.
- The shortName of an Identifiable (more precisely of an Referrable) must be (case insensitively) unique in the containing Identifiable. Examples are
  - shortName of an ARElement (e.g. ApplicationSwComponentType) must be unique within ARPackage (which is Identifiable). But there might be other ApplicationSwComponentTypes with the same shortName in a **different** ARPackage.
  - The shortName of an PortPrototype must be unique within an ApplicationSwComponentType (which is Identifiable). But there might be PortPrototypes of the same name in other ApplicationSwComponentTypes.

About CollectableElement:

[2]Nevertheless such a nesting of Referrables does not occur in the AUTOSAR meta model.

- CollectableElement represents the ability to be part of a collection (in particular to be referenced by a collection). This meta class does not introduce further attributes nor further possible aggregations.
- Even if CollectableElement is similar to ARElement it is not the same because it handles an entirely different aspect.

About ARPackage:

- ARPackage can be nested: ARPackage can contain ARPackage in the role arPackage.
- Thereby ARPackage consists of nested branches (ARPackages) and leaves (subclasses of PackageableElement, in particular subclasses of ArElement).
- ARPackage is a specialization of Identifiable. Otherwise it would not contribute to the name space hierarchy.
- PackageableElement is an abstract class which represents the ability that the objects can be defined stand-alone. These objects do not require a context. Such objects are sometimes called "first class citizens".
- PackageableElement (ARElement FibexElement) cannot contain further PackageableElements (ARElements resp. FibexElement).

About ARElement and FibexElement:

- ARElement is an abstract class which contributes to an AUTOSAR model in general.
- FibexElement is an abstract class which represents the ability that the elements contribute particularly to the description of communication and topology of a system.
- ARElement and FibexElement is Identifiable. So the derived elements also have a shortName.
- ARElement FibexElement may contain further elements derived from Identifiable. An example for this is ApplicationSwComponentType which is of class PPortPrototype.

4 General Template Classes

The nature of the general template classes given below is similar to the standard library of a compiler: a set of predefined structures and elements to be used in an AUTOSAR template model.

4.1 ARObject - Common Attributes for all Classes

[TPS_GST_00091] ARObject ⌈ ARObject is one meta-class which is inherited by all other meta-classes. ⌋*()*

The related pattern is shown in Figure 6.9.

Class	**ARObject (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ArObject			
Note	Implicit base class of all classes in meta-model.			
Base				
Attribute	***Type***	***Mul.***	***Kind***	***Note***
checksum	String	0..1	attr	Checksum calculated by the user's tool environment for an ArObject. May be used in an own tool environment to determine if an ArObject has changed. The checksum has no semantic meaning for an AUTOSAR model and there is no requirement for AUTOSAR tools to manage the checksum. **Tags:** xml.attribute=true; xml.name=S
timestamp	DateTime	0..1	attr	Timestamp calculated by the user's tool environment for an ArObject. May be used in an own tool environment to determine the last change of an ArObject. The timestamp has no semantic meaning for an AUTOSAR model and there is no requirement for AUTOSAR tools to manage the timestamp. **Tags:** xml.attribute=true; xml.name=T

Table 4.1: ARObject

4.2 Packages in Autosar

AUTOSAR M1 models can be organized as a number of packages, represented by class ARPackage. It allows allows to put together the model elements, e.g. in form of an OEM or project specific package containing entities like a windshield wiper software component.

The self aggregation (role arPackage) shows that packages may in fact contain other packages. Besides those, a package may contain an arbitrary number of elements, represented by the abstract class ARElement. Such an AUTOSAR element is an entity for which it makes sense to be defined in its own semantic context (stand-alone). An example for such an ARElement is the definition of a reusable software component type. On the other hand a parameter of an operation does not make sense to be defined stand-alone since its semantics is defined within and therefore highly dependent on the enclosing context: the operation.

[TPS_GST_00092] The purpose of a ARPackage ⌈ The purpose of ARPackage is to

- organize AUTOSAR M1 models and establish a name space for the elements in the package (as all Identifiables do)
- define the basis for relative references

⌋*()*

For details about relative references, see chapter 6.3.2.2.

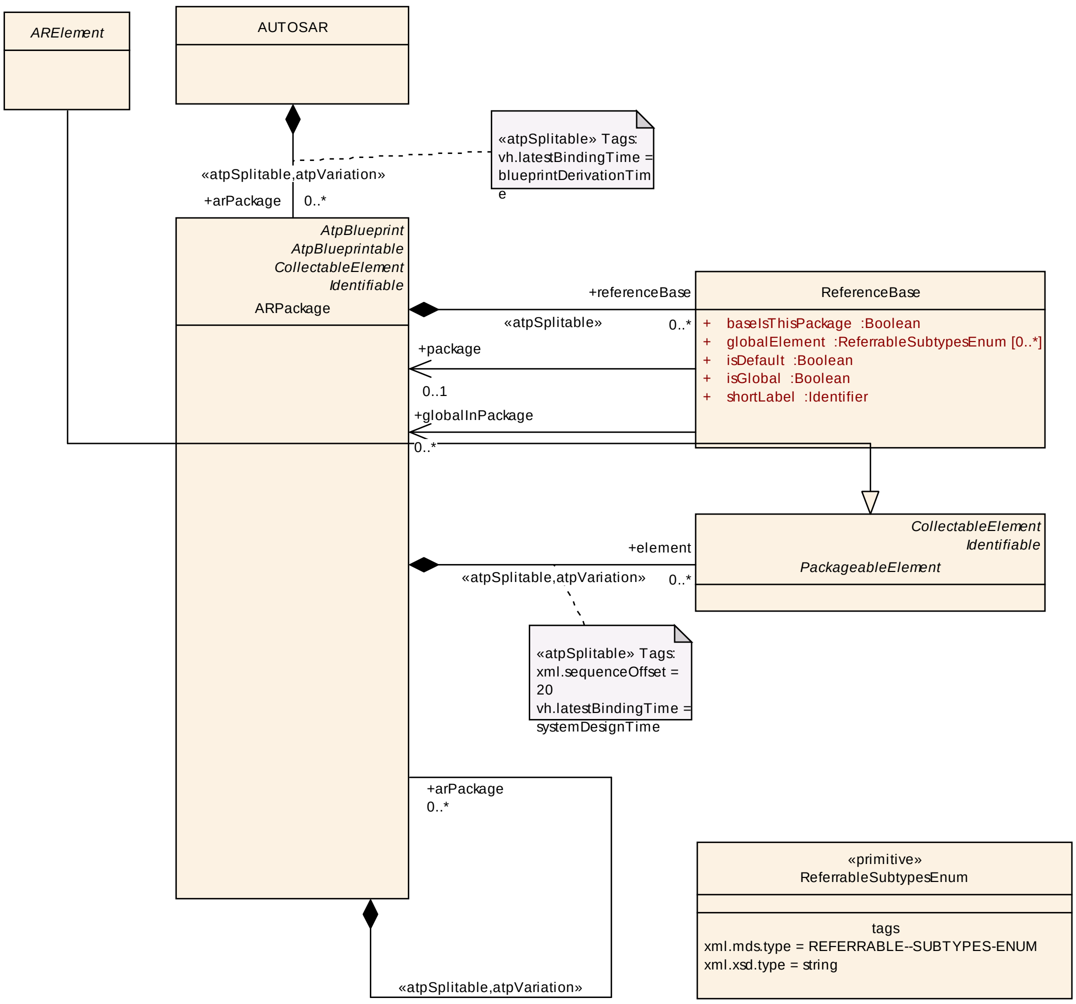


Figure 4.1: AUTOSAR package

Note that the aggregation of ARElement in ARPackage is subject to variation. The main use-case for this is to specify component alternatives with different interfaces within a product line architecture.

[constr_2537] Variation of PackageableElement is limited to components resp. modules ⌈ Variation of ARElement in ARPackage shall be applied only to elements on a kind of component level. In particular this is BswModuleDescription, Documentation, Implementation, SwComponentType, TimingExtension. This constraint only applies if the PackageableElement is not a blueprint. ⌋*()*

[constr_2509] ReferenceBase needs to be unique in a package ⌈ The shortLabel of a reference base needs to be unique in (not within) a package. Note that it is not necessary to be unique within (to say in deeper levels) of a package. ⌋*()*

[constr_2510] only one default ReferenceBase ⌈ Only one ReferenceBase per level can be marked as default (default="true"). ⌋*()*

[constr_2574] globalInPackage for global elements only ⌈ ReferenceBase.globalInPackage is allowed only if isGlobal is set to true. ⌋*()*

[constr_2538] Global reference is limited to certain elements ⌈ The ability to perform a global reference is limited to Chapter, Topic1, Caption, Traceable, XrefTarget, Std, Xdoc, Xfile ⌋*()*

Class	**ARPackage**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ARPackage			
Note	AUTOSAR package, allowing to create top level packages to structure the contained ARElements. ARPackages are open sets. This means that in a file based description system multiple files can be used to partially describe the contents of a package. This is an extended version of MSR's SW-SYSTEM.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
arPackage	ARPackage	*	aggr	This represents a sub package within an ARPackage, thus allowing for an unlimited package hierarchy. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=blueprintDerivationTime xml.sequenceOffset=30
element	PackageableElement	*	aggr	Elements that are part of this package **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=systemDesignTime xml.sequenceOffset=20

referenceBase	ReferenceBase	*	aggr	This denotes the reference bases for the package. This is the basis for all relative references within the package. The base needs to be selected according to the base attribute within the references. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=shortLabel xml.sequenceOffset=10

Table 4.2: ARPackage

Class	**PackageableElement (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ARPackage			
Note	This meta-class specifies the ability to be a member of an AUTOSAR package.			
Base	ARObject, CollectableElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.3: PackageableElement

Class	**ARElement (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ARPackage			
Note	An element that can be defined stand-alone, i.e. without being part of another element (except for packages of course).			
Base	ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.4: ARElement

Class	**ReferenceBase**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ARPackage			
Note	This meta-class establishes a basis for relative references. Reference bases are identified by the shortLabel which must be unique in the current package.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

baseIsThis Package	Boolean	1	attr	This indicates that this base is established by the current package. In this case the association "package" can be derived as the qualified shortName of the enclosing package. If the value of baseIsThisPackage is set to true then one of the following must be true: • target of the association "package" must be the enclosing package. • association "package" is omitted. **Tags:** xml.sequenceOffset=28
globalElem ent	ReferrableSubty pesEnum	*	attr	This attribute represents a meta-class for which the global referencing is supported via this reference base. **Tags:** xml.sequenceOffset=29
globalInPa ckage	ARPackage	*	ref	This represents the ability to express that global elements live in various packages which do not have a common ancestor package. Packages mentioned by ReferenceBase.globalInPackage are used in addition to the one in ReferenceBase.package. **Tags:** xml.sequenceOffset=28
isDefault	Boolean	1	attr	This attribute denotes if the current ReferenceBase is the default. Note that there can only be one default reference base within a package. **Tags:** xml.sequenceOffset=20
isGlobal	Boolean	1	attr	This indicates that the target of the applicable reference can be resolved via the non-qualified shortName. This requires that the shortName of the target is unique within the package referenced in the reference base. The default is false. Note that the reference base also maintains a list of elements which may be referenced using a "global Reference". **Tags:** xml.sequenceOffset=25
package	ARPackage	0..1	ref	This association specifies the basis of all relative references with the base equals shortLabel. This association must exist unless the value of baseIsThisPackage is set to true. **Tags:** xml.sequenceOffset=30

shortLabel	Identifier	1	attr	This is the name of the reference base. By this name, particular references can denote the applicable base. **Tags:** xml.sequenceOffset=10

Table 4.5: ReferenceBase

Primitive	**ReferrableSubtypesEnum**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ARPackage
Note	This primitive is a proxy for an enum generated by the MMT. It allows to refer to any subclass of Referrable. Due to technical reasons the possible values are not shown in this class table. **Tags:** xml.mds.type=REFERRABLE–SUBTYPES-ENUM; xml.xsd.type=string

Table 4.6: ReferrableSubtypesEnum

4.3 Identifiable and Referrable

[TPS_GST_00095] Main Purpose of `Identifiable` ⌈ The abstract base class `Identifiable` represents the ability to contribute significantly to the technical structure of an AUTOSAR system. ⌋*()*

[TPS_GST_00096] Main Purpose of `Referrable` ⌈ The abstract base class `Referrable` represents the ability to be the target of a reference. Such references can be simply links in a documentation or association contributing to the data model of an AUTOSAR system. ⌋*()*

It is important to understand the big picture of the properties of `Identifiable`. First, there are properties which have an identifying purpose:

- **[TPS_GST_00097] Purpose of `shortName`** ⌈ The `shortName` (provided by `Referrable`) unambiguously identifies the object within the context given by the first ancestor `Identifiable`. ⌋*()*

  [TPS_GST_00098] Recommendation to Choose Human Readable `shortNames` ⌈ It is intended that `shortName`s are "speaking names" but can also be used for reference purposes. ⌋*()*

- **[TPS_GST_00099] Purpose of `longName`** ⌈ `longName` (provided by `MultilanguageReferrable`) which contains the headline of the object as **single line** of text. The content `longName` is targeted to human readers. Therefore the long name can be described in different languages. ⌋*()*

- **[TPS_GST_00100] Purpose of `desc`** ⌈ `desc` which contains a brief description of **what** the object is. This is intended to help a human being to identify the object. It is one **single paragraph** also provided in multiple languages. ⌋*()*

- **[TPS_GST_00101] Purpose of adminData** ⌈ adminData contains administrative information about the object such as version information, language setting etc. This information also has identifying character. ⌋*()*
- **[TPS_GST_00365] Purpose of uuid** ⌈ uuid may be used in an user's tool environment to uniquely identify AUTOSAR elements, for example, when merging AUTOSAR elements into a company-specific data base. The uuid has no semantic meaning for an AUTOSAR model and there is no requirement for AUTOSAR tools to manage the uuid. ⌋*()*

In addition to these identifying properties, Identifiable carries further properties which are of specifying purpose. For simplification of the model, these properties are defined in Identifiable since they apply to mostly all identifiable objects representing the technical structure of an AUTOSAR system:

- **[TPS_GST_00102] Purpose of category** ⌈ category contains a keyword expressing a specific use case of the Identifiable. To some extent category can be compared with stereotypes in UML. The applicable categories are specified in the constraints of the objects in question. ⌋*()*

  [TPS_GST_00016] Values for category ⌈In general it is allowed to extend the categories defined in the template specifications by user-defined values. In this case the user is responsible to avoid any conflict with existing or future defined AUTOSAR categories. This can be achieved for example by using an appropriate prefix.

  Anyhow the constraints of specific elements may restrict the category to exactly the defined ones and in this case an extension is not allowed. ⌋*()*
- **[TPS_GST_00103] Purpose of introduction** ⌈ introduction contains introductory documentation about **how** the identified object is built or maybe used. ⌋*()*
- **[TPS_GST_00104] Purpose of annotation** ⌈ annotation contains development annotations ⌋*()*

  For more details on Annotation see chapter 4.10).

As an example, these properties for the AUTOSAR project would be:

- shortName: AUTOSAR
- longName: AUTomotive Open Systems ARchitecture
- desc: AUTOSAR is an open and standardized automotive software architecture, jointly developed by automobile manufacturers, suppliers and tool developers.
- introduction:

  AUTOSAR

  – paves the way for innovative electronic systems that further improve performance, safety and environmental friendliness

– is a strong global partnership that creates one common standard: "Cooperate on standards, compete on implementation"

– ...

The base class `Identifiable` has further content related attributes, which are shown in figure 4.2:

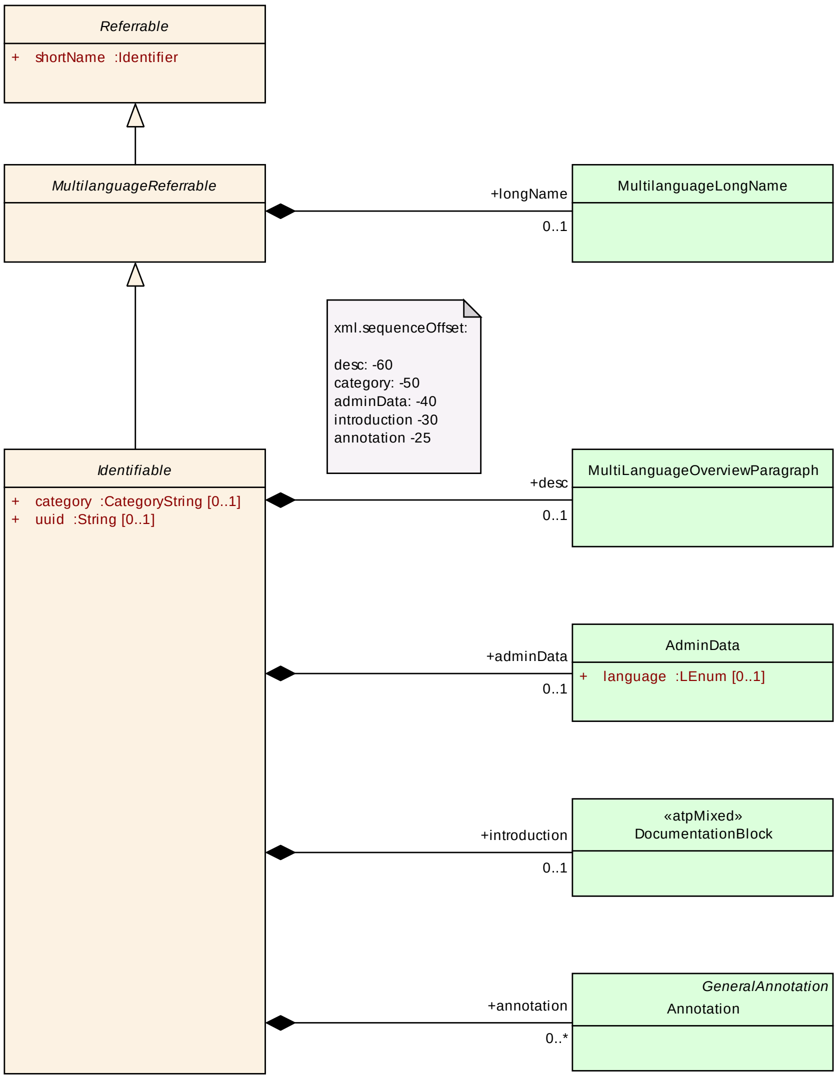


Figure 4.2: Identifiable

The base class `Referrable` and its specializations are shown in figure 4.3:

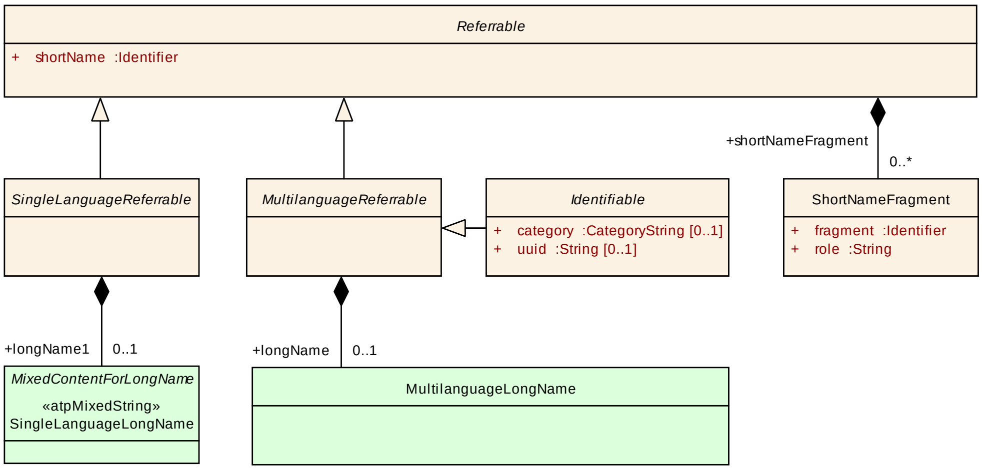


Figure 4.3: Referrable

In case a shortName is composed by different shortNames each of these particular shortNames shall be listed by one ShortNameFragment. In 4.1 the composed shortName is "A__B". The first ShortNameFragment is "A" and has the role "prefix". The second ShortNameFragment is "B" and has the role "suffix".

Listing 4.1: Example for shortNameFragments

```
<SHORT-NAME>A__B</SHORT-NAME>
<SHORT-NAME-FRAGMENTS>
  <SHORT-NAME-FRAGMENT>
    <ROLE>prefix</ROLE>
    <FRAGMENT>A</FRAGMENT>
  </SHORT-NAME-FRAGMENT>
  <SHORT-NAME-FRAGMENT>
    <ROLE>suffix</ROLE>
    <FRAGMENT>B</FRAGMENT>
  </SHORT-NAME-FRAGMENT>
</SHORT-NAME-FRAGMENTS>
```

This procedure allows to compose and to separate the atomic and composed shortNames without losing the original information.

For more details about DocumentationBlock please refer to chapter 8.2.

The attributes are given in the following class tables:

Class	**Identifiable (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable			
Note	Instances of this class can be referred to by their identifier (within the namespace borders). In addition to this, Identifiables are objects which contribute significantly to the overall structure of an AUTOSAR description. In particular, Identifiables might contain Identifiables.			
Base	ARObject, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

desc	MultiLanguageOverviewParagraph	0..1	aggr	This represents a general but brief (one paragraph) description what the object in question is about. It is only one paragraph! Desc is intended to be collected into overview tables. This property helps a human reader to identify the object in question. More elaborate documentation, (in particular how the object is built or used) should go to "introduction". **Tags:** xml.sequenceOffset=-60
category	CategoryString	0..1	attr	The category is a keyword that specializes the semantics of the Identifiable. It affects the expected existence of attributes and the applicability of constraints. **Tags:** xml.sequenceOffset=-50
adminData	AdminData	0..1	aggr	This represents the administrative data for the identifiable object. **Tags:** xml.sequenceOffset=-40
annotation	Annotation	*	aggr	Possibility to provide additional notes while defining a model element (e.g. the ECU Configuration Parameter Values). These are not intended as documentation but are mere design notes. **Tags:** xml.sequenceOffset=-25
introduction	DocumentationBlock	0..1	aggr	This represents more information about how the object in question is built or is used. Therefore it is a DocumentationBlock. **Tags:** xml.sequenceOffset=-30

uuid	String	0..1	attr	The purpose of this attribute is to provide a globally unique identifier for an instance of a meta-class. The values of this attribute should be globally unique strings prefixed by the type of identifier. For example, to include a DCE UUID as defined by The Open Group, the UUID would be preceded by "DCE:". The values of this attribute may be used to support merging of different AUTOSAR models. The form of the UUID (Universally Unique Identifier) is taken from a standard defined by the Open Group (was Open Software Foundation). This standard is widely used, including by Microsoft for COM (GUIDs) and by many companies for DCE, which is based on CORBA. The method for generating these 128-bit IDs is published in the standard and the effectiveness and uniqueness of the IDs is not in practice disputed. If the id namespace is omitted, DCE is assumed. An example is "DCE:2fac1234-31f8-11b4-a222-08002b34c003". The uuid attribute has no semantic meaning for an AUTOSAR model and there is no requirement for AUTOSAR tools to manage the timestamp. **Tags:** xml.attribute=true

Table 4.7: Identifiable

Primitive	**Identifier**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types			
Note	An Identifier is a string with a number of constraints on its appearance, satisfying the requirements typical programming languages define for their Identifiers. This datatype represents a string, that can be used as a c-Identifier. It shall start with a letter, may consist of letters, digits and underscores. **Tags:** xml.xsd.customType=IDENTIFIER; xml.xsd.maxLength=128; xml.xsd.pattern=[a-zA-Z][a-zA-Z0-9_]*; xml.xsd.type=string			
Attribute	***Datatype***	***Mul.***	***Kind***	***Note***
namePattern	String	0..1	attr	This attribute represents a pattern which shall be used to define the value of the identifier if the identifier in question is part of a blueprint. For more details refer to TPS_StandardizationTemplate. **Tags:** xml.attribute=true

Table 4.8: Identifier

Class	**MultilanguageLongName**			
Package	M2::MSR::Documentation::TextModel::MultilanguageData			
Note	This meta-class represents the ability to specify a long name which acts in the role of a headline. It is intended for human readers. Per language it should be around max 80 characters.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
l4	LLongName	1..*	aggr	This is the long name in one particular language. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

Table 4.9: MultilanguageLongName

Class	≪atpMixedString≫ **SingleLanguageLongName**			
Package	M2::MSR::Documentation::TextModel::SingleLanguageData			
Note	SingleLanguageLongName			
Base	ARObject, MixedContentForLongName			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table 4.10: SingleLanguageLongName

Class	≪atpMixedString≫ **LLongName**			
Package	M2::MSR::Documentation::TextModel::LanguageDataModel			
Note	MixedContentForLongNames in one particular language. The language is denoted in the attribute l.			
Base	ARObject, LanguageSpecific, MixedContentForLongName			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table 4.11: LLongName

Class	≪atpMixedString≫ **MixedContentForLongName (abstract)**			
Package	M2::MSR::Documentation::TextModel::InlineTextModel			
Note	This is the model for titles and long-names. It allows some emphasis and index entries but no reference target (which is provided by the identifiable in question). It is intended that the content model can also be rendered as plain text. The abstract class can be used for single language as well as for multi language elements.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
e	EmphasisText	1	aggr	This is emphasized text **Tags:** xml.sequenceOffset=40

ie	IndexEntry	1	aggr	This is an index entry. **Tags:** xml.sequenceOffset=70
sub	Superscript	1	attr	This is subscript text. **Tags:** xml.sequenceOffset=60
sup	Superscript	1	attr	This is superscript text. **Tags:** xml.sequenceOffset=50
tt	Tt	1	aggr	This is a technical term. **Tags:** xml.sequenceOffset=30

Table 4.12: MixedContentForLongName

Class	**MultiLanguageOverviewParagraph**			
Package	M2::MSR::Documentation::TextModel::MultilanguageData			
Note	This is the content of a multilingual paragraph in an overview item.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
l2	LOverviewParagraph	1..*	aggr	This represents the text in one particular language. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

Table 4.13: MultiLanguageOverviewParagraph

Class	≪`atpMixedString`≫ **LOverviewParagraph**			
Package	M2::MSR::Documentation::TextModel::LanguageDataModel			
Note	MixedContentForOverviewParagraph in one particular language. The language is denoted in the attribute l.			
Base	ARObject, LanguageSpecific, MixedContentForOverviewParagraph			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.14: LOverviewParagraph

Class	**Referrable (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable			
Note	Instances of this class can be referred to by their identifier (while adhering to namespace borders).			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

shortName	Identifier	1	attr	This specifies an identifying shortName for the object. It needs to be unique within its context and is intended for humans but even more for technical reference. **Tags:** xml.enforceMinMultiplicity=true; xml.sequenceOffset=-100
shortName Fragment	ShortNameFrag ment	*	aggr	This specifies how the Referrable.shortName is composed of several shortNameFragments. **Tags:** xml.sequenceOffset=-90

Table 4.15: Referrable

Class	**MultilanguageReferrable (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable			
Note	Instances of this class can be referred to by their identifier (while adhering to namespace borders). They also may have a longName. But they are not considered to contribute substantially to the overall structure of an AUTOSAR description. In particular it does not contain other Referrables.			
Base	ARObject, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
longName	MultilanguageL ongName	0..1	aggr	This specifies the long name of the object. Long name is targeted to human readers and acts like a headline.

Table 4.16: MultilanguageReferrable

Class	**SingleLanguageReferrable (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable			
Note	Instances of this class can be referred to by their identifier (while adhering to namespace borders). They also may have a longName but in one language only. Specializations of this class only occur as inline elements in one particular language. Therefore they aggregate But they are not considered to contribute substantially to the overall structure of an AUTOSAR description. In particular it does not contain other Referrables.			
Base	ARObject, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
longName 1	SingleLanguage LongName	0..1	aggr	This specifies the long name of the object. The role is longName1 for compatibilty to ASAM FSX

Table 4.17: SingleLanguageReferrable

Class	**ShortNameFragment**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable			
Note	This class describes how the Referrable.shortName is composed of several shortNameFragments.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
fragment	Identifier	1	attr	This specifies a single shortName (fragment) which is part of the composed shortName. **Tags:** xml.sequenceOffset=20
role	String	1	attr	This specifies the role of fragment to define e.g. the order of the fragments. **Tags:** xml.sequenceOffset=10

Table 4.18: ShortNameFragment

4.3.1 Name spaces and uniqueness of shortName

The shortName in Referrable contributes to the identification of specializations of Referrable, in particular Identifiable.

[TPS_GST_00018] Name Space established by Identifiable ⌈ Identifiable thereby establishes a name space in which the contained Identifiables respectively Referrables can unambiguously identified by their shortName. In some cases there are meta-classes derived from Identifiable that aggregate meta-classes that are not derived from Identifiable but they aggregate in turn a meta-class that **is** derived from Referrable. In other words, there are cases where Identifiables are aggregated only indirectly.

Anyhow the rules for interpreting the established name space apply in this case as well. In particular, for a given instance of Referrable, the name space is established by the nearest **ancestor** (not only parent) element which is an Identifiable. This expressed by the phrase "within a given Identifiable" in [constr_2508]. ⌋*()*

[TPS_GST_00019] Referrable does not establish Name Space ⌈ Note that Referrable does **not** establish a name space. Beyond Identifiable there is no use case where Referrable aggregates another Referrable. But if it would, the shortName of the aggregated one would need to be unique within the nearest ancestor Identifiable (not only the nearest ancestor Referrable). ⌋*()*

Note that it is possible to extend the name space for particular elements in order to support global references. See [constr_2538] in Chapter 4.2 for more details.

[TPS_GST_00021] Case Sensitivity of shortName ⌈ shortName shall be

- basically interpreted as case sensitive (see [TPS_GST_00020])
- but checked for uniqueness as not case sensitive ([constr_2508])

⌋*()*

[constr_2508] Name space of shortName ⌈The content of shortName needs to be unique (case insensitive) within a given Identifiable.

Note that the check for uniqueness of shortName must be performed case insensitively. This supports the good practice that names should not differ in upper / lower case only which would cause a lot of confusion.

The term “case insensitive” indicates that the characters in the sets

```
{a b c d e f g h i j k l m n o p q r s t u v w x y z}
{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z}
```

are respectively considered to be the same. In other words case-insensitive check for uniqueness of shortNames results in the fact that e.g. elements with shortName "X" and "x" are considered the same and shall **not** exist in the same package. ⌋*()*

4.4 Administrative Data

AdminData is used to denote administrative meta data to objects. It covers various aspects:

- **[TPS_GST_00105] Control of the Document Language by AdminData** ⌈control of the languages in the document. ⌋*()* (see chapter 3 and chapter 8.6).

  [constr_2572] Unique Control of Document Languages ⌈The settings for multiple languages are specified in the top-Level AdminData only ⌋*()*

- **[TPS_GST_00106] Version Management** ⌈Version and change management is performed using DocRevision. Note that entry for the current revision is the first one. Information about previous revisions can be provided as change history. ⌋*()*

  [TPS_GST_00107] Merge Operations in Version Management ⌈DocRevision allows to specify the revision label of its predecessors in order to document merge operations. ⌋*()*

  [TPS_GST_00108] Special Information in Version Management ⌈Sdg allows to denote specific information in addition to the AUTOSAR standardized model. The usage of Sdg shall be mutually agreed between the involved parties. ⌋*()*

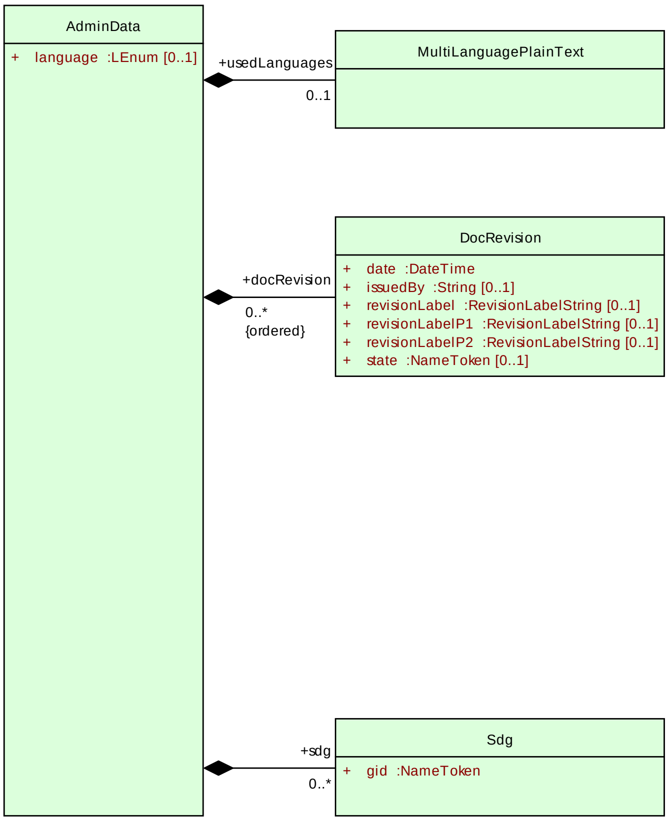


Figure 4.4: AdminData

Class	**AdminData**			
Package	M2::MSR::AsamHdo::AdminData			
Note	AdminData represents the ability to express administrative information for an element. This administration information is to be treated as meta-data such as revision id or state of the file. There are basically four kinds of meta-data • The language and/or used languages. • Revision information covering e.g. revision number, state, release date, changes. Note that this information can be given in general as well as related to a particular company. • Document meta-data specific for a company			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
docRevision (ordered)	DocRevision	*	aggr	This allows to denote information about the current revision of the object. Note that information about previous revisions can also be logged here. The entries shall be sorted descendant by date in order to reflect the history. Therefore the most recent entry representing the current version is denoted first. **Tags:** xml.roleElement=true; xml.roleWrapperElement=true; xml.sequenceOffset=50; xml.typeElement=false; xml.typeWrapperElement=false

language	LEnum	0..1	attr	This attribute specifies the master language of the document or the document fragment. The master language is the one in which the document is maintained and from which the other languages are derived from. In particular in case of inconsistencies, the information in the master language is priority. **Tags:** xml.sequenceOffset=20
sdg	Sdg	*	aggr	This property allows to keep special data which is not represented by the standard model. It can be utilized to keep e.g. tool specific data. **Tags:** xml.roleElement=true; xml.roleWrapper Element=true; xml.sequenceOffset=60; xml.type Element=false; xml.typeWrapperElement=false
usedLangu ages	MultiLanguageP lainText	0..1	aggr	This property specifies the languages which are provided in the document. Therefore it should only be specified in the top level admin data. For each language provided in the document there is one entry in MultilanguagePlainText. The content of each entry can be used for illustration of the language. The used language itself depends on the language attribute in the entry. **Tags:** xml.sequenceOffset=30

Table 4.19: AdminData

Class	**DocRevision**			
Package	M2::MSR::AsamHdo::AdminData			
Note	This meta-class represents the ability to maintain information which relates to revision management of documents or objects. **Tags:** xml.sequenceOffset=20			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
date	DateTime	1	attr	This specifies the date and time, when the object in question was released **Tags:** xml.sequenceOffset=80
issuedBy	String	0..1	attr	This is the name of an individual or an organization who issued the current revision of the document or document fragment. **Tags:** xml.sequenceOffset=60
modificatio n	Modification	*	aggr	This property represents one particular modification in comparison to its predecessor. **Tags:** xml.roleElement=true; xml.roleWrapper Element=true; xml.sequenceOffset=100; xml.type Element=false; xml.typeWrapperElement=false

revisionLabel	RevisionLabelString	0..1	attr	This attribute represents the version number of the object. **Tags:** xml.sequenceOffset=20
revisionLabelP1	RevisionLabelString	0..1	attr	This attribute represents the version number of the first predecessor of the object. **Tags:** xml.sequenceOffset=30
revisionLabelP2	RevisionLabelString	0..1	attr	This attribute represents the version number of the second predecessor of the object. This attribute is used if the object is the result of a merge process in which two branches are merged in to one new revision. **Tags:** xml.sequenceOffset=40
state	NameToken	0..1	attr	The attribute state represents the current state of the current file according to the configuration management plan. It is a NameToken until possible states are standardized. **Tags:** xml.sequenceOffset=50

Table 4.20: DocRevision

Class	**Modification**			
Package	M2::MSR::AsamHdo::AdminData			
Note	This meta-class represents the ability to record what has changed in a document in comparison to its predecessor.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
change	MultiLanguageOverviewParagraph	1	aggr	This property denotes the one particular change which was performed on the object. **Tags:** xml.sequenceOffset=20
reason	MultiLanguageOverviewParagraph	0..1	aggr	This property represents the rationale for the particular change. **Tags:** xml.sequenceOffset=30

Table 4.21: Modification

4.5 Special Data - Extension Mechanism

4.5.1 Special Data

Special data groups (`Sdg`s) provide a standardized mechanism to store arbitrary data for which no other element exists of the data model.

[TPS_GST_00223] Use Cases for Sdg ⌈ Intended use cases for special data are such as

- Representing proprietary information within an AUTOSAR model without the need for "sidedcar" files.
- Representing information to implement workarounds for deficiencies or features missing in the AUTOSAR meta model.
- Representing use case at dedicated places in the model e.g. BuildActionIoElement).

Application of Sdg depends on mutual agreement between the involved parties. ⌋*()*

[TPS_GST_00224] Applicable modeling support in Special Data ⌈ Basically Sdg allows a generic representation of arbitrary models (similar to "well formed XML") without the need of an explicit meta model. It provides the following approaches:

- Sdg aggregated outside of SdgContents represents the root container of special data.
- Sdg in the role SdgContents.sdg represents a container for structured information. It can contain an arbitrary mix of sdg, sd and sdx.
- Sd in the role Sdg.sd represents primitive information. In opposite to TagWithOptionalValue the value is represented implicitly and therefore can not be optional (see [TPS_GST_00358]).
- Sdg.sdx (a reference to Referrable) represents an association.

⌋*()*

[TPS_GST_00356] Application of Sdg ⌈ There is a slight difference in application of Sdg:

- AdminData.sdg is used for pure proprietary purposes
- Dedicated aggregations in other meta classes for which the purpose is described in the respective template.

⌋*()*

[TPS_GST_00225] Specifiation of roles in Special Data ⌈ The particular role of elements in special data is denoted in the attribute gid of Sd respectively of Sdg. Note that sdx does not have such an attribute. If specific roles need to be denoted, then an extra container sdg needs to be wrapped around the sdx. ⌋*()*

The following hints apply:

- Create a separate sdg per mutual agreement. This may be denoted in gid by the name an organization, or a name indicating a particular semantics.
- Choose distinctive names for gid since Sdg does **not** create name spaces.

- Chose a proper layout of containers (sdg): not one container per sd neither one "mega container" for all sd.
- Do not use sdg to represent information which is already supported by the meta model.
- Be aware that sd preserves white space.

Example 4.2 illustrates a use case "tracing-info" as a more complete example. This specifies some properties of a document with respect to requirements tracing. It is a simple container with a bunch of attributes.

Listing 4.2: Simple Example for Special Data

```
<SDG GID="TRACING-INFO">
  <SD GID="ITEM-PREFIX">BswM</SD>
  <SD GID="CONTRIBUTES-TO-GENERAL">SRS_BSWGeneral</SD>
  <SD GID="CONTRIBUTES-TO">SRS_ModeManagement</SD>
  <SD GID="INCLUDES">SWS_BSWGeneral</SD>
</SDG>
```

Example 4.3 illustrates a use case "Relation" as a simple example. This example illustrates how the relationship of a requirement and related development objects could be represented using Sdg. The example shows in particular:

- an Sdg with a caption (sdgCaption) which contains shortName and desc
- arbitrary associations represented by sdx
- that the role of the sdx referencing /My/Mypackage is not explicitly specified.
- the semantics of these associations to be expressed by a surrounding sdg
- the arbitrary mix of sdg and sd sdx in SdgContents

Listing 4.3: Example for Special Data with References

```
<SDG GID="EXAMPLE-RELATION">
  <SDG-CAPTION>
    <SHORT-NAME>Rel_90</SHORT-NAME>
    <LONG-NAME>
      <L-4 L="AA">This is the relationship no 90</L-4>
    </LONG-NAME>
    <DESC>
      <L-2 L="AA">This relationship specifies objects related to
         requirement 90.</L-2>
    </DESC>
  </SDG-CAPTION>
  <SDX-REF DEST="AR-PACKAGE">/My/Mypackage</SDX-REF>
  <SD GID="SEVERITY">significant</SD>
  <SDG GID="SOURCE">
    <SDX-REF DEST="TRACEABLE" BASE="ArTrace">RS_MyReq_0090</SDX-REF>
  </SDG>
  <SDG GID="TARGETS">
    <SDX-REF DEST="SW-COMPONENT-TYPE" BASE="MyComponent">SwComponentTypes
       /MyComponent</SDX-REF>
```

```
      <SDX-REF DEST="COMPU-METHOD" BASE="MyComponent">CompuMethods/MyMethod
         </SDX-REF>
      <SDX-REF DEST="AUTOSAR-DATA-TYPE" BASE="MyComponent">
         ImplementationDataTypes/MyType</SDX-REF>
    </SDG>
    <SD GID="Path">maintenance</SD>
  </SDG>
```

To express variability in special data group see listing 4.4.

Listing 4.4: Example for Special Data with Port-Reference and Variant

```
  <SDG GID="EXAMPLE-PORT-REF">
    <SDXF>
      <REFERRABLE-REF DEST="P-PORT-PROTOTYPE">SwComponentTypes/MyComponent/
         PData1</REFERRABLE-REF>
        <VARIATION-POINT>
          <SW-SYSCOND BINDING-TIME="PRE-COMPILE-TIME">
            <SYSC-REF DEST="SW-SYSTEMCONST" BASE="MySwSystemconsts">
               SwSystemconsts/ScVar1</SYSC-REF> &gt;= 1
          </SW-SYSCOND>
        </VARIATION-POINT>
    </SDXF>
    <SDF GID="EXAMPLE-VARIANT-SD">
      <VALUE><SYSC-REF DEST="SW-SYSTEMCONST" BASE="MySwSystemconsts">
         SwSystemconsts/ScVar2</SYSC-REF>+4</VALUE>
    </SDF>
    <SDG GID="EXAMPLE-VARIANT-SDG">
      <SD GID="Path">maintenance</SD>
      <VARIATION-POINT>
        <SW-SYSCOND BINDING-TIME="PRE-COMPILE-TIME">
          <SYSC-REF DEST="SW-SYSTEMCONST" BASE="MySwSystemconsts">
             SwSystemconsts/ScVar3</SYSC-REF> &lt; 1
        </SW-SYSCOND>
      </VARIATION-POINT>
    </SDG>
  </SDG>
</SDGS>
```

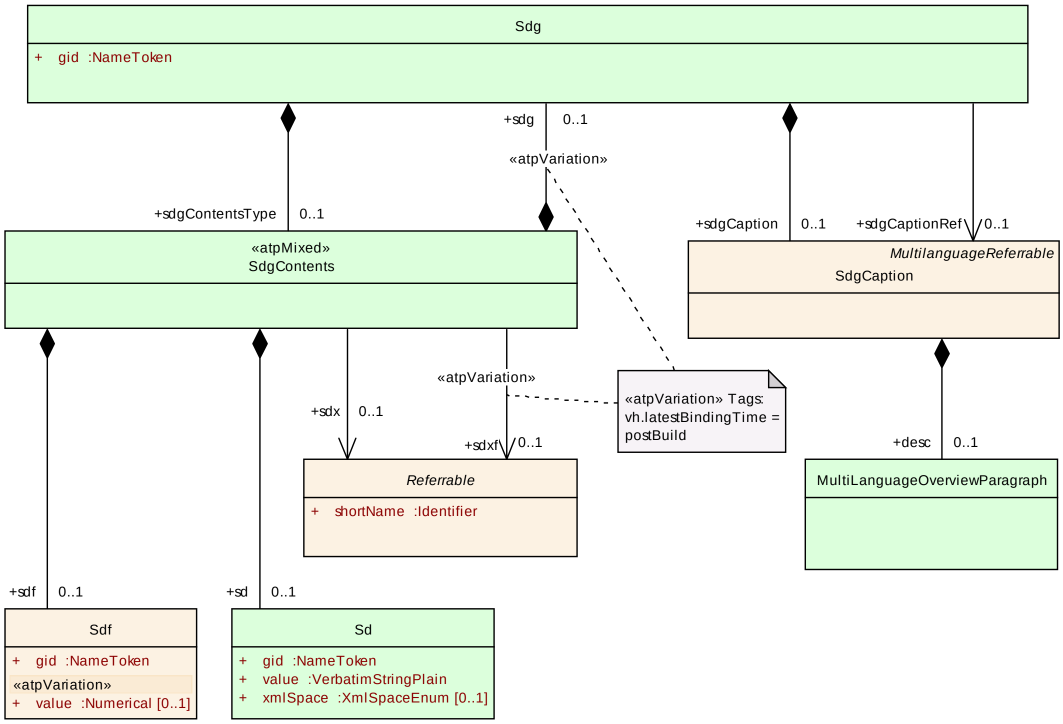


Figure 4.5: SpecialData

Class	**Sdg**			
Package	M2::MSR::AsamHdo::SpecialData			
Note	Sdg (SpecialDataGroup) is a generic model which can be used to keep arbitrary information which is not explicitly modeled in the meta-model. Sdg can have various contents as defined by sdgContentsType. Special Data should only be used moderately since all elements should be defined in the meta-model. Thereby SDG should be considered as a temporary solution when no explicit model is available. If an sdgCaption is available, it is possible to establish a reference to the sdg structure.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
gid	NameToken	1	attr	This attributes specifies an identifier. Gid comes from the SGML/XML-Term "Generic Identifier" which is the element name in XML. The role of this attribute is the same as the name of an XML - element. **Tags:** xml.attribute=true
sdgCaption	SdgCaption	0..1	aggr	This aggregation allows to assign the properties of Identifiable to the sdg. By this, a shortName etc. can be assigned to the Sdg. **Tags:** xml.sequenceOffset=20

sdgCaptionRef	SdgCaption	0..1	ref	This association allows to reuse an already existing caption. **Tags:** xml.name=SDG-CAPTION-REF; xml.sequenceOffset=25
sdgContentsType	SdgContents	0..1	aggr	This is the content of the Sdg. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.sequenceOffset=30; xml.typeElement=false; xml.typeWrapperElement=false

Table 4.22: Sdg

Class	≪**atpMixed**≫ **SdgContents**			
Package	M2::MSR::AsamHdo::SpecialData			
Note	This meta-class represents the possible contents of a special data group. It can be an arbitrary mix of references, of primitive special data and nested special data groups.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
sd	Sd	0..1	aggr	This is one particular special data element. **Tags:** xml.sequenceOffset=40
sdf	Sdf	0..1	aggr	This is one particular special data element. **Tags:** xml.sequenceOffset=60
sdg	Sdg	0..1	aggr	This aggregation allows to express nested special data groups. By this, any structure can be represented in SpeicalData. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=50
sdx	Referrable	0..1	ref	Reference to any identifiable element. This allows to use Sdg even to establish arbitrary relationships.
sdxf	Referrable	0..1	ref	Additional reference with variant support. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild

Table 4.23: SdgContents

Class	**SdgCaption**			
Package	M2::MSR::AsamHdo::SpecialData			
Note	This meta-class represents the caption of a special data group. This allows to have some parts of special data as identifiable.			
Base	ARObject, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

desc	MultiLanguageOverviewParagraph	0..1	aggr	This represents a general but brief (one paragraph) description what the special data in question is about. It is only one paragraph! Desc is intended to be collected into overview tables. This property helps a human reader to identify the special data in question.

Table 4.24: SdgCaption

Class	**Sd**			
Package	M2::MSR::AsamHdo::SpecialData			
Note	This class represents a primitive element in a special data group.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
gid	NameToken	1	attr	This attributes specifies an identifier. Gid comes from the SGML/XML-Term "Generic Identifier" which is the element name in XML. The role of this attribute is the same as the name of an XML - element. **Tags:** xml.attribute=true
value	VerbatimStringPlain	1	attr	This is the value of the special data. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.typeElement=false; xml.typeWrapperElement=false
xmlSpace	XmlSpaceEnum	0..1	attr	This attribute is used to signal an intention that in that element, white space should be preserved by applications. It is defined according to xml:space as declared by W3C. **Tags:** xml.attribute=true; xml.attributeRef=true; xml.enforceMinMultiplicity=true; xml.name=space; xml.nsPrefix=xml

Table 4.25: Sd

Class	**Sdf**			
Package	M2::MSR::AsamHdo::SpecialData			
Note	This class represents a numerical value in a special data group which may be subject to variability.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
gid	NameToken	1	attr	This attributes specifies an identifier. Gid comes from the SGML/XML-Term "Generic Identifier" which is the element name in XML. The role of this attribute is the same as the name of an XML - element. **Tags:** xml.attribute=true

value	Numerical	0..1	attr	This is the value of the special data. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime

Table 4.26: Sdf

4.5.2 Special Data Definitions

[TPS_GST_00374] Purpose of `SdgDef` ⌈ The Special Data Group Definition `SdgDef` specifies the structure of `Sdg`s that are accepted in `AUTOSAR Model`s. The structure is defined by specifying a `Meta-Model` using `SdgClass`es and its `SdgAttribute`s (`SdgPrimitiveAttribute`s, `SdgPrimitiveAttributeWithVariation`s, `SdgReference`s, `SdgAggregationWithVariation`s, `SdgForeignReference`s and `SdgForeignReferenceWithVariation`s). ⌋*()*

The `SdgDef` is the AUTOSAR counterpart of a UML Profile.

[TPS_GST_00375] Purpose of `SdgClass` ⌈ The `SdgClass` specifies the structure of a `Sdg` with a specific `gid`. ⌋*()*

The `SdgClass` is the AUTOSAR counterpart of a UML Stereotype.

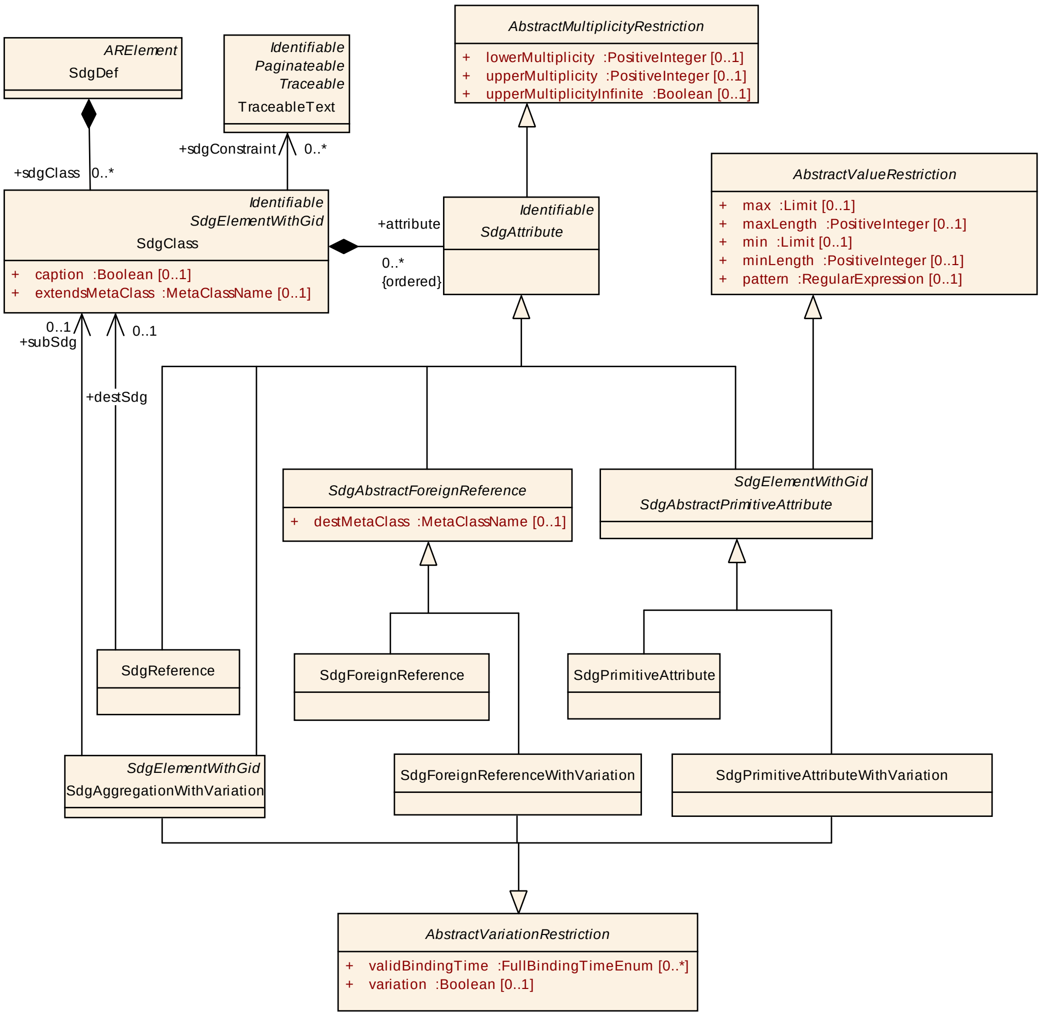


Figure 4.6: Special Data Group Definition

[constr_2605] If a SdgClass is referenced then it shall have a caption ⌈ destSdg.caption==true ⌋*()*

Example 4.5 specifies a special data group definition SdgDef that accepts simple extensions as described in example 4.2.

Listing 4.5: Example of a Special Data Definition

```
<SDG-DEF>
  <SHORT-NAME>TracingInfoExtension</SHORT-NAME>
  <SDG-CLASSES>
    <SDG-CLASS>
      <SHORT-NAME>TracingInfo</SHORT-NAME>
      <GID>TRACING-INFO</GID>
      <EXTENDS-META-CLASS>Documentation</EXTENDS-META-CLASS>
      <ATTRIBUTES>
        <SDG-PRIMITIVE-ATTRIBUTE>
          <SHORT-NAME>ItemPrefix</SHORT-NAME>
          <GID>ITEM-PREFIX</GID>
        </SDG-PRIMITIVE-ATTRIBUTE>
        <SDG-PRIMITIVE-ATTRIBUTE>
          <SHORT-NAME>ContributesToGeneral</SHORT-NAME>
```

```
          <GID>CONTRIBUTES-TO-GENERAL</GID>
        </SDG-PRIMITIVE-ATTRIBUTE>
        <SDG-PRIMITIVE-ATTRIBUTE>
          <SHORT-NAME>ContributesTo</SHORT-NAME>
          <GID>CONTRIBUTES-TO</GID>
        </SDG-PRIMITIVE-ATTRIBUTE>
        <SDG-PRIMITIVE-ATTRIBUTE>
          <SHORT-NAME>Includes</SHORT-NAME>
          <GID>INCLUDES</GID>
        </SDG-PRIMITIVE-ATTRIBUTE>
      </ATTRIBUTES>
    </SDG-CLASS>
  </SDG-CLASSES>
</SDG-DEF>
```

Example 4.6 specifies a special data group definition SdgDef that accepts extensions with nested Sdg containers and references to objects of a AUTOSAR model. An example of an accepted Sdg is provided in 4.3.

Listing 4.6: Example of a Special Data Definition that specifies a structure of Special Data with sub groups and references

```
<SDG-DEF>
  <SHORT-NAME>ExampleSdgDefWithForeignReferencesAndSubSdgs</SHORT-NAME>
  <SDG-CLASSES>
    <SDG-CLASS>
      <SHORT-NAME>ExampleRelation</SHORT-NAME>
      <GID>EXAMPLE-RELATION</GID>
      <EXTENDS-META-CLASS>ARPackage</EXTENDS-META-CLASS>
      <CAPTION>true</CAPTION>
      <ATTRIBUTES>
        <SDG-FOREIGN-REFERENCE>
          <SHORT-NAME>packageRef</SHORT-NAME>
          <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
          <DEST-META-CLASS>ArPackage</DEST-META-CLASS>
        </SDG-FOREIGN-REFERENCE>
        <SDG-PRIMITIVE-ATTRIBUTE>
          <SHORT-NAME>severity</SHORT-NAME>
          <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
          <GID>SEVERITY</GID>
          <PATTERN>critical|significant|minor|low</PATTERN>
        </SDG-PRIMITIVE-ATTRIBUTE>
        <SDG-AGGREGATION-WITH-VARIATION>
          <SHORT-NAME>source</SHORT-NAME>
          <LOWER-MULTIPLICITY>1</LOWER-MULTIPLICITY>
          <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
          <GID>SOURCE</GID>
          <VARIATION>false</VARIATION>
          <SUB-SDG-REF DEST="SDG-CLASS" BASE="Extensions">
             ExampleRelationExtension/SourceRefContainer</SUB-SDG-REF>
        </SDG-AGGREGATION-WITH-VARIATION>
        <SDG-AGGREGATION-WITH-VARIATION>
          <SHORT-NAME>target</SHORT-NAME>
          <LOWER-MULTIPLICITY>1</LOWER-MULTIPLICITY>
          <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
          <GID>TARGETS</GID>
```

```
        <VARIATION>false</VARIATION>
        <SUB-SDG-REF DEST="SDG-CLASS" BASE="Extensions">
           ExampleRelationExtension/TargetsRefContainer</SUB-SDG-REF>
      </SDG-AGGREGATION-WITH-VARIATION>
      <SDG-PRIMITIVE-ATTRIBUTE>
        <SHORT-NAME>path</SHORT-NAME>
        <LOWER-MULTIPLICITY>0</LOWER-MULTIPLICITY>
        <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
        <GID>Path</GID>
      </SDG-PRIMITIVE-ATTRIBUTE>
    </ATTRIBUTES>
  </SDG-CLASS>
  <SDG-CLASS>
    <SHORT-NAME>SourceRefContainer</SHORT-NAME>
    <ATTRIBUTES>
      <SDG-FOREIGN-REFERENCE>
        <SHORT-NAME>sourceRef</SHORT-NAME>
        <LOWER-MULTIPLICITY>1</LOWER-MULTIPLICITY>
        <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
        <DEST-META-CLASS>Traceable</DEST-META-CLASS>
      </SDG-FOREIGN-REFERENCE>
    </ATTRIBUTES>
  </SDG-CLASS>
  <SDG-CLASS>
    <SHORT-NAME>TargetsRefContainer</SHORT-NAME>
    <ATTRIBUTES>
      <SDG-FOREIGN-REFERENCE>
        <SHORT-NAME>targetRef</SHORT-NAME>
        <LOWER-MULTIPLICITY>1</LOWER-MULTIPLICITY>
        <UPPER-MULTIPLICITY-INFINITE>true</UPPER-MULTIPLICITY-INFINITE>
        <DEST-META-CLASS>Referrable</DEST-META-CLASS>
      </SDG-FOREIGN-REFERENCE>
    </ATTRIBUTES>
  </SDG-CLASS>
 </SDG-CLASSES>
</SDG-DEF>
```

Example 4.7 specifies a special data group definition SdgDef that accepts extensions with variation. An example of an accepted Sdg is provided in 4.4.

Listing 4.7: Example of a Special Data Definition that specifies a structure of Special Data with variation.

```
<SDG-DEF>
  <SHORT-NAME>ExampleSdgDefWithVariation</SHORT-NAME>
  <SDG-CLASSES>
    <SDG-CLASS>
      <SHORT-NAME>ExampleSdgWithVariation</SHORT-NAME>
      <GID>EXAMPLE-PORT-REF</GID>
      <ATTRIBUTES>
        <SDG-FOREIGN-REFERENCE-WITH-VARIATION>
          <SHORT-NAME>exampleVariantSfxf</SHORT-NAME>
          <LOWER-MULTIPLICITY>1</LOWER-MULTIPLICITY>
          <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
          <DEST-META-CLASS>PortPrototype</DEST-META-CLASS>
          <VARIATION>true</VARIATION>
```

```
          <VALID-BINDING-TIMES>
            <VALID-BINDING-TIME>PRE-COMPILE-TIME</VALID-BINDING-TIME>
            <VALID-BINDING-TIME>SYSTEM-DESIGN-TIME</VALID-BINDING-TIME>
          </VALID-BINDING-TIMES>
        </SDG-FOREIGN-REFERENCE-WITH-VARIATION>
        <SDG-PRIMITIVE-ATTRIBUTE-WITH-VARIATION>
          <SHORT-NAME>ExampleVariantSd</SHORT-NAME>
          <LOWER-MULTIPLICITY>1</LOWER-MULTIPLICITY>
          <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
          <GID>EXAMPLE-VARIANT-SD</GID>
          <VARIATION>true</VARIATION>
          <VALID-BINDING-TIMES>
            <VALID-BINDING-TIME>PRE-COMPILE-TIME</VALID-BINDING-TIME>
            <VALID-BINDING-TIME>SYSTEM-DESIGN-TIME</VALID-BINDING-TIME>
          </VALID-BINDING-TIMES>
        </SDG-PRIMITIVE-ATTRIBUTE-WITH-VARIATION>
        <SDG-AGGREGATION-WITH-VARIATION>
          <SHORT-NAME>ExampleVariantSdg</SHORT-NAME>
          <LOWER-MULTIPLICITY>1</LOWER-MULTIPLICITY>
          <UPPER-MULTIPLICITY>1</UPPER-MULTIPLICITY>
          <GID>EXAMPLE-VARIANT-SDG</GID>
          <VARIATION>true</VARIATION>
          <VALID-BINDING-TIMES>
            <VALID-BINDING-TIME>PRE-COMPILE-TIME</VALID-BINDING-TIME>
            <VALID-BINDING-TIME>SYSTEM-DESIGN-TIME</VALID-BINDING-TIME>
          </VALID-BINDING-TIMES>
          <SUB-SDG-REF DEST="SDG-CLASS" BASE="Extensions">
             ExampleSdgWithVariation/ExampleVariantSdgContainer</SUB-SDG-
             REF>
        </SDG-AGGREGATION-WITH-VARIATION>
      </ATTRIBUTES>
    </SDG-CLASS>
    <SDG-CLASS>
      <SHORT-NAME>ExampleVariantSdgContainer</SHORT-NAME>
      <ATTRIBUTES>
        <SDG-PRIMITIVE-ATTRIBUTE>
          <SHORT-NAME>Path</SHORT-NAME>
          <GID>Path</GID>
        </SDG-PRIMITIVE-ATTRIBUTE>
      </ATTRIBUTES>
    </SDG-CLASS>
  </SDG-CLASSES>
</SDG-DEF>
```

Class	**SdgDef**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	A SdgDef groups several SdgClasses which belong to the same extension. The concept of an SdgDef is similiar to an UML Profile. **Tags:** atp.recommendedPackage=SdgDefs			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
sdgClass	SdgClass	*	aggr	The owned sdgClasses which define the structure of the Sdgs **Tags:** xml.namePlural=SDG-CLASSES

Table 4.27: SdgDef

Class	**SdgElementWithGid (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	A special data group element with gid is an abstract element that shall have a name (gid, "Generic Identifier").			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
gid	NameToken	0..1	attr	Specifies the name that identifies the element.

Table 4.28: SdgElementWithGid

Class	**SdgClass**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	An SdgClass specifies the name and structure of the SDG that may be used to store proprietary data in an AUTOSAR model. The SdgClass is similar to an UML stereotype.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable, SdgElementWithGid			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
attribute (ordered)	SdgAttribute	*	aggr	Defintion of the structure of the Sdg **Tags:** xml.sequenceOffset=30
caption	Boolean	0..1	attr	Specifies if a caption is required. Note: only Sdgs that have a caption can be referenced **Tags:** xml.sequenceOffset=20
extendsMetaClass	MetaClassName	0..1	attr	The AUTOSAR Meta-Class that may be extended by this SdgClass. **Tags:** xml.sequenceOffset=10

sdgConstraint	TraceableText	*	ref	Semantic constraints that restrict the structure of the special data group. **Tags:** xml.sequenceOffset=40

Table 4.29: SdgClass

Class	**SdgAttribute (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	Describes the attributes of an Sdg.			
Base	ARObject, AbstractMultiplicityRestriction, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.30: SdgAttribute

Class	**SdgAbstractPrimitiveAttribute (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	Describes primitive attributes of a special data group.			
Base	ARObject, AbstractMultiplicityRestriction, AbstractValueRestriction, Identifiable, MultilanguageReferrable, Referrable, SdgAttribute, SdgElementWithGid			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.31: SdgAbstractPrimitiveAttribute

Class	**SdgPrimitiveAttribute**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	Describes primitive special data attributes without variation. This class accepts an special data "sd"attribute.			
Base	ARObject, AbstractMultiplicityRestriction, AbstractValueRestriction, Identifiable, MultilanguageReferrable, Referrable, SdgAbstractPrimitiveAttribute, SdgAttribute, SdgElementWithGid			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.32: SdgPrimitiveAttribute

Class	**SdgPrimitiveAttributeWithVariation**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	Describes a primitive numerical special data attribute with variation. This class accepts an special data "sdf" element.			
Base	ARObject, AbstractMultiplicityRestriction, AbstractValueRestriction, AbstractVariationRestriction, Identifiable, MultilanguageReferrable, Referrable, SdgAbstractPrimitiveAttribute, SdgAttribute, SdgElementWithGid			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table 4.33: SdgPrimitiveAttributeWithVariation

Class	**SdgAggregationWithVariation**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	Describes that the Sdg may contain another Sdg. The gid of the nested Sdg is defined by subSdg. Represents 'sdg'.			
Base	ARObject, AbstractMultiplicityRestriction, AbstractVariationRestriction, Identifiable, MultilanguageReferrable, Referrable, SdgAttribute, SdgElementWithGid			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
subSdg	SdgClass	0..1	ref	Supported sub Sdg Class

Table 4.34: SdgAggregationWithVariation

Class	**SdgReference**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	A reference without variation support that refers to a Sdg. Represents 'sdgCaptionRef'.			
Base	ARObject, AbstractMultiplicityRestriction, Identifiable, MultilanguageReferrable, Referrable, SdgAttribute			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
destSdg	SdgClass	0..1	ref	Destination type of the SdgReference

Table 4.35: SdgReference

Class	**SdgAbstractForeignReference (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	An abstract reference that can point to any referrable object in an AUTOSAR Model.			
Base	ARObject, AbstractMultiplicityRestriction, Identifiable, MultilanguageReferrable, Referrable, SdgAttribute			
Attribute	**Type**	**Mul.**	**Kind**	**Note**

destMetaClass	MetaClassName	0..1	attr	specifies the destination meta class of the reference.

Table 4.36: SdgAbstractForeignReference

Class	**SdgForeignReference**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	A reference without variation support that can point to any referrable object in an AUTOSAR Model. This class accepts the special data "Sdx" reference.			
Base	ARObject, AbstractMultiplicityRestriction, Identifiable, MultilanguageReferrable, Referrable, SdgAbstractForeignReference, SdgAttribute			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.37: SdgForeignReference

Class	**SdgForeignReferenceWithVariation**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef			
Note	A reference with variation support that can point to any referrable object in an AUTOSAR Model. This class accepts the special data "Sdxf" reference.			
Base	ARObject, AbstractMultiplicityRestriction, AbstractVariationRestriction, Identifiable, MultilanguageReferrable, Referrable, SdgAbstractForeignReference, SdgAttribute			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.38: SdgForeignReferenceWithVariation

Primitive	**MetaClassName**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::SpecialDataDef
Note	Name of an class in the AUTOSAR Meta-Model. **Tags:** xml.xsd.customType=META-CLASS-NAME; xml.xsd.pattern=[A-Z][a-zA-Z0-9_]*; xml.xsd.type=string

Table 4.39: MetaClassName

4.6 Model Restriction Types

[TPS_GST_00376] Purpose of Model Restriction Types ⌈ Model Restriction Types specify rules that restrict the content of AUTOSAR models. Those restrictions are e.g. used in the context of Special Data Group Definitions 4.5.2 or Data Exchange Points [2]. ⌋ *()*

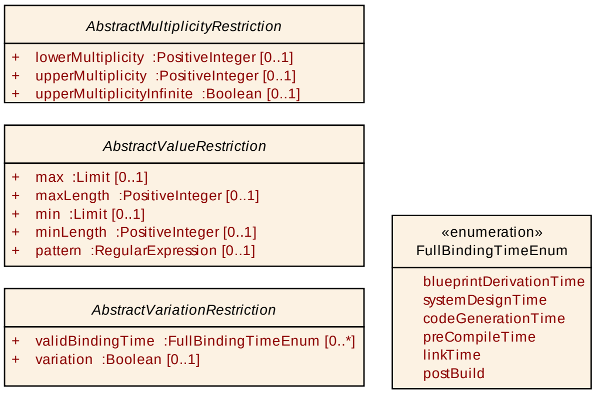


Figure 4.7: Model Restriction Types

4.6.1 Restriction of Simple Primitive Values

[TPS_GST_00377] Purpose of `AbstractValueRestriction` ⌈ The `AbstractValueRestriction` defines constraints on the value space of a simple primitive data type. The attributes of this class represent constraining facets according to the XML Schema Specification [9]. A value is valid if it is valid according to all defined constraints. ⌋*()*

Class	**AbstractValueRestriction (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ModelRestrictionTypes			
Note	Restricts primitive values. A value is valid if all rules that are defined by this restriction evaluate to true.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
max	Limit	0..1	attr	Specifies the upper bounds for numeric values.
maxLength	PositiveInteger	0..1	attr	Specifies the maximum number of characters of textual values.
min	Limit	0..1	attr	Specifies the lower bounds for numeric values.
minLength	PositiveInteger	0..1	attr	Specifies the minimal number of characters of textual values.
pattern	RegularExpression	0..1	attr	Defines the exact sequence of characters that are acceptable.

Table 4.40: AbstractValueRestriction

4.6.2 Restriction of Multiplicities

[TPS_GST_00378] Purpose of `AbstractMultiplicityRestriction` ⌈ The `AbstractMultiplicityRestriction` specifies how often an element may occur. With the two attributes `lowerMultiplicity` and `upperMultiplicity` the minimum and maximum occurrence of the configuration element is specified. ⌋*()*

[TPS_GST_00380] Countably infinite number of elements ⌈ To express a countable infinite number of occurrences of elements the upperMultiplicityInfinite element shall exist and shall be set to true. ⌋*()*

[constr_2606] Existence of upperMultiplicityInfinite and upperMultiplicity of AbstractMultiplicityRestriction is mutually exclusive ⌈ The existence of the elements upperMultiplicityInfinite and upperMultiplicity of AbstractMultiplicityRestriction shall be mutually exclusive. ⌋*()*

[constr_2607] lowerMultiplicity of AbstractMultiplicityRestriction shall be smaller or equal to upperMultiplicity ⌈ lowerMultiplicity of AbstractMultiplicityRestriction shall be smaller or equal to upperMultiplicity. ⌋*()*

4.6.3 Restriction of use of Variation

[TPS_GST_00379] Purpose of AbstractVariationRestriction ⌈ The AbstractVariationRestriction defines constraints on the usage of variation and on the valid binding times. ⌋*()*

Class	**AbstractVariationRestriction (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ModelRestrictionTypes			
Note	Defines constraints on the usage of variation and on the valid binding times.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
validBindingTime	FullBindingTimeEnum	*	attr	List of valid binding times. **Tags:** xml.sequenceOffset=20
variation	Boolean	0..1	attr	Defines if the AUTOSAR model may define a VariationPoint at this location. **Tags:** xml.sequenceOffset=10

Table 4.41: AbstractVariationRestriction

Enumeration	**FullBindingTimeEnum**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ModelRestrictionTypes
Note	This enumeration specifies the BindingTimes that can be used in AUTOSAR models.
Literal	***Description***
blueprintDerivationTime	The point in time when an object is created from a blueprint. **Tags:** atp.EnumerationValue=0

codeGenerationTime	• Coding by hand, based on requirements document. • Tool based code generation, e.g. from a model. • The model may contain variants. • Only code for the selected variant(s) is actually generated. **Tags:** atp.EnumerationValue=2
linkTime	Configure what is included in object code, and what is omitted Based on which variant(s) are selected E.g. for modules that are delivered as object code (as opposed to those that are delivered as source code) **Tags:** atp.EnumerationValue=4
postBuild	PostBuild is the binding time which is bound latest at startup of the ECU. In other words this is everything between creation of the executable program and startup of the ECU. **Tags:** atp.EnumerationValue=5
preCompile Time	This is typically the C-Preprocessor. Exclude parts of the code from the compilation process, e.g., because they are not required for the selected variant, because they are incompatible with the selected variant, because they require resources that are not present in the selected variant. Object code is only generated for the selected variant(s). The code that is excluded at this stage code will not be available at later stages. **Tags:** atp.EnumerationValue=3
systemDesignTime	• Designing the VFB. • Software Component types (PortInterfaces). • SWC Prototypes and the Connections between SWCprototypes. • Designing the Topology • ECUs and interconnecting Networks • Designing the Communication Matrix and Data Mapping **Tags:** atp.EnumerationValue=1

Table 4.42: FullBindingTimeEnum

4.7 Primitive Types

This chapter describes the primitive types which are used in the AUTOSAR M2 model. These primitives are shown in the class tables below. In addition to these primitives some packages may define some own local primitives.

Note that the AUTOSAR meta model does not use the built in primitives provided by UML.

Note further that some of these primitives also have attributes. Such attributes result in xml attributes of xml elements representing the primitive.

Primitive	**Address**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This is used to specify an address within the CPU. **Tags:** xml.xsd.customType=ADDRESS; xml.xsd.pattern=0x[0-9a-z]*; xml.xsd.type=string

Table 4.43: Address

Primitive	**AlignmentType**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This primitive represents the alignment of objects within a memory section. The value is in number of bits or UNKNOWN (deprecated), 8 , 16, 32 UNSPECIFIED, BOOLEAN, or PTR. Typical values for numbers are 8, 16, 32. **Tags:** xml.xsd.customType=ALIGNMENT-TYPE; xml.xsd.pattern=[1-9][0-9]*|0[xX][0-9a-fA-F]*|0[bB][0-1]+|0[0-7]*|UNSPECIFIED|UNKNOWN|BOOLEAN|PTR; xml.xsd.type=string

Table 4.44: AlignmentType

In former releases of the GST strings as "0b" were accepted as valid due to 0[bB][0-1]*. The change of the binary part to 0[bB][0-1]+ in the regular expression intents on that the given string is valid if the regular expression has exactly one match which covers the whole string. Non meaningful inputs (e.g. "0b") will now identified as invalid binary number. This also applies to other regular expressions containing the binary part.

Enumeration	**ArgumentDirectionEnum**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	Use cases: • Arguments in ClientServerOperation can have different directions that need to be formally indicated because they have an impact on how the function signature looks like eventually. • Arguments in BswModuleEntry already determine a function signature, but the direction is used to specify the semantics, especially of pointer arguments.
Literal	***Description***
in	The argument value is passed to the callee. **Tags:** atp.EnumerationValue=0

inout	The argument value is passed to the callee but also passed back from the callee to the caller. **Tags:** atp.EnumerationValue=1
out	The argument value is passed from the callee to the caller. **Tags:** atp.EnumerationValue=2

Table 4.45: ArgumentDirectionEnum

Primitive	**Boolean**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	A Boolean value denotes a logical condition that is either 'true' or 'false'. It can be one of "0", "1", "true", "false" **Tags:** xml.xsd.customType=BOOLEAN; xml.xsd.pattern=0|1|true|false; xml.xsd.type=string

Table 4.46: Boolean

Enumeration	**ByteOrderEnum**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	When more than one byte is stored in the memory the order of those bytes may differ depending on the architecture of the processing unit. If the least significant byte is stored at the lowest address, this architecture is called little endian and otherwise it is called big endian. ByteOrder is very important in case of communication between different PUs or ECUs.
Literal	***Description***
mostSignificantByte First	Most significant byte shall come at the lowest address (also known as BigEndian or as Motorola-Format) **Tags:** atp.EnumerationValue=0
mostSignificantByte Last	Most significant byte shall come highest address (also known as LittleEndian or as Intel-Format) **Tags:** atp.EnumerationValue=1
opaque	For opaque data endianness conversion has to be configured to Opaque. See AUTOSAR COM Specification for more details. **Tags:** atp.EnumerationValue=2

Table 4.47: ByteOrderEnum

Primitive	**CategoryString**

Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This represents the pattern applicable to categories. It is basically the same as Identifier but has a different semantics. Therefore it is modeled as a primitive of its own. **Tags:** xml.xsd.customType=CATEGORY-STRING; xml.xsd.pattern=[a-zA-Z][a-zA-Z0-9_]*; xml.xsd.type=string

Table 4.48: CategoryString

Primitive	**CIdentifier**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types			
Note	This datatype represents a string, that follows the rules of C-identifiers. **Tags:** xml.xsd.customType=C-IDENTIFIER; xml.xsd.pattern=[a-zA-Z_][a-zA-Z0-9_]*; xml.xsd.type=string			
Attribute	***Datatype***	***Mul.***	***Kind***	***Note***
namePattern	String	0..1	attr	This attribute represents a pattern which shall be used to define the value of the identifier if the CIdentifier in question is part of a blueprint. For more details refer to TPS_StandardizationTemplate. **Tags:** xml.attribute=true

Table 4.49: CIdentifier

Primitive	**CIdentifierWithIndex**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This datatype represents a string, that follows the rules of C-identifiers with an index. **Tags:** xml.xsd.customType=C-IDENTIFIER-WITH-INDEX; xml.xsd.pattern=[a-zA-Z_][a-zA-Z0-9_]*\[[0-9]+\]; xml.xsd.type=string

Table 4.50: CIdentifierWithIndex

Primitive	**DateTime**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types

Note	A datatype representing a timestamp. The smallest granularity is 1 second. This datatype represents a timestamp in the format yyyy-mm-dd followed by an optional time. The lead-in character for the time is "T" and the format is hh:mm:ss. In addition, a time zone designator must be specified. The time zone designator can either be "Z" (for UTC) or the time offset to UTC, i.e. (+|-)hh:mm. Examples: 2009-07-23 2009-07-23T14:38:00+01:00 2009-07-23T13:38:00Z **Tags:** xml.xsd.customType=DATE; xml.xsd.pattern=([0-9]{4}-[0-9]{2}-[0-9]{2})(T[0-9]{2}:[0-9]{2}:[0-9]{2}(Z|([+\-][0-9]{2}:[0-9]{2})))?; xml.xsd.type=string

Table 4.51: DateTime

Primitive	**DisplayFormatString**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes

Note	This is a display format specifier for the display of values e.g. in documents or in measurement and calibration systems. The display format specifier is a subset of the ANSI C printf specifiers with the following form: `% [flags] [width] [.prec] type character` For more details refer to "ASAM-HarmonizedDataObjects-V1.1.pdf" chapter 13.3.2 DISPLAY OF DATA. Due to the numerical nature of value settings, only the following type characters are allowed: • d: Signed decimal integer • i: Signed decimal integer • o: Unsigned octal integer • u: Unsigned decimal integer • x: Unsigned hexadecimal integer, using "abcdef" • X: Unsigned hexadecimal integer, using "ABCDEF" • e: Signed value having the form [-]d.dddd e [sign]ddd where d is a single decimal digit, dddd is one or more decimal digits, ddd is exactly three decimal digits, and sign is + or - • E: Identical to the e format except that E rather than e introduces the exponent • f: Signed value having the form [-]dddd.dddd, where dddd is one or more decimal digits; the number of digits before the decimal point depends on the magnitude of the number, and the number of digits after the decimal point depends on the requested precision • g: Signed value printed in f or e format, whichever is more compact for the given value and precision; trailing zeros are truncated, and the decimal point appears only if one or more digits follow it • G: Identical to the g format, except that E, rather than e, introduces the exponent (where appropriate) **Tags:** xml.xsd.customType=DISPLAY-FORMAT-STRING; xml.xsd.pattern=%[\-+#]?[0-9]*(\.[0-9])?[diouxXfeEgGcs]; xml.xsd.type=string

Table 4.52: DisplayFormatString

Primitive	**Float**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes
Note	An instance of Float is an element from the set of real numbers. The value must comply with IEEE 754 and is limited to what can be expressed by a 64 bit binary representation. **Tags:** xml.xsd.customType=FLOAT; xml.xsd.type=double

Table 4.53: Float

Primitive	**Identifier**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes			
Note	An Identifier is a string with a number of constraints on its appearance, satisfying the requirements typical programming languages define for their Identifiers. This datatype represents a string, that can be used as a c-Identifier. It shall start with a letter, may consist of letters, digits and underscores. **Tags:** xml.xsd.customType=IDENTIFIER; xml.xsd.maxLength=128; xml.xsd.pattern=[a-zA-Z][a-zA-Z0-9_]*; xml.xsd.type=string			
Attribute	*Datatype*	*Mul.*	*Kind*	*Note*
namePattern	String	0..1	attr	This attribute represents a pattern which shall be used to define the value of the identifier if the identifier in question is part of a blueprint. For more details refer to TPS_StandardizationTemplate. **Tags:** xml.attribute=true

Table 4.54: Identifier

Primitive	**Ip4AddressString**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes
Note	This is used to specify an IP4 address. Notation: 255.255.255.255 **Tags:** xml.xsd.customType=IP4-ADDRESS-STRING; xml.xsd.pattern=(25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)\.(25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)\.(25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)\.(25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)|ANY; xml.xsd.type=string

Table 4.55: Ip4AddressString

Primitive	**Ip6AddressString**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes
Note	This is used to specify an IP6 address. Notation: FFFF:FFFF;FFFF;FFFF;FFFF;FFFF;FFFF;FFFF **Tags:** xml.xsd.customType=IP6-ADDRESS-STRING; xml.xsd.pattern=[0-9A-Fa-f]{1,4}(:[0-9A-Fa-f]{1,4}){7,7}|ANY; xml.xsd.type=string

Table 4.56: Ip6AddressString

Primitive	**Integer**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes
Note	An instance of Integer is an element in the set of integer numbers (..., -2, -1, 0, 1, 2, ...). The value can be expressed in decimal, octal, hexadecimal and binary representation. Negative numbers can only be expressed in decimal notation Range is from -2147483648 and 2147483647. **Tags:** xml.xsd.customType=INTEGER; xml.xsd.pattern=[+\-]?[1-9][0-9]*|0[xX][0-9a-fA-F]+|0[bB][0-1]+|0[0-7]*; xml.xsd.type=string

Table 4.57: Integer

Enumeration	**IntervalTypeEnum**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes
Note	This enumerator specifies the type of an interval.
Literal	***Description***
closed	The area is limited by the value given. The value itself is included. **Tags:** atp.EnumerationValue=0
open	The area is limited by the value given. The value itself is not included. **Tags:** atp.EnumerationValue=2

Table 4.58: IntervalTypeEnum

Primitive	**Limit**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes			
Note	This class represents the ability to express a numerical limit. Note that this is in fact a NumericalVariationPoint but has the additional attribute intervalType. **Tags:** xml.xsd.customType=LIMIT-VALUE; xml.xsd.pattern=(0[xX][0-9a-fA-F]+)|(0[0-7]+)|(0[bB][0-1]+)|(([+\-]?[1-9][0-9]+(\.[0-9]+)?|[+\-]?[0-9](\.[0-9]+)?)([eE]([+\-]?)[0-9]+)?)|\.0|INF|-INF|NaN; xml.xsd.type=string			
Attribute	***Datatype***	***Mul.***	***Kind***	***Note***
intervalType	IntervalTypeEnum	0..1	attr	This specifies the type of the interval. If the attribute is missing the interval shall be considered as "CLOSED". **Tags:** xml.attribute=true

Table 4.59: Limit

Primitive	**MacAddressString**

Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This primitive specifies a Mac Address. **Tags:** xml.xsd.customType=MAC-ADDRESS-STRING; xml.xsd.pattern=([0-9a-fA-F]{2}:){5}[0-9a-fA-F]{2}; xml.xsd.type=string

Table 4.60: MacAddressString

Primitive	**McdIdentifier**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This primitive denotes a name used for measurement and calibration systems and shall follow the restrictions for an ASAM ASAP2 ident. For detailed syntax see the xsd.pattern. The size limitations are not captured. McdIdentifiers are random names which may contain characters A through Z, a through z, underscore (_), numerals 0 through 9, points ('.') and brackets ('[','\]'). However, the following limitations apply: the first character must be a letter or an underscore, brackets must occur in pairs at the end of a partial string and must contain a number or an alpha-numerical string (description of the index of an array element). **Tags:** xml.xsd.customType=MCD-IDENTIFIER; xml.xsd.pattern=[a-zA-Z_][a-zA-Z0-9_]*(\[([a-zA-Z_][a-zA-Z0-9_]*|[0-9]+)\])*(\.[a-zA-Z_][a-zA-Z0-9_]*(\[([a-zA-Z_][a-zA-Z0-9_]*|[0-9]+)\])*)*; xml.xsd.type=string

Table 4.61: McdIdentifier

Primitive	**MimeTypeString**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This primitive denotes the an Internet media type, originally called a MIME type after MIME and sometimes a Content-type after the name of a header in several protocols whose value is such a type, is a two-part identifier for file formats on the Internet. **Tags:** xml.xsd.customType=MIME-TYPE-STRING; xml.xsd.type=string

Table 4.62: MimeTypeString

Enumeration	**MonotonyEnum**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This enumerator denotes the values for specification of monotony for e.g. curves.
Literal	***Description***
decreasing	This indicates that the related curve needs to be monotony decreasing. **Tags:** atp.EnumerationValue=0

increasing	This indicates that the related curve needs to be monotony increasing. **Tags:** atp.EnumerationValue=1
monotonous	This indicates that the values shall be monotonously decreasing or increasing, depending on the trend set by the first values of the series. **Tags:** atp.EnumerationValue=2
noMonotony	This indicates that the related curve needs not to be monotony. **Tags:** atp.EnumerationValue=3
strict Monotonous	This indicates that the values shall be strict monotonously decreasing or increasing, depending on the trend set by the first values of the series. **Tags:** atp.EnumerationValue=6
strictlyDe-creasing	This indicates that the related curve needs to be strictly monotony decreasing. **Tags:** atp.EnumerationValue=4
strictlyIn-creasing	This indicates that the related curve needs to be strictly monotony increasing. **Tags:** atp.EnumerationValue=5

Table 4.63: MonotonyEnum

Primitive	**NameToken**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This is an identifier as used in xml, e.g. xml-names. Basic difference to Identifier is the fact that it can contain "-". **Tags:** xml.xsd.customType=NMTOKEN-STRING; xml.xsd.type=NMTOKEN

Table 4.64: NameToken

Primitive	**NameTokens**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This is a white-space separated list of name tokens. **Tags:** xml.xsd.customType=NMTOKENS-STRING; xml.xsd.type=NMTOKENS

Table 4.65: NameTokens

Primitive	**NativeDeclarationString**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types

Note	This string contains a native data declaration of a data type in a programming language. It is basically a string, but white-space must be preserved. **Tags:** xml.xsd.customType=NATIVE-DECLARATION-STRING; xml.xsd.type=string; xml.xsd.whiteSpace=preserve

Table 4.66: NativeDeclarationString

Primitive	**Numerical**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This primitive specifies a numerical value. It can be denoted in different formats such as Decimal, Octal, Hexadecimal, Float. See the xsd pattern for details. The value can be expressed in octal, hexadecimal, binary representation. Negative numbers can only be expressed in decimal or float notation. **Tags:** xml.xsd.customType=NUMERICAL-VALUE; xml.xsd.pattern=(0[xX][0-9a-fA-F]+)|(0[0-7]+)|(0[bB][0-1]+)|(([+\-]?[1-9][0-9]+(\.[0-9]+)?|[+\-]?[0-9](\.[0-9]+)?)([eE]([+\-]?)[0-9]+)?)|\.0|INF|-INF|NaN; xml.xsd.type=string

Table 4.67: Numerical

Primitive	**PositiveInteger**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This is a positive integer which can be denoted in decimal, binary, octal and hexadecimal. The value is between 0 and 4294967295. **Tags:** xml.xsd.customType=POSITIVE-INTEGER; xml.xsd.pattern=[1-9][0-9]*|0[xX][0-9a-fA-F]+|0[bB][0-1]+|0[0-7]*; xml.xsd.type=string

Table 4.68: PositiveInteger

Primitive	**PositiveUnlimitedInteger**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This is a positive unlimited integer which can be denoted in decimal, binary, octal and hexadecimal. **Tags:** xml.xsd.customType=POSITIVE-UNLIMITED-INTEGER; xml.xsd.pattern=[1-9][0-9]*|0[xX][0-9a-fA-F]+|0[bB][0-1]+|0[0-7]*; xml.xsd.type=string

Table 4.69: PositiveUnlimitedInteger

Primitive	**PrimitiveIdentifier**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types

Note	This meta-class has the ability to contain a string. Please note that this meta-class has only been introduced to fix an issue with the generation of attributes on primitives in context with [TR_APRXML_00024]. **Tags:** xml.xsd.customType=PRIMITIVE-IDENTIFIER; xml.xsd.maxLength=128; xml.xsd.pattern=[a-zA-Z]([a-zA-Z0-9]|_[a-zA-Z0-9])*_?; xml.xsd.type=string

Table 4.70: PrimitiveIdentifier

Primitive	**Ref**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types			
Note	This primitive denotes a name based reference. For detailed syntax see the xsd.pattern. • first slash (relative or absolute reference) [optional] • Identifier [required] • a sequence of slashes and Identifiers [optional] This primitive is used by the meta-model tools to create the references. **Tags:** xml.xsd.customType=REF; xml.xsd.pattern=/?[a-zA-Z][a-zA-Z0-9_]{0,127}(/[a-zA-Z][a-zA-Z0-9_]{0,127})*; xml.xsd.type=string			
Attribute	***Datatype***	***Mul.***	***Kind***	***Note***
base	Identifier	0..1	attr	This attribute reflects the base to be used for this reference. **Tags:** xml.attribute=true
index	PositiveInteger	0..1	attr	This attribute supports the use case to point on specific elements in an array. This is in particular required if arrays are used to implement particular data objects. **Tags:** xml.attribute=true

Table 4.71: Ref

[constr_2552] Index attribute is only valid for arrays ⌈The index attribute in references is valid only if the reference target is an ApplicationArrayElement or if the reference target is an ImplementationDataTypeElement owned by an ImplementationDataType/ImplementationDataTypeElement of category ARRAY and has an attribute maxNumberOfElements/arraySize.⌋*()*

Primitive	**RegularExpression**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types

Note	This is a regular expression as defined in [http://www.w3.org/TR/xmlschema-2] As of now it is still produced as a string in XSD. **Tags:** xml.xsd.customType=REGULAR-EXPRESSION; xml.xsd.type=string

Table 4.72: RegularExpression

Primitive	**RevisionLabelString**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This primitive represents a revision label which identifies an engineering object. It represents a pattern which • requires three integers representing from left to right MajorVersion, MinorVersion, PatchVersion. • may add an application specific suffix separated by one of ".", "_", ";". Legal patterns are for example: 4.0.0 4.0.0.1234565 4.0.0_vendor specific;13 4.0.0;12 **Tags:** xml.xsd.customType=REVISION-LABEL-STRING; xml.xsd.pattern=[0-9]+\.[0-9]+\.[0-9]+([\._;].*)?; xml.xsd.type=string

Table 4.73: RevisionLabelString

Primitive	**SectionInitializationPolicyType**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types

Note	SectionInitializationPolicyType describes the intended initialization of MemorySections. The following values are standardized in AUTOSAR Methodology: • **NO-INIT**: No initialization and no clearing is performed. Such data elements shall not be read before one has written a value into it. • **INIT**: To be used for data that are initialized by every reset to the specified value (initValue). • **POWER-ON-INIT**: To be used for data that are initialized by "Power On" to the specified value (initValue). Note: there might be several resets between power on resets. • **CLEARED**: To be used for data that are initialized by every reset to zero. • **POWER-ON-CLEARED**: To be used for data that are initialized by "Power On" to zero. Note: there might be several resets between power on resets. Please note that the values are defined similar to the representation of enumeration types in the XML schema to ensure backward compatibility. **Tags:** xml.xsd.customType=SECTION-INITIALIZATION-POLICY-TYPE; xml.xsd.type=NMTOKEN

Table 4.74: SectionInitializationPolicyType

Primitive	**String**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This represents a String in which white-space must be normalized before processing. For example: in order to compare two Strings: • leading and trailing white-space needs to be removed • consecutive white-space (blank, cr, lf, tab) needs to be replaced by one blank. **Tags:** xml.xsd.customType=STRING; xml.xsd.type=string

Table 4.75: String

Primitive	**SymbolString**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types			
Note	This meta-class has the ability to contain a string plus an additional namePattern. Please note that this meta-class has only been introduced to fix an issue with the backwards compatibility between R4.0.3 and R4.1.1 in the context of McDataInstance **Tags:** xml.xsd.customType=SYMBOL-STRING; xml.xsd.type=string			
Attribute	***Datatype***	***Mul.***	***Kind***	***Note***

namePattern	String	1	attr	This attribute represents a pattern which shall be used to define the value of the identifier if the CIdentifier in question is part of a blueprint. For more details refer to TPS_StandardizationTemplate. **Tags:** xml.attribute=true

Table 4.76: SymbolString

Primitive	**TimeValue**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes
Note	This primitive type is taken for expressing time values. The numerical value is supposed to be interpreted in the physical unit second. **Tags:** xml.xsd.customType=TIME-VALUE; xml.xsd.type=double

Table 4.77: TimeValue

Primitive	**UnlimitedInteger**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes
Note	An instance of UnlimitedInteger is an element in the set of integer numbers (..., -2, -1, 0, 1, 2, ...). The range is limited by constraint 2534. The value can be expressed in decimal, octal, hexadecimal and binary representation. Negative numbers can only be expressed in decimal notation. **Tags:** xml.xsd.customType=UNLIMITED-INTEGER; xml.xsd.pattern=[+\-]?[1-9][0-9]*|0[xX][0-9a-fA-F]+|0[bB][0-1]+|0[0-7]*; xml.xsd.type=string

Table 4.78: UnlimitedInteger

Primitive	**VerbatimString**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::PrimitiveTypes			
Note	This primitive represents a string in which white-space needs to be preserved. **Tags:** xml.xsd.customType=VERBATIM-STRING; xml.xsd.type=string; xml.xsd.whiteSpace=preserve			
Attribute	***Datatype***	***Mul.***	***Kind***	***Note***

xmlSpace	XmlSpaceEnum	0..1	attr	This attribute is used to signal an intention that in that element, white space should be preserved by applications. It is defined according to xml:space as declared by W3C. **Tags:** atp.Status=shallBecomeMandatory xml.attribute=true; xml.attributeRef=true; xml.name=space; xml.nsPrefix=xml

Table 4.79: VerbatimString

Primitive	**VerbatimStringPlain**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	This primitive represents a string in which white-space needs to be preserved. This primitive is applied in cases where xml:space attribute cannot be provided by the primitive type but needs to be provided by the container class. This is in particular the case in applications of TR_APRXML_00024. **Tags:** xml.xsd.customType=VERBATIM-STRING-PLAIN; xml.xsd.type=string; xml.xsd.whiteSpace=preserve

Table 4.80: VerbatimStringPlain

[constr_2534] Limits of unlimited Integer ⌈ Practically `UnlimitedInteger` shall be limited such that it fits into 64 bit.

If a signed value is represented the min value can be down to -9223372036854775808 (0x800000000000000014) and the max value can be up to 9223372036854775807 (`0x7fffffffffffffff`).

If an unsigned value is represented the min value can be down to 0 and the max value can be up to 18446744073709551615 (`0xffffffffffffffff`). ⌋*()*

[TPS_GST_02501] Compatibility of Numerical Values ⌈ Compatibility of numerical values (in particular `Float`, `Numerical`, `PositiveInteger`, `UnlimitedInteger`) is defined independent of the representation (float, integer.octal/hex/binary/decimal) as:

$v1$ and $v2$ are compatible if and only if $abs(v1 - v2) < epsilon$ ⌋*()*

Primitive	**UriString**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types
Note	A Uniform Resource Identifier (URI), is a compact string of characters used to identify or name a resource. **Tags:** xml.xsd.customType=URI-STRING; xml.xsd.type=string

Table 4.81: UriString

Primitive	**VerbatimString**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Primitive Types			
Note	This primitive represents a string in which white-space needs to be preserved. **Tags:** xml.xsd.customType=VERBATIM-STRING; xml.xsd.type=string; xml.xsd.white Space=preserve			
Attribute	***Datatype***	***Mul.***	***Kind***	***Note***
xmlSpace	XmlSpaceEnum	0..1	attr	This attribute is used to signal an intention that in that element, white space should be preserved by applications. It is defined according to xml:space as declared by W3C. **Tags:** atp.Status=shallBecomeMandatory xml.attribute=true; xml.attributeRef=true; xml.name=space; xml.nsPrefix=xml

Table 4.82: VerbatimString

4.8 Formula Language

This chapter details the introduction of a general purpose formula language. The formula language can be used in different processing steps in the methodology, e.g. XML-processors, C preprocessor, Modeling tools.

4.8.1 Applying Formula Language

Until Release 3 the AUTOSAR artifacts could not express dependencies, i.e. calculate the value of one parameter based on other parameter values, or define values based on variant information. Each of these use cases is represented as a specialization of the abstract meta-class `FormulaExpression` as shown in figure 4.8.

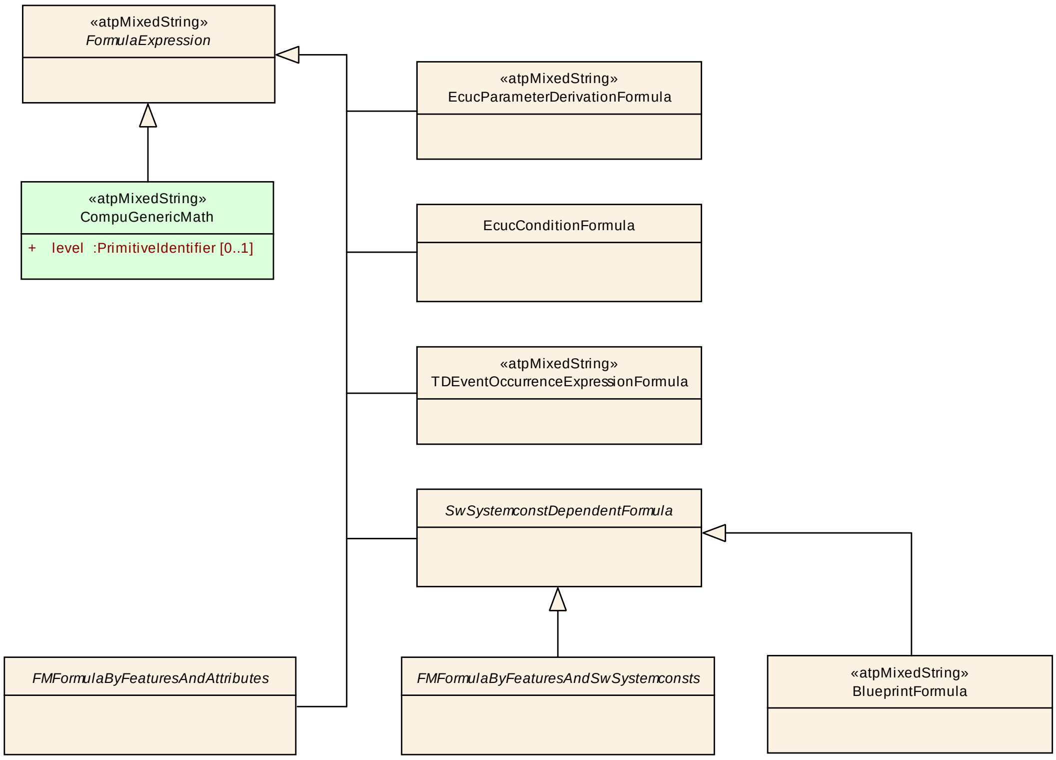


Figure 4.8: Formula language class hierarchy

[TPS_GST_00355] Specialization of `FormulaExpression` ⌈ These specializations represent three kinds of extensions:

- The applicable operands are specified as associations in the subclasses (see [TPS_GST_00001] in Chapter 4.8.2.1 for more details). An example is given in figure 4.10. The valid `reference` in the grammar below are taken from the role names in the meta model. Maintaining the references as formal associations allows to retrieve dependencies even without parsing the formula expressions.
- Additional functions are represented by the specialization and documented in the context of the same (see [TPS_GST_00293] in Chapter 4.8.2.1 for more details). It is not possible to extend the language by further operators.
- The particular application constrains the expected result. E.g. in `AttributeValueVariationPoint`, the result is given by the type of the variant attribute. Another example is `swSyscond` which expects a boolean result.

⌋*()*

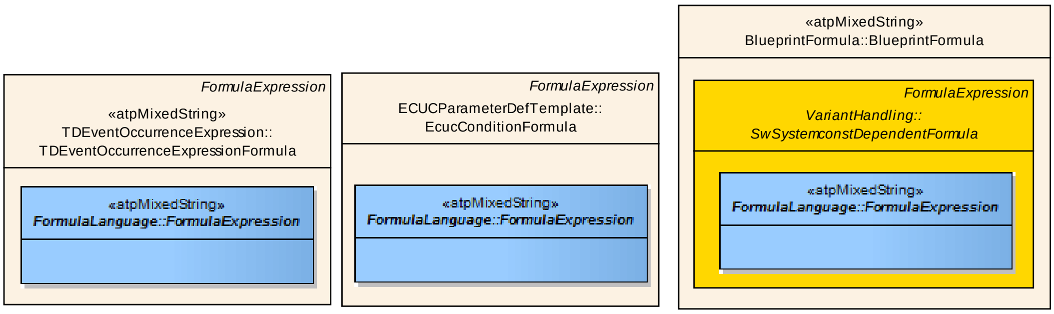


Figure 4.9: Formula language family

The formula language defined here is the core part of the specialization, blue part in figure 4.9.

Please note that `FormulaExpression` is ≪atpMixedString≫ (see Chapter 2.3.1). Therefore one expression can e.g. be dependent on multiple `SwSystemconst`s.

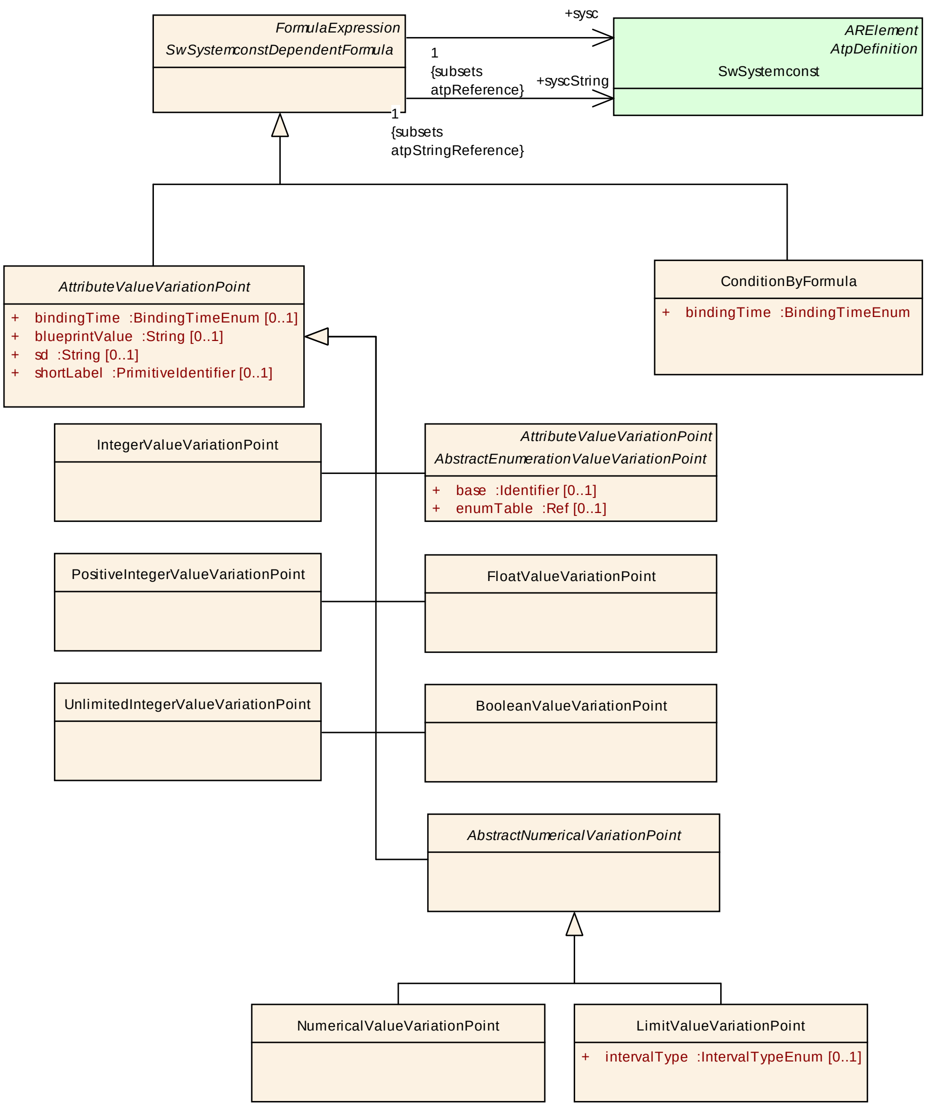


Figure 4.10: Formula depending on `SwSystemconst`

4.8.2 Formula Language Syntax

The connection between the formula and referenced meta model objects acting as operands is established by associations in the meta model and represented in the grammar as rule named `reference` and `stringReference` (see [TPS_GST_00001]). Therefore `FormulaExpression`s are «`atpMixedString`»s when serialized in ARXML. The grammar for the expressions, however, is defined after the processing of the mixed strings by a XML Parser, i.e. they no longer contain any XML-Tags, -Entities, -Comments, etc.. This is done to not "mimic" XML in the grammar but to focus on the expressions itself.

The following rules must be applied to come from the ARXML representation to the string that is then subject to the definition by the grammar:

- XML-Entities are replaced by the UTF characters they stand for (e.g. "<" is replaced by "<")
- XML-Comments are removed
- ARXML References are replaced by:
  - `reference`("‘{value of the DEST attribute}:{text content of the tag}") if they are subsets of the `+/atpReference` Association between `FormulaExpression` and `Referrable`
  - `stringReference`("{value of the DEST attribute}:{text content of the tag}") if they are subsets of the `+/atpStringReference` Association between `FormulaExpression` and `Referrable`

E.g. consider the following ARXML snippet:

```
<VARIATION-POINT>
  <SW-SYSCOND>
    defined(<SYSC-REF DEST="SYSTEM-CONSTANT">SY_COUNT<SYSC-REF>)
    <!-- this is a comment -->
    &amp;&amp; <SYSC-REF DEST="SYSTEM-CONSTANT">SY_COUNT<SYSC-REF> &lt; 10
  </SW-SYSCOND>
<VARIATION-POINT>
```

The `FormulaExpression` is serialized in ARXML in the «`atpMixedStrig`» Tag `<SW-SYSCOND>`. It is transformed by the above rules into:

```
defined(reference("SW-SYSTEMCONST:SY_COUNT") &&
        reference("SW-SYSTEMCONST:SY_COUNT") < 10
```

This `FormulaExpression` is than considered as well-formed according to the syntax defined by the formula language grammar.

Use case specific extensions may be applied by redefining particular token definitions according to [TPS_GST_00293].

[TPS_GST_00012] AUTOSAR Formula language ⌈ The AUTOSAR formula language uses the following syntax described in Listing 4.8 defined according to [10]. ⌋*()*

Listing 4.8: AUTOSAR Formula language

```
grammar autosarFormulaLanguage;

expr
    : atomExpr ;

atomExpr
    : condExpr ;

condExpr
    : orExpr (CondOperator orExpr AltOperator orExpr)? ;

orExpr
    : xorExpr (OrOperator xorExpr)* ;

xorExpr
    : andExpr (XorOperator andExpr)* ;

andExpr
    : bitOrExpr (AndOperator bitOrExpr)* ;

bitOrExpr
    : bitXorExpr (BitOrOperator bitXorExpr)* ;

bitXorExpr
    : bitAndExpr (BitXorOperator bitAndExpr)* ;

bitAndExpr
    : compEqExpr (BitAndOperator compEqExpr)* ;

compEqExpr
    : compExpr (CompEqOperator compExpr)* ;

compExpr
    : shiftExpr (CompOperator shiftExpr)* ;

shiftExpr
    : sumExpr (ShiftOperator sumExpr)* ;

sumExpr
    : mulExpr (SumOperator mulExpr)* ;

mulExpr
    : powExpr (MulOperator powExpr)* ;

powExpr
    : unaryExpr (PowOperator unaryExpr)? ;

unaryExpr
    : unaryOperator? atom;

atom
    : DecIntegerLiteral
    | reference
    | BooleanLiteral
```

```
    | HexIntegerLiteral
    | OctIntegerLiteral
    | BinIntegerLiteral
    | DecimalLiteral
    | DoubleLiteral
    | ArgumentOperand
    | DefinedFuncName LPAREN (reference | stringReference)  RPAREN
    | StringFuncName LPAREN stringArg COMMA stringArg RPAREN
    | BinaryFuncName LPAREN atomExpr COMMA atomExpr RPAREN
    | UnaryFuncName LPAREN atomExpr RPAREN
    | Keyword
    | (LPAREN atomExpr RPAREN)

    // Here the supported extension points are listed:
    // Depending on which of the extension points are defined in a
    // spcialisation of the formula language, the following one,
    // two or all of the following alternatives are added to this rule:
    // | ExtBinaryFuncName LPAREN atomExpr COMMA atomExpr RPAREN
    // | ExtUnaryFuncName LPAREN atomExpr RPAREN
    // | ExtKeyword
    // end of extension points
    ;

stringArg
    : stringReference | StringLiteral ;

unaryOperator
    : SumOperator | OtherUnaryOperator ;

//------------------------------------------------------------------
// these rules represent the reference to operands
// in an XML-Arttifact, this is represented as XML-Artifact
//
// Applicable RefFuncNames depend on the associations in the
// particular specialization of FormulaLanguage in the
// metamodel
// see [TPS_GST_00001]

stringReference
    : StringReferenceFuncName LPAREN StringLiteral RPAREN ;

reference
    : ReferenceFuncName LPAREN StringLiteral RPAREN ;

// argumentOperand is valid only in formula derived from CompuGenericMath

ArgumentOperand
    : 'X' ('1' .. '9')('0' .. '9')* ;


// Tokens
OrOperator
    : '||';

XorOperator
    : '^^' ;
```

```
AndOperator
    : '&&';

BitOrOperator
    : '|';

BitXorOperator
    : '^';

BitAndOperator
    : '&';

CompEqOperator
    : '==' | '!=';

CompOperator
    : '<=' | '<' | '>=' | '>' ;

ShiftOperator
    : '<<' | '>>' ;

SumOperator
    : '+' | '-' ;

OtherUnaryOperator
    : '!' | '~' ;

MulOperator
    : '*' | '/' | '%' ;

PowOperator
    : '**' ;

CondOperator
    : '?';

AltOperator
    : ':';

DefinedFuncName
    : 'defined' ;

StringFuncName
    : 'streqcs' | 'streqci';

UnaryFuncName
    : 'round'
    | 'ceil'
    | 'floor'
    | 'abs'
    | 'log'
    | 'exp'
    | 'sin'
    | 'cos'
    | 'asin'
```

```
    | 'acos'
    | 'atan'
    | 'sinh'
    | 'cosh'
    | 'tan'
    | 'tanh'
    | 'sqrt'
    | 'log10'
    | 'sgn'
    ;

ReferenceFuncName : 'reference' ;

StringReferenceFuncName : 'stringReference' ;

BinaryFuncName
    : 'max'
    | 'min'
    | 'pow'
    ;

Keyword
   : 'epsilon'
   | 'undefined'
     ;

//////////////////////////////////////////////////////////////////
//Here the definitions for the extenstion points would be included
//////////////////////////////////////////////////////////////////


BooleanLiteral
     : 'true'
     | 'false'
     ;

LPAREN : '(' ;
RPAREN : ')' ;
COMMA  : ',' ;


//
   --------------------------------------------------------------------------------


DecIntegerLiteral
    : '0'
    | ('1'..'9')('0'..'9')*
    ;

HexIntegerLiteral
    : '0' ('x' | 'X') (('0'..'9') | ('a'..'f') | ('A'..'F'))+ ;

OctIntegerLiteral
    : '0'('0'..'7')+ ;
```

```
BinIntegerLiteral
    : '0' ('b' | 'B') ('0' ..'1')+ ;

DecimalLiteral
    :  ('0'? '.' ('0'..'9')+) |  (('1'..'9')('0'..'9')* ('.' ('0'..'9')*)) ;

DoubleLiteral
    :  ((('0'? '.' ('0'..'9')+) |  (('1'..'9')('0'..'9')* ('.' ('0'..'9')*)
       ?))
       ('e' | 'E') ('+' | '-')? ('0'..'9')+)
    | 'NaN'
    | 'INF'
    ;

// The next rule defines StringLiterals as double quoted sequences of
// (almost) arbitrary characters with the backslash as escape character.
// Please notice that the tilde is used in the ANTLR syntax to denote
// negation and it is necessary to escape the backslash to match itself.

StringLiteral
    : '"' ((~('"'|'\\') | '\\' ~('\\') | '\\\\')*) '"'
    ;

WS : (' ' | '\t' | '\r' | '\n' )+ {$channel=HIDDEN;}
    ;
```

Please note the following:

- The semantics of the operators is shown in Table 4.83
- The supported mathematical functions are shown in Table 4.84

Symbol	Operator	Return Types see
!, ~	**[TPS_GST_00111] Negation Operator** ⌈(yields boolean, bit-wise negation) ⌋()	[TPS_GST_00039]
**	**[TPS_GST_00112] Exponentiation Operator** ⌈ yields operand 1 power operand 2 ⌋()	[TPS_GST_00035]
*, /, %	**[TPS_GST_00113] Multiplicative Operator / division** ⌈ yields Multiplication, division, modulo ⌋()	[TPS_GST_00035]
+, -	**[TPS_GST_00114] Additive Operator** ⌈ Yields Addition, subtraction, sign ⌋()	[TPS_GST_00034]
<<,>>	**[TPS_GST_00115] Shift Operator** ⌈ Yields bit-wise shift (left, right) note that the ends are filled with "0". ⌋()	[TPS_GST_00037]
<, <=, >, >=	**[TPS_GST_00116] Ranking Operator** ⌈ Yields comparison: less than, less than or equal to, greater than, greater than or equal to ⌋()	[TPS_GST_00036]
==, !=	**[TPS_GST_00117] Comparison: equality** ⌈ Yields equal, unequal to ⌋()	[TPS_GST_00036]
&	**[TPS_GST_00118] Bit-wise AND** ⌈ Yields the bit wise and of the operators ⌋()	[TPS_GST_00037]
ˆ	**[TPS_GST_00119] Bit-wise XOR** ⌈ Yields the bit wise xor of the operators ⌋()	[TPS_GST_00037]
|	**[TPS_GST_00120] Bit-wise OR** ⌈ Yields the bit wise or of the operators ⌋()	[TPS_GST_00037]

&&	**[TPS_GST_00121] Boolean AND** ⌈ Yields a boolean AND with operand value 0 -> false, others -> true ⌋ *()*	[TPS_GST_00036]
^^	**[TPS_GST_00122] Boolean XOR** ⌈ Yields a boolean XOR with operand value 0 -> false, others -> true ⌋ *()* where operand value 0 -> false, others -> true	[TPS_GST_00036]
||	**[TPS_GST_00123] Boolean OR** ⌈ Yields a boolean OR with operand value 0 -> false, others -> true ⌋ *()*	[TPS_GST_00036]

Table 4.83: Operators in arithmetic expressions

Function	Param.	Type of result	Meaning
round	1	integer	**[TPS_GST_00124] Round Function** ⌈ This rounds positive and negative numbers to the nearest whole number. Note that when processing such expressions, that `round` is defined for the value ranges -2147483648 to +4294967295.⌋ *()*
ceil	1	integer	**[TPS_GST_00125] Round Up Function** ⌈ This rounds positive and negative numbers up to the next whole number. Note that when processing such expressions, that `ceil` is defined for the value ranges -2147483648 to +4294967295. ⌋ *()*
floor	1	integer	**[TPS_GST_00126] Round Down Function** ⌈ This rounds positive and negative numbers down to the next whole number. Note that when processing such expressions, that `floor` is defined for the value ranges -2147483648 to +4294967295. ⌋ *()*
abs	1	like operand	**[TPS_GST_00127] Absolute Value** ⌈ This yields the absolute value of the operand ⌋ *()*
log	1	float	**[TPS_GST_00128] Natural Logarithm** ⌈ This yields the natural logarithm (base e) of the argumnent. ⌋ *()*
log10	1	float	**[TPS_GST_00129] Decimal Logarithm** ⌈ This yields the logarithm base 10 - Provided for A2L 1.6 ⌋ *()*
sqrt	1	float	**[TPS_GST_00130] Square Root** ⌈ This yields the square root - Provided for A2L 1.6 ⌋ *()*
sin	1	float	**[TPS_GST_00131] Sinus** ⌈ This yields sinus - Provided for A2L 1.6 ⌋ *()*
asin	1	float	**[TPS_GST_00132] Arcus Sinus** ⌈ This yields arcus sinus - Provided for A2L 1.6 ⌋ *()*
cos	1	float	**[TPS_GST_00133] Cosinus** ⌈ This yields cosinus - Provided for A2L 1.6 ⌋ *()*
acos	1	float	**[TPS_GST_00134] Arcus Cosiuns** ⌈ This yields arcus cosinus - Provided for A2L 1.6 ⌋ *()*
sinh	1	float	**[TPS_GST_00135] Sinus Hyperbolicus** ⌈ This yields sinus hyperbolicus - Provided for A2L 1.6 ⌋ *()*
cosh	1	float	**[TPS_GST_00136] Cosinus Hyperbolicus** ⌈ This yields cosinus hyperbolicus - Provided for A2L 1.6 ⌋ *()*
tan	1	float	**[TPS_GST_00137] Tangens** ⌈ This yields tangens - Provided for A2L 1.6 ⌋ *()*
atan	1	float	**[TPS_GST_00138] Arcus Tangens** ⌈ This yields arcus tangens - Provided for A2L 1.6 ⌋ *()*
tanh	1	float	**[TPS_GST_00139] Tangens Hyperbolicus** ⌈ This yields tangens hyperbolicus - Provided for A2L 1.6 ⌋ *()*
exp	1	float	**[TPS_GST_00140] Exponential** ⌈ This yields exponential function (base e) ⌋ *()*

defined	1	0 or 1	**[TPS_GST_00141] Is Defined** ⌈ This checks whether the reference given as the argument is defined ⌋*()*
sgn	1	integer	**[TPS_GST_00142] Signum** ⌈ This yields signum, result is one of -1, 0, +1 ⌋*()*
max	2	depends on operands	**[TPS_GST_00143] Maximum Value** ⌈ This finds the maximum value of the arguments ⌋*()*
min	2	depends on operands	**[TPS_GST_00144] Minium Value** ⌈ This finds the minimum value of the arguments ⌋*()*
pow	2	depends on arguments	**[TPS_GST_00145] Power Function** ⌈ This yields argument 1 power argument 2 - provided for A2L 1.6. This is equivalent to [TPS_GST_00112]. ⌋*()* Result type follows [TPS_GST_00035].
streqcs	2	0 or 1	**[TPS_GST_00146] Case Sensitive String Compare** ⌈ This compares two strings in case sensitive manner. ⌋*()*
streqci	2	0 or 1	**[TPS_GST_00147] Non Case Insensitive String Compare** ⌈ This compares two strings in non case sensitive manner. ⌋*()*

Table 4.84: mathematical functions in arithmetic expressions

4.8.2.1 Implementation details of a Formula Processor

The following implementation details apply:

- **[TPS_GST_00001] Connection between Formula and Model Elements** ⌈ The formula language mentioned above has production rules (**reference**, **stringReference**) which are defined as

```
stringReference
    :       'stringReference' LPAREN StringLiteral RPAREN;

reference
    :       'reference' LPAREN StringLiteral RPAREN;
```

  This production indicates, that at this point, a reference to a model element needs to be resolved. It is not allowed to accept AUTOSAR artifacts which contain such a textual representation. ⌋*()*

- **[TPS_GST_00293] Use Case Specific Extension of Formula Language** ⌈ A use case specific extension is indicated in the meta model by a specialization of `FormulaExpression`. The semantics of the extension is specified in the context of this specialization as a fragment of an ANTLR specification redefining the following Tokens:

  – `ExtKeyword` - this provides additional keywords similar to `epsilon`

  – `ExtUnaryFuncName` - this provides additional names for unary functions

  – `ExtBinaryFuncName` - this provides additional names for binary functions

  It is not possible to extend the formula language by additional operators. ⌋*()*

Thus the list of functions in Table 4.83 is extended. An example for the definition of additional Keywords based on an unary function is given in Listing 4.9.

Listing 4.9: AUTOSAR Formula language extension

```
ExtUnaryFuncName    :   'TIMEX_value' |
                        'TIMEX_occurs' |
                        'TIMEX_hasOccurred' |
                        'TIMEX_timeSinceLastOccurrence' |
                        'TIMEX_angleSinceLastOccurrence'
                        ;
```

- **[TPS_GST_00015] result of reference/stringReference** ⌈
  - `reference` shall yield a numerical / boolean value.
  - `stringReference` shall yield a string value.

  ⌋*()*

- **[TPS_GST_00002] aborting logical expressions** ⌈ The calculation of expressions with boolean AND or OR is aborted if the first operand has produced a result so that the total result cannot be changed anymore by the second operand (as in C). ⌋*()*

  Note: This is useful e.g. in the context of `SwSystemconstDependentFormula`, a specialization of the formula language. This behavior gives meaningful results in expressions such as:

  ```
  defined(reference("SW-SYSTEMCONST:SY_COUNT")) &&
          reference("SW-SYSTEMCONST:SY_COUNT") > 1
  ```

  since here, if `SY_COUNT` is not defined, the check for "`> 1`" is not carried out and an unwanted error message is thus avoided.

- **[TPS_GST_00003] true and false** ⌈ Like in C a integer "0" respectively floating point "0.0" and "-0.0" are interpreted as false. Every other value is treated as true within boolean expressions.

  The language also provides the literals "`true`" yielding `1` respectively "`false`" yielding `0` to express literal boolean values in expressions. ⌋*()*

  It is strongly recommended not to apply the Boolean operations ||, &&, ^^, ==, != to floating-point values. Caused by the limited ability of float operands to hold exact integer (in the mathematical meaning) numbers the result of these operations may have (as implementation specifics have a huge impact here) values that are hard to predict.

- **[TPS_GST_00004] Priority of Operations** ⌈
  The priority rules of C++[1] apply and are modeled in the grammar: multiplication and division take precedence over addition and subtraction. The exponent operator (`**`) has priority over these other mathematical operators.

[1] Note that XOR is not defined in C++.

The unary minus has greater precedence than all other operators. For a complete list of the priorities please refer to [11].

Example:

- `-2**3` becomes `-8 = (-2)**3`
- `-log(2.718281828)**2` corresponds to `(-log(2.718281828))**2` and therefore is equal to `+1`.

⌋()

- **[TPS_GST_00005] left-to-right evaluation** ⌈ Binary operators shall be evaluated from left to right (left-to-right associativity). For example 2 == 2 == 2 shall be evaluated as (2 == 2) == 2. ⌋()

- **[TPS_GST_00006] Associativity of XOR** ⌈ Boolean XOR operator ^^ is an additional operator which has no counterpart in C. The result of a boolean XOR is "1" if one of the operands is interpreted as false and the other as true. The result of a boolean XOR is "0" if both operands have the same value independent of whether the value is true or false. Other than boolean AND (&&) and boolean OR (||), boolean XOR always evaluates both operands. This is because the result of a boolean XOR cannot be determined by only evaluating e.g. the first operand.

  Hint: In hardware circuits sometimes an XOR gate with more than two inputs is used. For such a hardware XOR gate the output is "1" if and only if one of the inputs is "1" and all other inputs are "0". The XOR operator within arithmetic expressions is a binary operator and therefore behaves different than hardware XOR gates. This means in particular that according to left-to-right associativity e.g.
  1 ^^ 1 ^^ 1 is interpreted as (1 ^^ 1) ^^ 1 which yields "1". ⌋()

- **[TPS_GST_00007] Shift operation** ⌈
  When the shift operation is performed, the first or the last bit (depending on the direction of the shift) is filled with "0".

  Shift left means that the bits are shifted towards the higher values. Shift right means that the bits are shifted towards the lower values.

  Shift is performed as long as we are in the range defined by [TPS_GST_00008]
  ⌋()

  Implementers shall apply a mask on the intended size number of bits on the result. For example if `0b1111 << 1` shall still yield 4 bits, then user shall write

  ```
  (0b1111 << 1) & 0b1111
  ```

  to get the intended result of `0b1110`. Without the mask, the result would be `0b11110` which is 5 bit.

  Example based on 32 bit integer implementation of the formula processor (note that not all leading zero digits are shown):

  - `0b0001 << 1` returns `0b00010`
  - `0b1111 >> 1` returns `0b0111`
  - `0b1111 << 1` returns `0b11110`
  - `0b1111 << 2` returns `0b111100`

- **[TPS_GST_00008] Types in Formula Expressions** ⌈
  The type of an arithmetic expression is one of
  - Integer in the range (32 bit implementation)

    ```
    0x80000000 .. 0xffffffff
    -2147483648 .. +4294967295
    ```

    respectively (in a 64 bit implementation)

    ```
    0x8000000000000000 .. +0xffffffffffffffff
    -9223372036854775808 .. +18446744073709551615
    ```

  - Float (internally represented by double)

  ⌋*()* For the result type of a function or operand see 4.8.2.2.

  Note: The ranges of the 32-bit implementation are the set union of signed INT (-2147483648 .. 2147483647) and unsigned INT (0 .. 4294967295) resulting in (-2147483648 .. 4294967295). The same procedure is applied for the 64-bit implementation.

- **[TPS_GST_00359] Handling of the Sign** ⌈
  In consequence of [TPS_GST_00008], implementations of a formula processor need to provide an extra handling of the sign in case of integer values.

  ```
  -2147483648 < value < 0          => signed INT (sign "-")
  -2147483648 < value < 2147483647 => signed INT (sign "-" or "+")
  -0                               => signed INT (sign "-")
  +0                               => signed INT (sign "+")
   0          < value < 2147483647 => unsigned INT
  2147483647  < value < 4294967295 => unsigned INT.
  ```

  ⌋*()*

- **[TPS_GST_00009] Keyword 'epsilon'** ⌈
  `epsilon` represents an implementation specific constant intended to support the comparison of float values. It represents the smallest increment which can be expressed by the given implementation.

  For example instead of comparing a float with zero, one should use

  ```
  abs(sysc(x)) < epsilon ? 0 : 1
  ```

  ⌋*()*

- **[TPS_GST_00276] Power of Null** ⌈
  `pow(0, 0)` respectively `0**0` is undefined and shall raise an error (see also [TPS_GST_00014]).

⌋()

- **[TPS_GST_00010] Keyword `undefined`** ⌈
  `undefined` represents a sub term which is undefined. It is subject to be replaced in further process steps. The main purpose is to denote blueprints of expressions. The result of `undefined` is the same as an undefined operand. Usually it yields a runtime error. The following expressions hold true:

  ```
  defined(undefined) = false
  true && undefined = error
  false && undefined = false
  undefined = error
  ```

  And consequently for OR it is

  ```
  true || undefined = true
  false || undefined = error
  ```

  ⌋()

- **[TPS_GST_00275] Float Literals `INF`, `NaN`** ⌈ In order to maintain consistency with `Float`, formula expressions also supports the special float literals `INF` and `NaN`.

  The support of these literals is in particular:

  – `INF` is allowed only in the context of operators `"=="`, `"!="`, unary `"-"`, result of `condExpr`

  – `NaN` is allowed only in the context of operators `"=="`, `"!="`, result of `condExpr`

  – `INF`, `NaN` can only be obtained by literal specification (e.g. in a `SwSystemconstValue`) but not as the result of an arithmetic operation (In particular [TPS_GST_00014] is not affected by these literals).

  ⌋()

  Note that there is no specific literal `-INF` since this is supported via the unary operator `"-"`.

  An example from the context of `SwSystemconstDependentFormula` for an expression yielding `INF` is

  ```
  reference("SW-SYSTEMCONST:unlimited") == true ? INF : 10000
  ```

- **[TPS_GST_00011] Functions `round`, `ceil`, `floor`** ⌈
  These act as 'Integer-Cast' with rounding. The following applies:

  – **`round`**
  rounds positive and negative numbers to the next whole number.

  ```
  Ex. : round(4.4) = 4       round(-4.4) = -4
        round(4.7) = 5       round(-4.7) = -5
        round(4.5) = 5       round(-4.5) = -5
  ```

- **floor**
  rounds positive and negative numbers down to the next whole number.

```
Ex. : floor(4.4) = 4      floor(-4.4) = -5
      floor(4.7) = 4      floor(-4.7) = -5
      floor(4.0) = 4      floor(-4.0) = -4
```

- **ceil**
  rounds positive and negative numbers up to the next whole number.

```
Ex. : ceil(4.4)  = 5      ceil(-4.4)  = -4
      ceil(4.7)  = 5      ceil(-4.7)  = -4
      ceil(4.0)  = 4      ceil(-4.0)  = -4
```

⌋()

- **[TPS_GST_00013] Function `defined`** ⌈ `defined(reference)` returns `1` if the reference passed as a parameter is defined. If a `reference(...)` is defined by a formula `defined(reference(...))` returns 1. The expression `defined(stringReference(...))` yields 1 if the reference passed as parameter can yield a string. In all other cases it returns 0. ⌋()

  Note that for example `SwSystemconstValue` can be defined using a formula. Such a 'redefined' `SwSystemconst` is always treated as 'defined' even if its formula refers to an undefined `SwSystemconst`. A `reference` can return a string if for example, in case of a `SwSystemconstDependentFormula`, the referenced `SwSystemconst` refers a `CompuMethod` of category `TEXTTABLE`.

  Example:

```
suppose
   reference("SW-SYSTEMCONST:ZYLZA")  is set to 4
   reference("SW-SYSTEMCONST:ZYLZA2") is set to reference("SW-SYSTEMCONST:ZYLZA")+2
   reference("SW-SYSTEMCONST:TURBO")  is left undefined
   reference("SW-SYSTEMCONST:TURBO2") is set to reference("SW-SYSTEMCONST:TURBO")+2
then
   defined(reference("SW-SYSTEMCONST:ZYLZA"))  yields 1
   defined(reference("SW-SYSTEMCONST:ZYLZA2")) yields 1
   defined(reference("SW-SYSTEMCONST:TURBO"))  yields 0
   defined(reference("SW-SYSTEMCONST:TURBO2")) yields 1 (TURBO2 is defined, even
                                                         though the referenced
                                                             TURBO is undefined.)
```

- **[TPS_GST_00014] Error handling in Formula Evaluator** ⌈
  Error messages shall be exposed by an evaluator
  - if the arithmetic expression is syntactically incorrect
  - in case of division by 0
  - in case `0**0` respectively `pow(0, 0)` (see [TPS_GST_00276])
  - if the definition range of a function is violated
  - if the function value of a function is outside the range which can be represented (for example, this applies to `floor(10E22)`)

- if the evaluation of an operand fails (see [TPS_GST_00002], [TPS_GST_00010])
- if the range that can be represented is exceeded when using the basic arithmetic operators '-', '+', '*', '/'

⌋()

- **[TPS_GST_00094] Return values of the BlueprintFormula.ecuc query** ⌈
The return values are defined in Table 4.85. In the case several EcucContainerValue(s) or EcucParameterValue(s) are asigned to the EcucContainerDef / EcucParameterDef the return value is undefined. ⌋()

Return values	Description
EcucContainerDef	Ecuc returns the value of the shortName of the EcucContainerValue
EcucBooleanParamDef	Ecuc returns the assigned value of the EcucNumericalParamValue
EcucIntegerParamDef	Ecuc returns the assigned value of the EcucNumericalParamValue
EcucFloatParamDef	Ecuc returns the assigned value of the EcucNumericalParamValue
EcucEnumerationParamDef	Ecuc returns the assigned value of the EcucTextualParamValue
EcucAbstractStringParamDef	Ecuc returns the assigned value of the EcucTextualParamValue
EcucReferenceDef	Ecuc returns the referenced container object qualified by the destination attribute.
EcucChoiceReferenceDef	Ecuc returns the referenced container objects (list) qualified by the destination attributes.
EcucSymbolicNameReferenceDef	Ecuc returns the referenced container object qualified by the destination attribute.
EcucUriReferenceDef	Ecuc returns the referenced container objects (list) qualified by the destinationUri attribute.

Table 4.85: Return values of the BlueprintFormula.ecuc query

4.8.2.2 Resulting Data Types of Formula Expressions

The following return types apply for operator/operands:

[TPS_GST_00034] Return Types for Additive 0perators ⌈

```
+ - / *
      Integer, Integer  -> Integer (this is an integer division)

      Integer, Float    -> Float
      Float, Integer    -> Float
      Float, Float      -> Float
```

⌋()

[TPS_GST_00035] Return Types for Multiply Operators ⌈

```
**, pow
      Integer, Integer  -> Integer

      Integer, Float    -> Float
      Float, Integer    -> Float
      Float, Float      -> Float
```

⌋()

[TPS_GST_00036] Return Types for Logical Operators ⌈

```
||, &&,^^, ==, <=, <, >, >=, !=
      Integer, Integer  -> Integer representing boolean (0: false,  1: true)

      Integer, Float    -> Integer representing boolean (0: false,  1: true)
      Float, Integer    -> Integer representing boolean (0: false,  1: true)
      Float, Float      -> Integer representing boolean (0: false,  1: true)
```

⌋()

[TPS_GST_00037] Return Types for Bitwise Operators ⌈

```
|, &, ^, <<, >>         bit-wise operators always render Integer
                        with value >= 0
      Integer, Integer  -> Integer
      Integer, Float    -> Fault
      Float, Integer    -> Fault
      Float, Float      -> Fault
                         using an operand of type Float
                         or negative Integer leads to incorrect
                         arithmetic expression and an error message
```

⌋()

[TPS_GST_00038] Return Types for Binary Function ⌈

```
min
      Integer, Integer  -> Integer

      Float, Integer    -> Float
      Integer, Float    -> Float
      Float, Float      -> Float

max
      Integer, Integer  -> Integer
      Integer, Float    -> Float
      Float, Integer    -> Float
      Float, Float      -> Float
```

⌋()

[TPS_GST_00039] Return Types for Negation Operators ⌈

```
~, !
      Integer           -> Integer
      Float             -> Fault
```

```
                            using an operand of type Float
                            or negative Integer leads to incorrect
                            arithmetic expression and an error message
```

⌋()

[TPS_GST_00040] Return Types for Define ⌈

```
defined                 -> Integer representing boolean (0: false,  1: true)
```

⌋()

[TPS_GST_00041] Return Types for Unary Functions ⌈

```
log, log10, exp
      Integer           -> Float
      Float             -> Float

abs
      Integer           -> Integer
      Float             -> Float

sgn
      Integer           -> Integer (the result is one of -1, 0, 1)
      Float             -> Integer (the result is one of -1, 0, 1)

ceil, floor, round
      Integer           -> Integer
      Float             -> Integer
```

⌋()

[TPS_GST_00042] Return Types for Keywords ⌈

```
epsilon                 -> Float

true, false             -> Integer representing boolean (0: false,  1: true)
```

⌋()

[TPS_GST_00208] Representation of return type in float ⌈ The serialisation of the final return value of type float shall be in float format and even if the result has no decimal places one decimal place shall be emitted (e.g. 5.0). ⌋()

4.8.2.3 Examples for the Formula Language expressions

Examples of correct arithmetic expressions are[2]:

```
<APPLICATION-VALUE-SPECIFICATION>
  <SW-VALUE-CONT>
    <SW-VALUES-PHYS>
      <VF>1</VF>
    </SW-VALUES-PHYS>
  </SW-VALUE-CONT>
```

[2]Note that the example does not reflect the BINDING-TIME

```
</APPLICATION-VALUE-SPECIFICATION>
```

```
...
      <VF>2.0</VF>
...
```

```
...
      <VF>1.5E5</VF>
...
```

```
...
      <VF>2.0 * (1 + 2)</VF>
...
```

```
...
      <VF>2 > 1</VF>
...
```

Example without entities. The grammar is defined for strings AFTER replacement of the entities.

```
...
      <VF>2 &gt; 1</VF>
...
```

Example with entities. When looking in real ARXML-Files, e.g. with a text editor, one may find entities in the formula expression. Entities are things like

```
&gt;
```

standing for "‘>"’.

Additional formula language expression are available as test cases in [12] [AUTOSAR_TP_FormulaLanguage_TestCase_Blueprint.arxml]. For further examples with references see content below [TPS_GST_00265].

4.9 EngineeringObject

While developing AUTOSAR based systems, it is necessary to refer to physical files. These files can be artifacts in which an AUTOSAR model is stored, but may also be source files, diagrams etc. AUTOSAR M1 models may need to refer to such files.

[TPS_GST_00109] Abstraction of Artifacts from Physical File Systems ⌈ It is required to keep AUTOSAR XML files independent of the physical layout of hard drives. Therefore, references to physical file such is abstracted as an `AutosarEngineeringObject`. ⌋*()*

This follows the approach in [13].

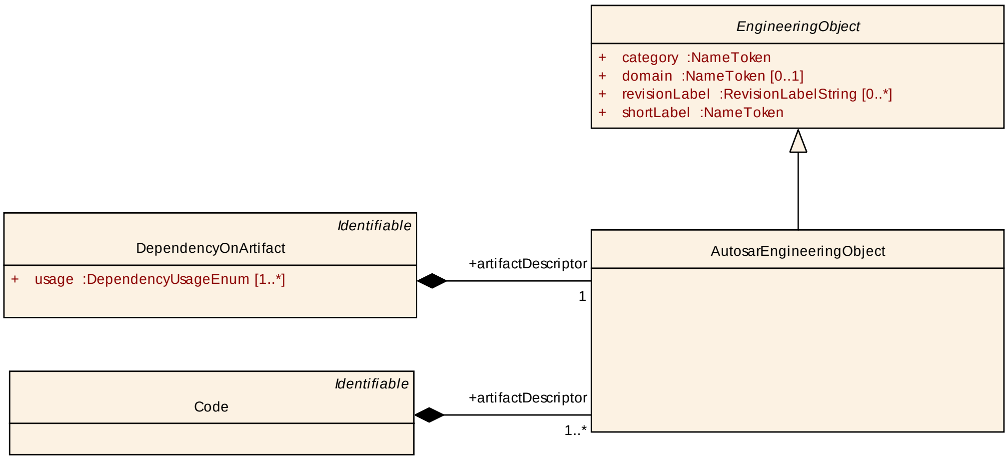


Figure 4.11: Engineering Object

Class	**EngineeringObject (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Engineering Object			
Note	This class specifies an engineering object. Usually such an object is represented by a file artifact. The properties of engineering object are such that the artifact can be found by querying an ASAM catalog file. The engineering object is uniquely identified by domain+category+shortLabel+revisionLabel.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
category	NameToken	1	attr	This denotes the role of the engineering object in the development cycle. Categories are such as • SWSRC for source code • SWOBJ for object code • SWHDR for a C-header file Further roles need to be defined via Methodology. **Tags:** xml.sequenceOffset=20
domain	NameToken	0..1	attr	This denotes the domain in which the engineering object is stored. This allows to indicate various segments in the repository keeping the engineering objects. The domain may segregate companies, as well as automotive domains. Details need to be defined by the Methodology. Attribute is optional to support a default domain. **Tags:** xml.sequenceOffset=40
revisionLabel	RevisionLabelString	*	attr	This is a revision label denoting a particular version of the engineering object. **Tags:** xml.sequenceOffset=30

shortLabel	NameToken	1	attr	This is the short name of the engineering object. Note that it is modeled as NameToken and not as Identifier since in ASAM-CC it is also a NameToken. **Tags:** xml.sequenceOffset=10

Table 4.86: EngineeringObject

Class	**AutosarEngineeringObject**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Engineering Object			
Note	This denotes an engineering object being part of the process. It is a specialization of the abstract class EngineeringObject for usage within AUTOSAR.			
Base	ARObject, EngineeringObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.87: AutosarEngineeringObject

The following example illustrates the usage of an `EngineeringObject` to refer to a physical file.

Listing 4.10: Example for an artifact description

```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xmlns="http://autosar.org/schema/r4.0"
         xsi:schemaLocation="http://autosar.org/schema/r4.0␣AUTOSAR_4-1-3.
             xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>demo</SHORT-NAME>
      <ELEMENTS>
        <SWC-IMPLEMENTATION>
          <SHORT-NAME>foo</SHORT-NAME>
          <ANNOTATIONS>
            <ANNOTATION>
                <ANNOTATION-TEXT>
                  <P>
                  </P>
                  <FORMULA>
                  </FORMULA>
                  <VERBATIM>
                  </VERBATIM>
                  <P>
                  </P>
                </ANNOTATION-TEXT>
            </ANNOTATION>
          </ANNOTATIONS>
          <REQUIRED-ARTIFACTS>
            <DEPENDENCY-ON-ARTIFACT>
              <SHORT-NAME>Foo</SHORT-NAME>
```

```
              <ARTIFACT-DESCRIPTOR>
                <SHORT-LABEL>FOO</SHORT-LABEL>
                <CATEGORY>SWSRC</CATEGORY>
                <DOMAIN>AUTOSAR</DOMAIN>
              </ARTIFACT-DESCRIPTOR>
              <USAGES>
                <USAGE>COMPILE</USAGE>
              </USAGES>
            </DEPENDENCY-ON-ARTIFACT>
          </REQUIRED-ARTIFACTS>
        </SWC-IMPLEMENTATION>
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

[TPS_GST_00110] ⌈ EngineeringObject can be resolved via a container catalog as defined in [14] in order to find the physical File. ⌋*()*

The `artifactDescriptor` in the example above describes the artifact "FOO" which is of category "SWSRC". Using this information, the path to the physical file can be resolved via the following catalog example. There it is the first ABLOCK.

Listing 4.11: Example for an ASAM catalog

```
<?xml version = "1.0" encoding = "utf-8"?>
<CATALOG xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:noNamespaceSchemaLocation="catalog_V3_0_0.ml.xsd">
  <SHORT-NAME>sample</SHORT-NAME>
  <ABLOCKS>
    <ABLOCK>
      <SHORT-NAME>FOO</SHORT-NAME>
      <CATEGORY>SWSRC</CATEGORY>
      <DOMAIN>AUTOSAR</DOMAIN>
      <FILES>
        <FILE>source/c/foo.c</FILE>
      </FILES>
    </ABLOCK>
    <ABLOCK>
      <SHORT-NAME>FOO</SHORT-NAME>
      <CATEGORY>SWCT</CATEGORY>
      <DOMAIN>AUTOSAR</DOMAIN>
      <FILES>
        <FILE>AUTOSAR/xml/foo.arxml</FILE>
      </FILES>
    </ABLOCK>
    <ABLOCK>
      <SHORT-NAME>FOO</SHORT-NAME>
      <CATEGORY>ECUC</CATEGORY>
      <DOMAIN>AUTOSAR</DOMAIN>
      <FILES>
        <FILE>AUTOSAR/ecuc/foo.ecucvalues.arxml</FILE>
      </FILES>
    </ABLOCK>
  </ABLOCKS>
</CATALOG>
```

4.10 Annotations

[TPS_GST_00148] Annotation ⌈ In the development process it is often required to place annotation (a kind of yellow pads) to the model. In order to support this in a generic way, the abstract meta-class `GeneralAnnotation` is applied and specialized according to the particular use case.

If no further attributes are required, the concrete meta-class `Annotation` is applied. ⌋*()*

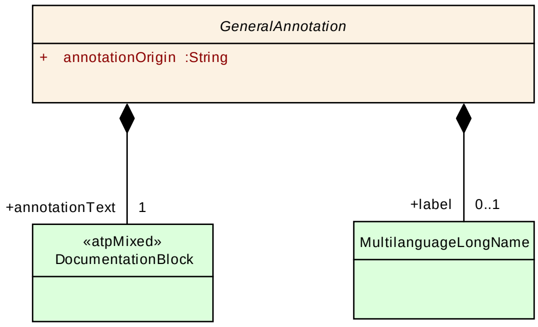


Figure 4.12: General Annotation

Class	**GeneralAnnotation (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::General Annotation			
Note	This class represents textual comments (called annotations) which relate to the object in which it is aggregated. These annotations are intended for use during the development process for transferring information from one step of the development process to the next one. The approach is similar to the "yellow pads" ... This abstract class can be specialized in order to add some further formal properties.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
annotation Origin	String	1	attr	This attribute identifies the origin of the annotation. It is an arbitrary string since it can be an individual's name as well as the name of a tool or even the name of a process step. **Tags:** xml.sequenceOffset=30
annotation Text	Documentation Block	1	aggr	This is the text of the annotation. **Tags:** xml.sequenceOffset=40
label	MultilanguageL ongName	0..1	aggr	This is the headline for the annotation. **Tags:** xml.sequenceOffset=20

Table 4.88: GeneralAnnotation

Class	**Annotation**			
Package	M2::MSR::Documentation::Annotation			
Note	This is a plain annotation which does not have further formal data.			
Base	ARObject, GeneralAnnotation			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 4.89: Annotation

4.11 MultiDimensionalTime

[TPS_GST_00149] Usage of MultiDimensionalTime ⌈ From timing point of view, it is important to specify a clear semantics for the timing properties (e.g. if a property has as unit seconds, or angular degrees). With the model element `MultidimensionalTime`, this can be done by using ASAM CSE code types (Codes for Scaling Units) as defined in [15]. ⌋*()*

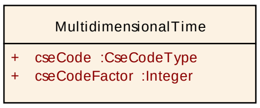


Figure 4.13: MultiDimensionalTime

Class	**MultidimensionalTime**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::MultidimensionalTime			
Note	This is used to specify a multidimensional time value based on ASAM CSE codes. It is specified by a code which defined the basis of the time and a scaling factor which finally determines the time value. If for example the cseCode is 100 and the cseCodeFactor is 360, it represents 360 angular degrees. If the cseCode is 0 and the cseCodeFactor is 50 it represents 50 microseconds.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
cseCode	CseCodeType	1	attr	Specifies the time base by means of CSE codes.
cseCodeFactor	Integer	1	attr	The scaling factor for the time value based on the specified CSE code.

Table 4.90: MultidimensionalTime

Primitive	**CseCodeType**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::MultidimensionalTime

Note	This primitive represents an ASAM CSE (Codes for Scaling Units) based on the definition in the ASAM-MCD-2MC-ASAP2 specification. The particular semantics is specified in [TPS_GST_00354]. **Tags:** xml.xsd.customType=CSE-CODE-TYPE-STRING; xml.xsd.type=unsignedInt

Table 4.91: CseCodeType

[TPS_GST_00354] Semantics of CseCodeType ⌈ The semantics of CseCodeType are defined due to Time Domain in Table 4.92, due to Angle Domain in Table 4.93 and due to Other Domain in Table 4.94. ⌋*()*

CSE-Code	Semantics Time Domain
0	1 μsec (microsecond)
1	10 μsec (microsecond)
2	100 μsec (microsecond)
3	1 msec (millisecond)
4	10 msec (millisecond)
5	100 msec (millisecond)
6	1 sec (second)
7	10 sec (second)
8	1 min (minute)
9	1 hour (hour)
10	1 day (day)
20	1 fs (femtosecond)
21	10 fs (femtosecond)
22	100 fs (femtosecond)
23	1 ps (picosecond)
24	10 ps (picosecond)
25	100 ps (picosecond)
26	1 ns (nanosecond)
27	10 ns (nanosecond)
28	100 ns (nanosecond)

Table 4.92: CseCodeType in Time Domain

CSE-Code	Semantics Angle Domain
100	Angular degrees
101	Revolutions (1=360 degrees)
102	Cycle (1=720 degrees) e.g. in case of IC engines

Table 4.93: CseCodeType in Angle Domain

CSE-Code	Semantics Other Domain
997	Computing Cycle
998	When frame available; Time Source defined in the ASAP 2 keyword FRAME
999	Always if there is new value Calculation of a new upper range limit after receiving a new partial value, e.g. when calculating a complex trigger condition
1000	Non deterministic Without fixed scaling

Table 4.94: CseCodeType in Other Domain

4.12 TagWithOptionalValue

[TPS_GST_00358] Purpose of TagWithOptionalValue ⌈ The `TagWithOptionalValue` provides the possibility to attach tags with values and tags without values to an element. Note that in opposite to `Sd` the `TagWithOptionalValue` has the ability to attach a tag to an object which has no value (see [TPS_GST_00224]). ⌋*()*

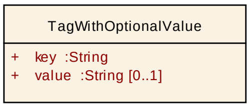


Figure 4.14: TagWithOptionalValue

Class	**TagWithOptionalValue**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::TagWithOptionalValue			
Note	A tagged value is a combination of a tag (key) and a value that gives supplementary information that is attached to a model element. Please note that keys without a value are allowed.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
key	String	1	attr	Defines a key.
value	String	0..1	attr	Defines the corresponding value.

Table 4.95: TagWithOptionalValue

5 AbstractStructure

Abstract structures are used to define a kind of pattern which is applied by specialization. Abstract structures are established by

- abstract meta-classes
- relations between these meta-classes
  - marked as ≪atpAbstract≫ (see [TPS_GST_00022]) and/or ≪atpDerived≫ , (see [TPS_GST_00023]),
  - if it is ≪atpDerived≫ the target of the relation is marked as **derived**. This is shown in the diagrams by a slash preceding the role name.

    [TPS_GST_00150] Derived Attributes Do not Appear in the XML Schema ⌈ Derived means that the attribute is not directly in the model but somehow calculated from other information in the model. As an example, `base` in `AtpInstanceRef` is calculated as the container of the first `atpContext`.

    In consequence of this, derived relations do not appear in the XML schema. ⌋*()*.

    [TPS_GST_00151] Specializations of Derived Relations ⌈ Specializations of abstract relations marked as **derived** are also be marked **derived** but are not necessarily abstract. This allows to specify concrete derivations. ⌋*()*

    [TPS_GST_00152] Derived Union ⌈ Optionally the target of the relation can be marked as **derived union**. In this case the attribute is calculated as union of all concrete relations. This is shown in diagrams at the relation end in curly brackets. Note for such relations the upper multiplicity obviously needs to be greater than one. ⌋*()*

Abstract structures are applied by

[TPS_GST_00153] Applying Abstract Structures ⌈

- subclasses of the abstract meta-classes mentioned before.
- relations between these subclasses. These relations specialize the relationships between the abstract meta-classes.

⌋*()*

[TPS_GST_00154] Specialization of Relations ⌈

There are two kinds of specialization:

- **redefines**
  redefine replaces the abstract relationship entirely

- **subsets**
  subset contributes to the abstract relation such that it can be derived by building the union of all subsets.

The specialization is shown in diagrams at the relation end in curly brackets. Note that relations of upper multiplicity equal 1 can only be "redefined" but not "subsetted". On the other hand, relations with upper multiplicity greater than 1 can only be "subsetted" but not "redefined". ⌋()

Figure 5.1 illustrates the approach.

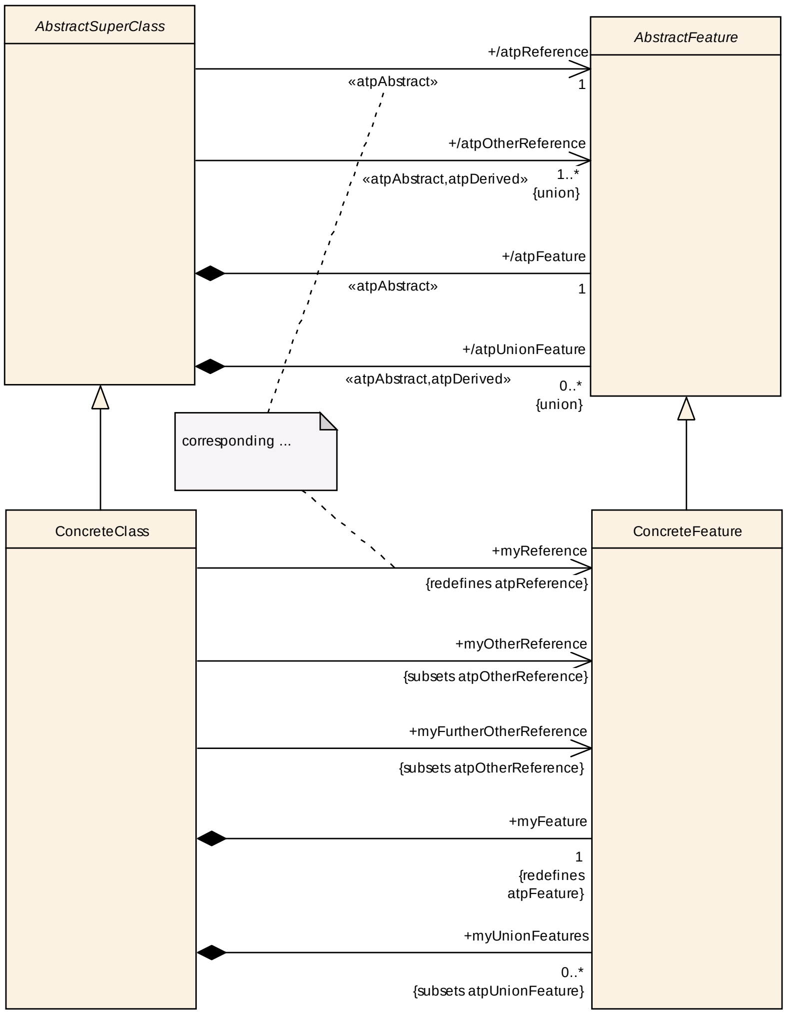


Figure 5.1: Definition and usage of abstract structures

5.1 Reusable Structural Hierarchies

5.1.1 Motivation

When designing a system it is often the case that elements in the runtime space share the same structure. A well-known example domain is object-oriented programming, where objects instantiated from the same class all have the same structure specified by that class. The ability to specify a structure once and then use it in multiple places in the design is also useful in the automotive domain. To account for this, the concepts of *types* and *prototypes* have been introduced into the AUTOSAR metamodel. A type represents a reusable structure and a prototype represents a use of such structure in a certain *role* within a type.

Consider the M1 model in Fig. 5.2. It shows an application component type ”WindowControllerType” with a port prototype ”ctrl” typed by ”ControlInterface”, and a composition type ”PowerWindowType” which has two component prototypes by the names ”leftController” and ”rightController”, both typed by ”WindowControllerType”. Hence the type ”WindowControllerType” is used twice in the ”PowerWindowType” composition - once in the role of left and once in the role of right controller. Note that though the port ”ctrl” appears graphically twice within ”PowerWindowType” it is in fact specified only once, as part of the structure of ”WindowControllerType”.

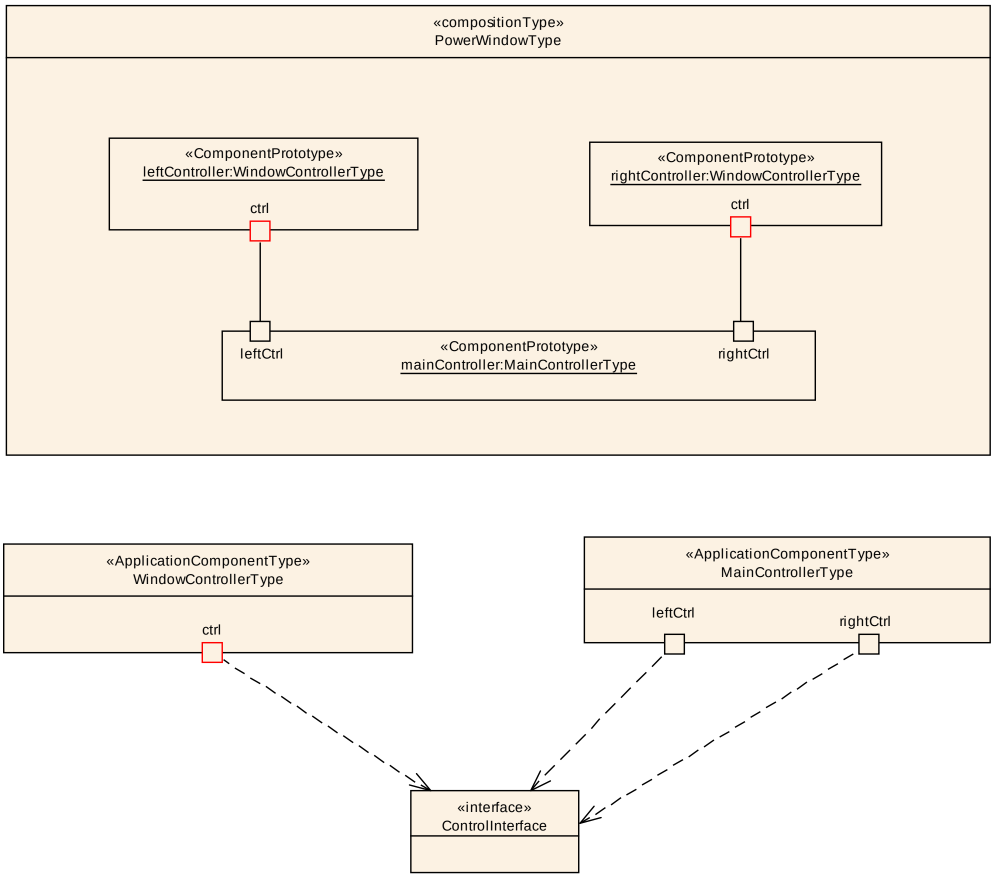


Figure 5.2: Reusable type example

The concept of reusable types results in a situation where a flat M1 model specifies deep, tree-like M0 instances. The structure of M0 instances of ”PowerWindowType” is (partly) shown in 5.3. As can be seen, there are two instances corresponding to the ”ctrl” port, defined once in M1.

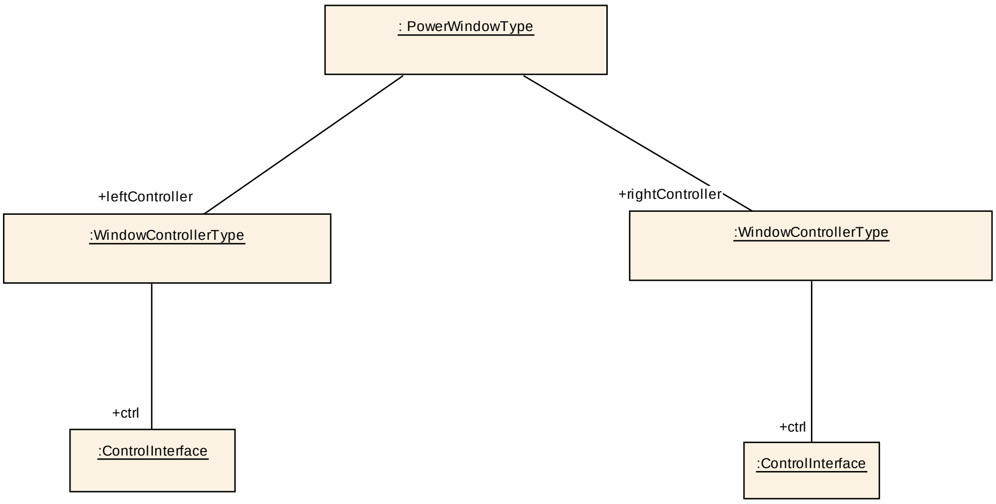


Figure 5.3: M0 instances of reusable types

It turns out that this duplication of structure in different roles also has consequences in the level of M1 models. Returning to Fig. 5.2, the "PowerWindowType" composition also contains a component prototype "mainController" typed by "MainControllerType" which has left and right control ports. The connectors inside the composition connect the port of the left window controller to the left port of the main controller and the port of the right window controller to the right port of the main controller.

Recall that though the "ctrl" port of the left and right controller appear graphically twice in the figure they in fact appear only once in the M1 specification - in the type "WindowControllerType". But in order to well-define the connector (e.g. in the XML description) there must be a way to distinguish *in the M1 model specification* between those two future M0 instances. This is because we need to attach the left instance to the "leftCtrl" port of the main controller and the right to the "rightCtrl" port. So the problem is how to refer to distinct would-be M0 instances which originate from the same M1 model element. This is addressed by the concept of *instance refs*.

The next section introduces the abstract layer for types, prototypes, and structure elements, and provides a more detailed account of these concepts. The next one introduces the abstract layer for instance refs and explains this concept in more detail.

5.1.2 Types, Prototypes and Structure elements

Figure 5.4 shows the abstract layer for elements with internal structure.

[TPS_GST_00155] Representation of Classifier and Feature ⌈ A *classifier* classifies instances according to their *features*. Here a "classifier" means an M1 instance of (a concrete subclass of) the M2 meta-model class `AtpClassifier`, and "features" are instances of (concrete subclasses of) the M2 meta-model class `AtpFeature`. ⌋*()*

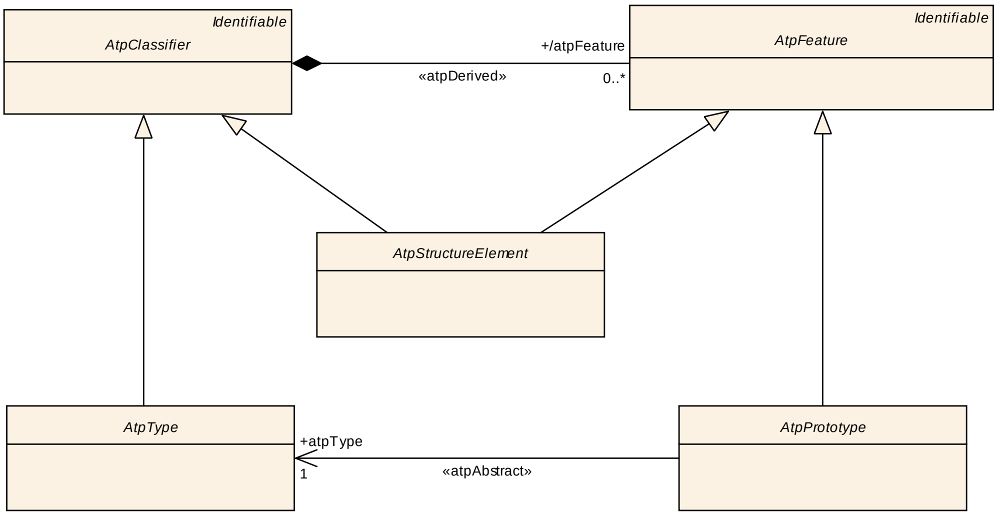


Figure 5.4: Abstract structure

An example of a classifier is some given component type and an example of a feature is some given port. So for example, the component type ”WindowControllerType” from Fig. 5.2 has a feature ”ctrl”, which is a port through which control signals arrive. Those elements are M1 elements and what they do is characterize M0 elements in the ”runtime” system. So the runtime system will have several instances of ”WindowControllerType” (two in each instance of ”PowerWindowType”) each of which will have a control port.

The set of all M0 instances of a given system may be partitioned, or classified, according to the features of each instance. A classifier represents an assembly of such features into a meaningful whole.

[TPS_GST_00156] Purpose of `AtpClassifier` ⌈ The M2 meta-class `AtpClassifier` is a ”vertical” concept in that its semantics, or meaning, cuts through layers of abstraction: the meaning of this M2 class is that M1 instances of it classify the M0 instance space. ⌋ *()*

The interplay of classifiers and features is such that the way by which a feature contributes to the specification of the classifier of which it is a part is via another classifier which specifies the structure of the feature.

[TPS_GST_00157] Purpose of `AtpPrototype` ⌈ The meta-class `AtpPrototype` stands for features whose structure is given by another classifier, which types them. The meta-class `AtpType` stands for classifiers which type prototypes. ⌋ *()*

Some classifiers do not need to be reusable. This case is captured by the concept of *structure elements*.

[TPS_GST_00158] Purpose of `AtpStructureElement` ⌈ A structure element is a feature which is **also** a classifier and hence specifies its own structure instead of referencing to a type.

The abstract class for this kind of element is AtpStructureElement. Structure elements are simpler to define because a single element does the job of both type and prototype. ⌋*()*

Both types and structure elements are classifiers, i.e. have M0 instances. The difference is that types are reusable within an M1 model: a given type, e.g. "WindowControllerType", may be used to type many prototypes within a given model. Those prototypes represent different *roles* that instances of "WindowLifterType" - window controller components - play in the containing composition. For example, one instance may play the role of "leftLifter" and the other of "rightLifter".

The meta-classes AtpType, AtpPrototype, and AtpStructureElement are abstract. They are used in the meta-model as parent classes for concrete meta-classes. Figure 5.5 shows an example where composition types are defined as containers of component prototypes which in turn are typed by component types.

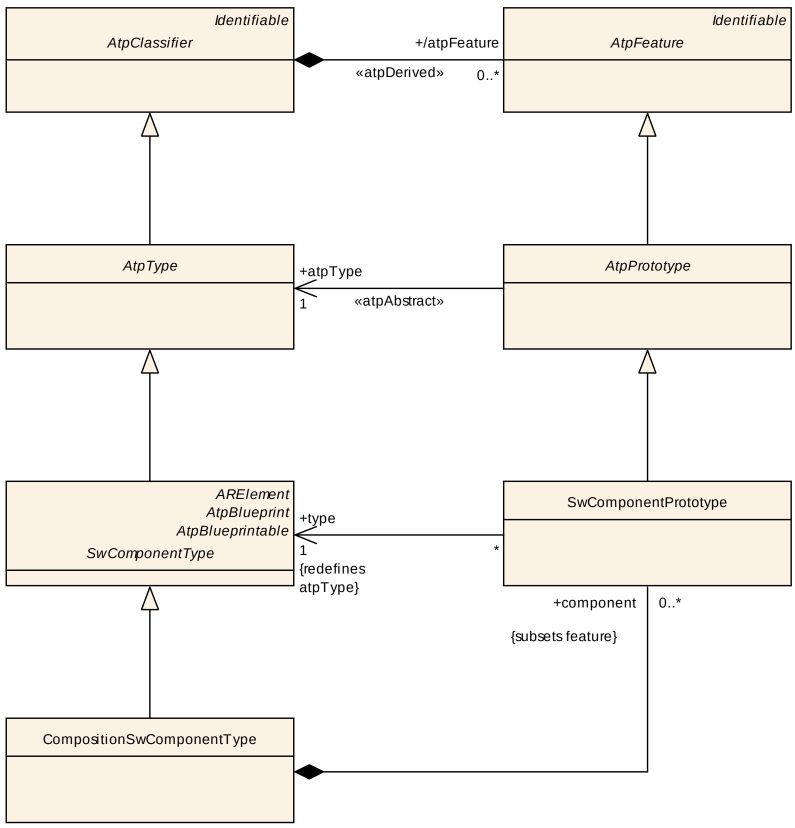


Figure 5.5: Concrete type-prototype

The structure of components as shown in the figure is a specialization of the general structure shown in figure 5.4.

[TPS_GST_00159] Deriving features in abstract structures ⌈ In addition to specializing the classes, the associations roled "atpType" and "atpFeature" are also specialized. "atpType is redefined whereas "atpFeature" is subsetted, in accordance with the fact that the first is abstract and the latter is a derived union.

The concrete "type" association redefines the abstract "atpType" one.

The union of the concrete feature associations (notice the plural) results in the derived atpFeature. ⌋()

So for example the features of a given component type include all its component prototypes **and** its ports. For technical reasons, the subsetting of features is not indicated in the meta-model diagrams.

Figure 5.6 shows an example of a concrete structure element.

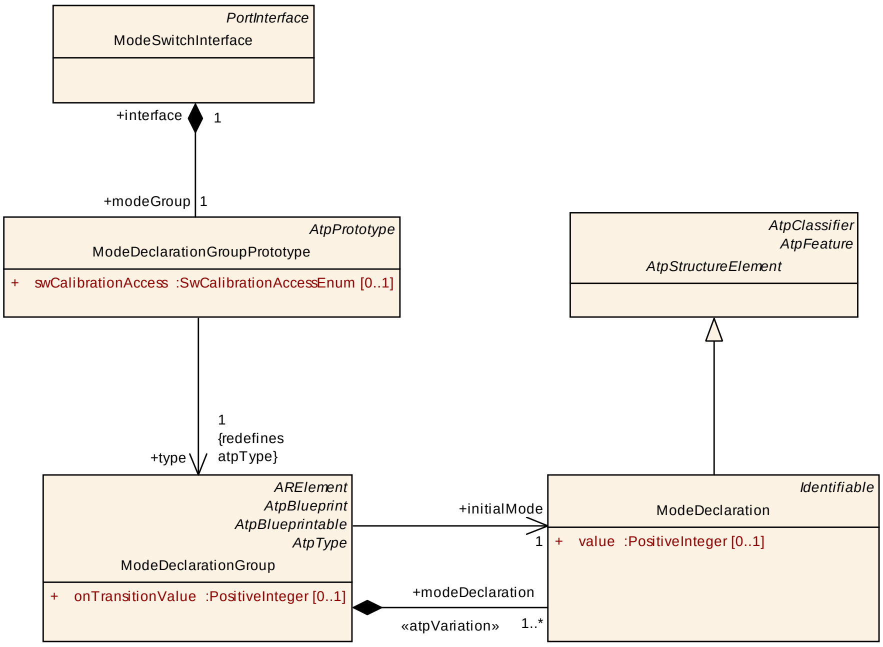


Figure 5.6: Concrete structure element

Class	**AtpClassifier (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::AbstractStructure			
Note	A classifier classifies M0 instances according to their features. Or: a classifier is something that has instances - an M1 classifier has M0 instances.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
atpFeature	AtpFeature	*	aggr	This is a feature of the classifier. **Stereotypes:** atpDerived

Table 5.1: AtpClassifier

Class	**AtpFeature (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::AbstractStructure			
Note	Features are properties via which a classifier classifies instances. Or: a classifier has features and every M0 instance of it will have those features.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
–	–	–	–	–

Table 5.2: AtpFeature

Class	**AtpInstanceRef (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::AbstractStructure			
Note	An M0 instance of a classifier may be represented as a tree rooted at that instance, where under each node come the sub-trees representing the instances which act as features under that node. An instance ref specifies a navigation path from any M0 tree-instance of the base (which is a classifier) to a leaf (which is an instance of the target).			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
atpBase	AtpClassifier	1	ref	This is the base from which the navigaion path starts. **Stereotypes:** atpAbstract; atpDerived
atpContextElement (ordered)	AtpPrototype	*	ref	This is one particular step in the navigation path. **Stereotypes:** atpAbstract
atpTarget	AtpFeature	1	ref	This is the target of the instance ref. In other words it is the terminal of the navigation path. **Stereotypes:** atpAbstract

Table 5.3: AtpInstanceRef

Class	**AtpPrototype (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::AbstractStructure			
Note	A prototype is a typed feature. A prototype in a classifier indicates that instances of that classifier will have a feature, and the structure of that feature is given by the its type. An instance of that type will play the role indicated by the feature in the owning classifier. A feature is not an instance but an indication of an instance-to-be.			
Base	ARObject, AtpFeature, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
atpType	AtpType	1	ref	This is the type of the feature. **Stereotypes:** atpAbstract

Table 5.4: AtpPrototype

Class	**AtpStructureElement (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::AbstractStructure			
Note	A structure element is both a classifier and a feature. As a feature, its structure is given by the feature it owns as a classifier.			
Base	ARObject, AtpClassifier, AtpFeature, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 5.5: AtpStructureElement

Class	AtpType (abstract)			
Package	M2::AUTOSARTemplates::GenericStructure::AbstractStructure			
Note	A type is a classifier that may serve to type prototypes. It is a reusable classifier.			
Base	ARObject, AtpClassifier, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mul.	Kind	Note
–	–	–	–	–

Table 5.6: AtpType

5.1.3 Instance Refs

[TPS_GST_00160] Instance Reference ⌈ Instance refs are M1 elements which define a particular navigation within future M0 instance trees of M1 classifiers. ⌋*()*

Figure 5.7 shows an M1 instance ref called ”ctrlInRightControllerInPowerWindowType”. In each M0 instance of ”PowerWindowType”, which has the structure shown in Fig. 5.3, this instance ref identifies the bottom most instance on the right side of that figure. It has the composition type ”PowerWindowType” as *base*, the component prototype ”rightController” as *context*, and the port ”ctrl” as *target*. The context servers to navigate the instance tree in a particular path, the right path in this example.

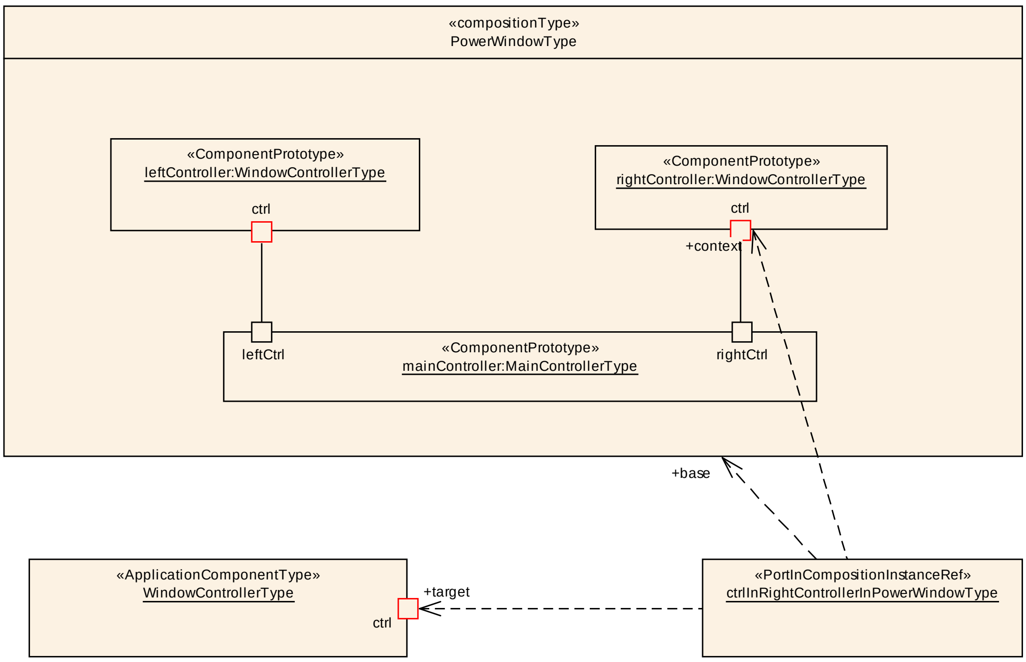


Figure 5.7: M1 Instance Ref

An M1 instance ref is an instance of a concrete subclass of the meta-class `AtpInstanceRef`. Figure 5.8 shows the abstract layer for instance refs.

[TPS_GST_00161] Definition of an instance ref ⌈ Each instance ref is defined with respect to a *base* which is a classifier. What the instance ref does is specify a particular navigation leading from the root of any M0 instance of the base to an inner instance in the tree. One instance ref, i.e. one navigation, works for *any* M0 instance of the base. The navigation is specified via a series of *context elements*, which are features, and a *target* which is also a feature. ⌋*()*

[TPS_GST_00162] Context path in instance ref ⌈ The ordered set of context features plus the target constitutes the *path* leading from the root to the specified inner instance. In other words, the context starts with the first element of the InstanceRef. The target is always the last element in the InstanceRef-class. ⌋*()*

[constr_2530] `InstanceRefs` must be consistent ⌈ The first `atpContextElement` in the path must be an `atpFeature` of the `atpBase`. For all subsequent `atpContextElements`, they must be an `atpFeature` of the `atpType` of the previous element (which is an `AtpPrototype`). ⌋*()*

[constr_2531] `AtpInstanceRef` shall be close to the base ⌈ An `AtpInstanceRef` shall be aggregated such that its relationship to the `AtpClassifier` referenced in the role `atpBase` is unambiguous. This is the case in one of the following situations:

- The `AtpInstanceRef` is aggregated within the `AtpFeature` referenced in the role `atpBase`.
- The `atpBase` is the root of the instance tree. It is the `AtpClassifier` which is aggregating the first `AtpFeature` representing the first (outermost) `atpContextElement`.

⌋*()*

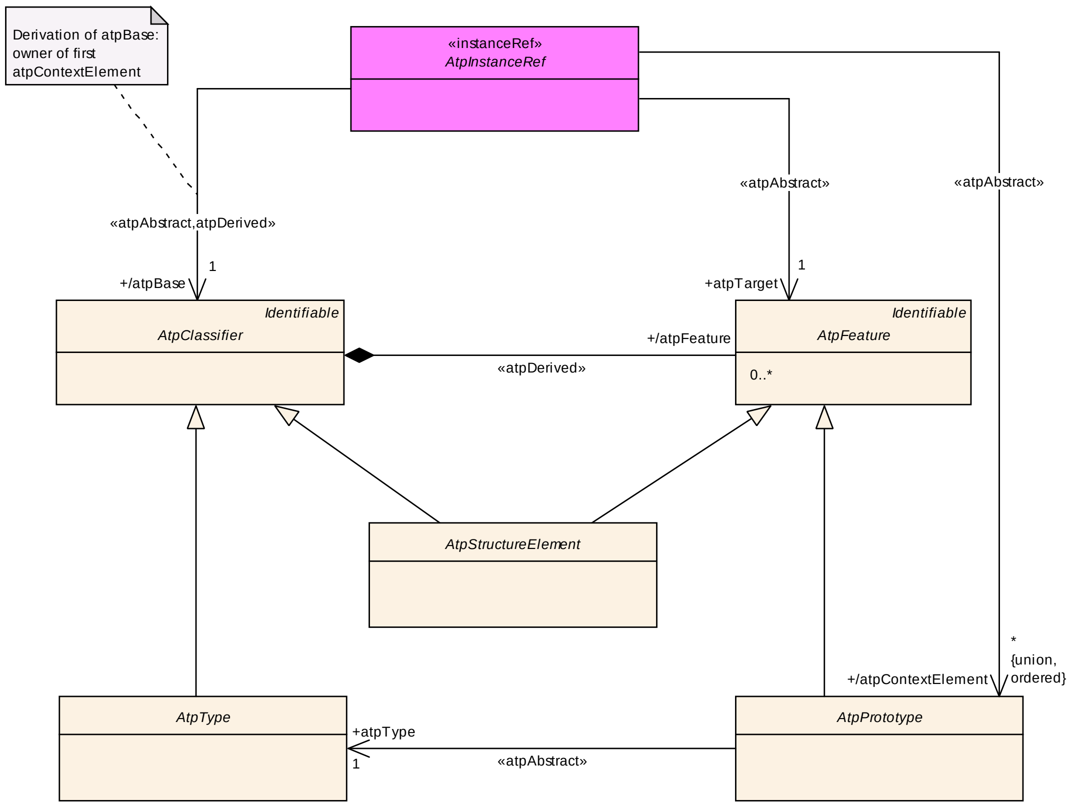


Figure 5.8: Abstract instance Refs

Figure 5.9 shows a concrete subclass of AtpInstanceRef, named RPortInCompositionInstanceRef, used to define instance refs which navigate to a port within a composition type via an inner component prototype. This concrete meta-class specifies that the base must be a composition type, that there must be exactly one context element which is a component prototype, and that the target is a port. The instance ref ”ctrlInRightControllerInPowerWindowType” is an instance of RPortInCompositionInstanceRef.

Figure 5.9 also illustrates how such an instance ref is applied in the meta model:

[TPS_GST_00043] Application of Instance Ref ⌈ Instance refs are applied in the meta model by two representations which shall exist together:

- A **dependency** with stereotype ≪instanceRef≫ which represents the intention and contributes to documentation and classtables.
- A corresponding **aggregation** of the concrete subclass of AtpInstanceRef in the source of the reference which represents the implementation and therefore contributes to the xml schema.

Note that both representations are relevant and shall exist in the meta model. ⌋*()*

[TPS_GST_00044] Identification of corresponding Instance Ref representations ⌈ The target role name of the **dependency** and the target role name of the corresponding **aggregation** used to model an instance ref (as described in [TPS_GST_00043]) shall be identical.⌋*()*[1]

Please find an example of the application of [TPS_GST_00044] in Figure 5.9. The target role name of the dependency from AssemblySwConnector to AbstractRequiredPortPrototype (i.e. requester) is identical to the target role name of the aggregation of RPortInCompositionInstanceRef at AssemblySwConnector.

Listing 5.1 illustrates the ARXML representation of a scenario according to Figure 5.9, in particular the instance refs in the AssemblySwConnector at the end of the example.

[1]Note that the UML-tool used to generate the diagrams allows to specify role names on dependencies, even if it is not supported by UML.

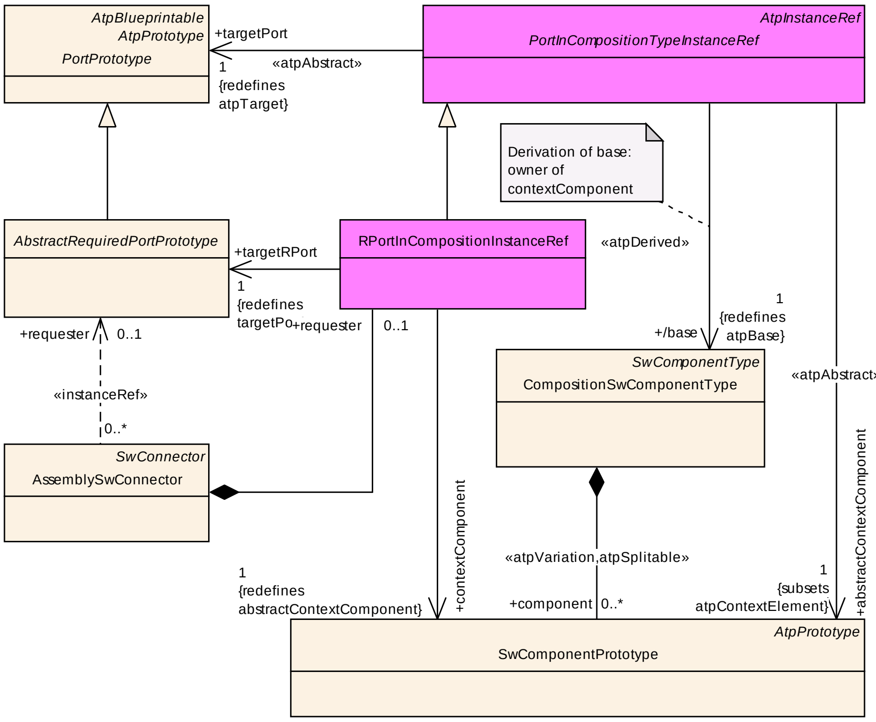


Figure 5.9: Application of an instance Ref

Listing 5.1: Application of an instance Ref

```
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0␣AUTOSAR_4-1-3.xsd">
  <ADMIN-DATA>
    <USED-LANGUAGES>
      <L-10 xml:space="preserve" L="EN">English</L-10>
    </USED-LANGUAGES>
  </ADMIN-DATA>
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Example</SHORT-NAME>
      <INTRODUCTION>
        <P>
          <L-1 L="EN">This example fragment illustrates an instance ref </L
              -1>
        </P>
      </INTRODUCTION>
      <ELEMENTS>
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>MainControllerType</SHORT-NAME>
          <PORTS>
            <P-PORT-PROTOTYPE>
              <SHORT-NAME>leftCtrl</SHORT-NAME>
            </P-PORT-PROTOTYPE>
            <P-PORT-PROTOTYPE>
              <SHORT-NAME>rightCtrl</SHORT-NAME>
            </P-PORT-PROTOTYPE>
          </PORTS>
        </APPLICATION-SW-COMPONENT-TYPE>
```

```
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>WindowControllerType</SHORT-NAME>
          <PORTS>
            <R-PORT-PROTOTYPE>
              <SHORT-NAME>ctrl</SHORT-NAME>
            </R-PORT-PROTOTYPE>
          </PORTS>
        </APPLICATION-SW-COMPONENT-TYPE>
        <COMPOSITION-SW-COMPONENT-TYPE>
          <SHORT-NAME>PowerWindowType</SHORT-NAME>
          <COMPONENTS>
            <SW-COMPONENT-PROTOTYPE>
              <SHORT-NAME>rightController</SHORT-NAME>
              <TYPE-TREF DEST="APPLICATION-SW-COMPONENT-TYPE">/Example/
                 WindowControllerType</TYPE-TREF>
            </SW-COMPONENT-PROTOTYPE>
            <SW-COMPONENT-PROTOTYPE>
              <SHORT-NAME>mainController</SHORT-NAME>
              <TYPE-TREF DEST="APPLICATION-SW-COMPONENT-TYPE">/Example/
                 MainControllerType</TYPE-TREF>
            </SW-COMPONENT-PROTOTYPE>
          </COMPONENTS>
          <CONNECTORS>
            <ASSEMBLY-SW-CONNECTOR>
              <SHORT-NAME>rightControl</SHORT-NAME>
              <PROVIDER-IREF>
                <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PROTOTYPE">/
                   Example/PowerWindowType/mainController</CONTEXT-
                   COMPONENT-REF>
                <TARGET-P-PORT-REF DEST="P-PORT-PROTOTYPE">/Example/
                   MainControllerType/rightCtrl</TARGET-P-PORT-REF>
              </PROVIDER-IREF>
              <REQUESTER-IREF>
                <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PROTOTYPE">/
                   Example/PowerWindowType/rightController</CONTEXT-
                   COMPONENT-REF>
                <TARGET-R-PORT-REF DEST="R-PORT-PROTOTYPE">/Example/
                   WindowControllerType/ctrl</TARGET-R-PORT-REF>
              </REQUESTER-IREF>
            </ASSEMBLY-SW-CONNECTOR>
          </CONNECTORS>
        </COMPOSITION-SW-COMPONENT-TYPE>
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

5.1.4 Any Instance Refs

The MetaClass AnyInstanceRef provides a generic ability to describe an InstanceRef to any target being an AtpFeature. Nevertheless the M1 model of such an InstanceRef needs to follow the rules described in section 5.1.3.

Class	AtpInstanceRef (abstract)			
Package	M2::AUTOSARTemplates::GenericStructure::AbstractStructure			
Note	An M0 instance of a classifier may be represented as a tree rooted at that instance, where under each node come the sub-trees representing the instances which act as features under that node. An instance ref specifies a navigation path from any M0 tree-instance of the base (which is a classifier) to a leaf (which is an instance of the target).			
Base	ARObject			
Attribute	Type	Mul.	Kind	Note
atpBase	AtpClassifier	1	ref	This is the base from which the navigaion path starts. **Stereotypes:** atpAbstract; atpDerived
atpContextElement (ordered)	AtpPrototype	*	ref	This is one particular step in the navigation path. **Stereotypes:** atpAbstract
atpTarget	AtpFeature	1	ref	This is the target of the instance ref. In other words it is the terminal of the navigation path. **Stereotypes:** atpAbstract

Table 5.7: AtpInstanceRef

A System could be used as an AtpFeature for example as the first contextElement in the AnyInstanceRef. Deriving the base of the AnyInstanceRef would then return the owner of System, an ARPackage. But an ARPackage is not an AtpClassifier and this would contradict the specification of the AnyInstanceRef which defines that the derived base reference of the AnyInstanceRef shall return an AtpClassifier. To avoid this inconsistency [constr_2587] applies.

[constr_2587] No System in AnyInstanceRef ⌈ In consequence of [constr_2531] System shall not be contextElement nor target of an AnyInstanceRef. Otherwise atpBase would not be determined. ⌋*()*

5.1.4.1 AnyInstanceRef applied to ImplementationDataTypeElement

In case the AnyInstanceRef references as a target an ImplementationDataTypeElement further constraints apply in order to ensure a consistent model. In this case it can be required to provide additional contexts even if no type-prototype sequence occurs.

[constr_2602] Completeness of AnyInstanceRef referencing ImplementationDataTypeElement ⌈ If the target references an ImplementationDataTypeElement the AnyInstanceRef shall define a contextElement reference for

1. each leaf ImplementationDataTypeElement in a chain of referencing ImplementationDataTypes which is not the target

2. and each ImplementationDataTypeElement of category ARRAY in a chain of referencing ImplementationDataTypes

Thereby the contexts are created according [TPS_GST_00162] from the root to the leaf ImplementationDataTypeElement which is either typed (directly or indirectly via ImplementationDataType of category TYPE_REFERENCE) or owns the target. ⌋()

Note: technically, it would be possible to avoid the context for a one-dimensional array in the hierarchy. The context is still required because then the rule for the existence of contexts becomes much simpler.

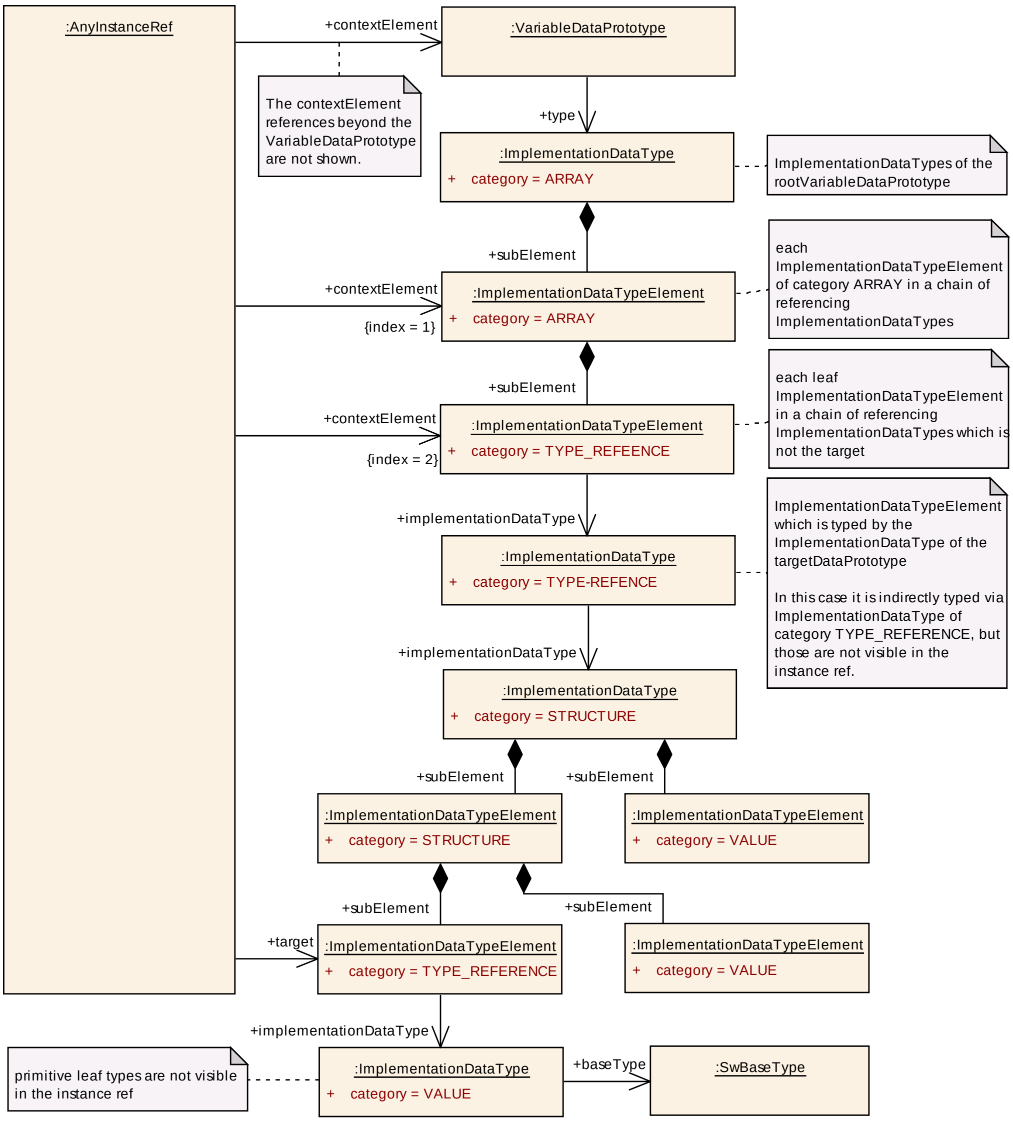


Figure 5.10: AnyInstanceRef applied to ImplementationDataTypeElement

6 Metamodeling Patterns and Model Transformation

A metamodeling pattern is a parameterized structure which, when applied to actual parameters, yields a regular, non-parameterized structure. A *structure* is just a collection of meta-classes related by associations and aggregations. The benefit of patterns is that they allow recurring structures to be used over and over again without the need to repeat their definitions. This chapter describes the concept of metamodeling patterns as well as their use and notation in the AUTOSAR Metamodel. Another advantage is that the original structure of the metamodel is preserved and not blurred with implementation details.

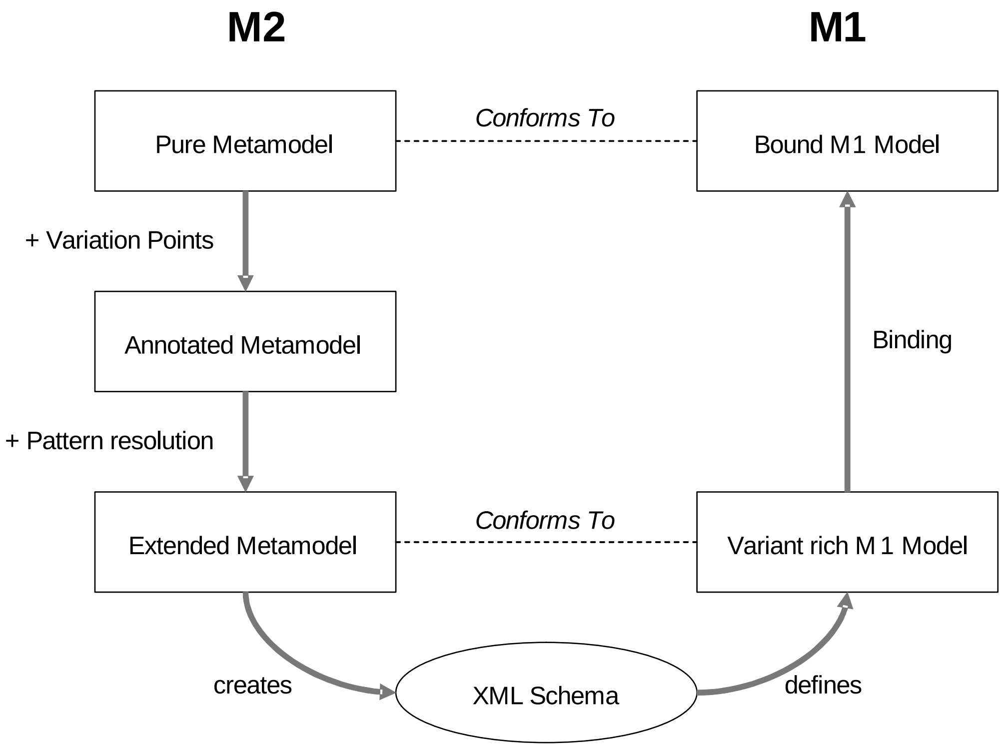


Figure 6.1: Metamodeling Patterns and Model Transformation Overview

Figure 6.1 presents a quick overview of the approach. Thereby it uses as an example the variant handling in AUTOSAR[1]:

1. **[TPS_GST_00197] Pure meta model** ⌈ AUTOSAR primarily defines a meta model representing the general approach without annotations and transformations (e.g. without support for variation). ⌋*()*
2. **[TPS_GST_00163] Annotated meta model** ⌈ The pure meta model is then annotated using stereotypes and UML tags to describe intended transformations (e.g. ≪`atpVariation`≫ and UML tag (`vh.latestBindingTime`).

[1] Note that "model" in this context is a conceptual entity regardless of its representation. In that sense, XML, C and PDF etc. are considered as representations of the "model". The term "model" relates to the AUTOSAR related content, not physical entities.

Note that finally only the annotated meta model is maintained manually and part of AUTOSAR deliverables. ⌋()

3. **[TPS_GST_00164] Extended meta model** ⌈ A **model transformation** converts the *annotated meta model* into the *extended meta model*, which is then used to generate the schema.

   The *extended meta model* differs from the *annotated meta model* such that it adds several more elements that provide all the information which is necessary to fully describe e.g. a variation point. It also introduces additional constraints e.g. to support the variation points.

   These additional elements are generated by applying patterns to those locations in the *annotated meta model* that are annotated e.g. as variation points. ⌋()

To illustrate consider the pattern `VHUnboundedAggregationPattern` in Fig. 6.2. It shows a parameterized structure consisting of four classes and some aggregations between them. The parameters, shown in the figure between curly brackets ({}) are:

- `WholeClass`, which is a class.
- `PartClass`, which an aggregated class.
- `partRole`, which is the role of the aggregated class.
- `vh.latestBindingTime`, which is a value of the enumeration type `BindingTimeEnum`.

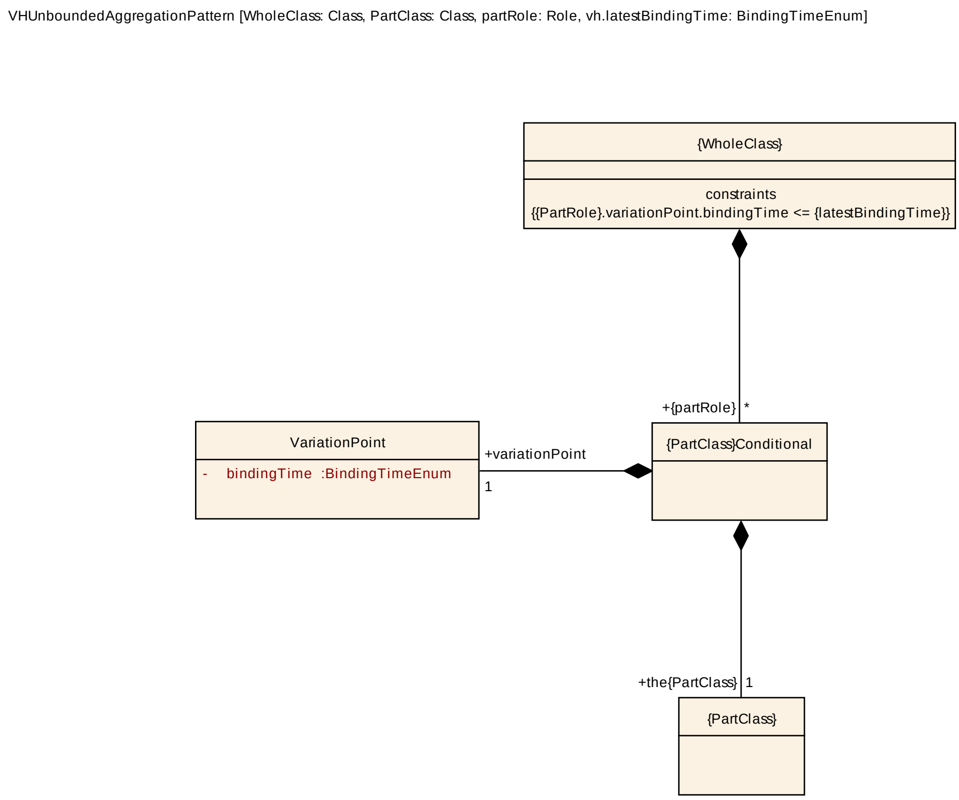


Figure 6.2: Pattern Example (VHUnboundedAggregationPattern)

This pattern may now be applied to actual parameters to yield a non-parameterized structure. For example, by assigning the actual parameters

- WholeClass = SwComponentTypes
- PartClass = PortPrototype
- partRole = port
- vh.latestBindingTime = systemDesignTime

we obtain the structure in Fig. 6.3. Many different structures may be obtained by applying the same pattern to different parameters.

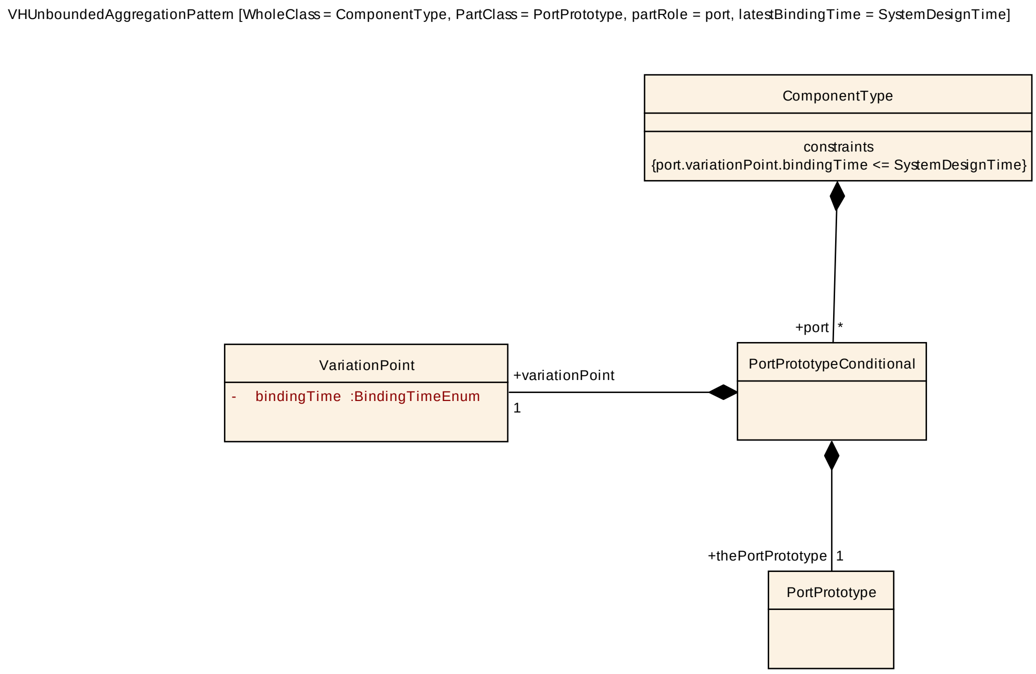


Figure 6.3: Pattern Application Result Example

6.1 Notation for Pattern Application

A recurring structure which has been abstracted into a pattern usually has a well-defined semantics explained in terms of the roles played by the parameters. This semantics will usually suggest an intuitive notation for the application of the pattern, which is of course specific to the pattern at hand.

Figure 6.4 shows a notation for the application of the VHUnboundedAggregation-Pattern on component types and ports. The notation uses an aggregation arrow between the classes playing the role of *WholeClass* and *PartClass*, decorated with the ≪atpVariation≫ stereotype. This notation suggests that the class SwComponentTypes "semantically aggregates" the class PortPrototype in role port while allowing for variations. This diagram is a notation for a pattern application which results in the diagram in Fig. 6.3

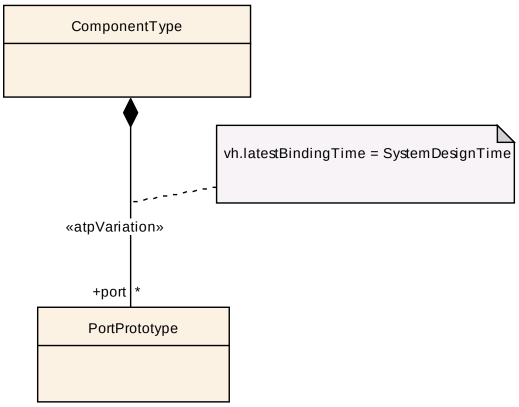


Figure 6.4: Pattern Application Notation Example

A similar notation is used for all variation-related patterns. The particular patterns are described below along with their notations. A major benefit of this kind of notation is that it is similar to a variation-free aggregation. This makes it possible to specify the variations "on top" of the regular, variation-free design instead of meddling with the conceptual design itself. It is however important to keep in mind that aggregation arrows decorated by ≪atpVariation≫ such as the one in Fig. 6.4 are not real aggregations: they are a notation for the application of a pattern (the result of which includes real aggregations).

6.2 Pattern Specification

[TPS_GST_00165] specification of a transformation pattern ⌈ The specification of a pattern includes:

- The name of the pattern
- The list of parameters
- The parameterized structure
- The notation for the pattern application

⌋*()*

The above elements are all specified via a single diagram as illustrated in Fig. 6.5 for the unbounded aggregation pattern.

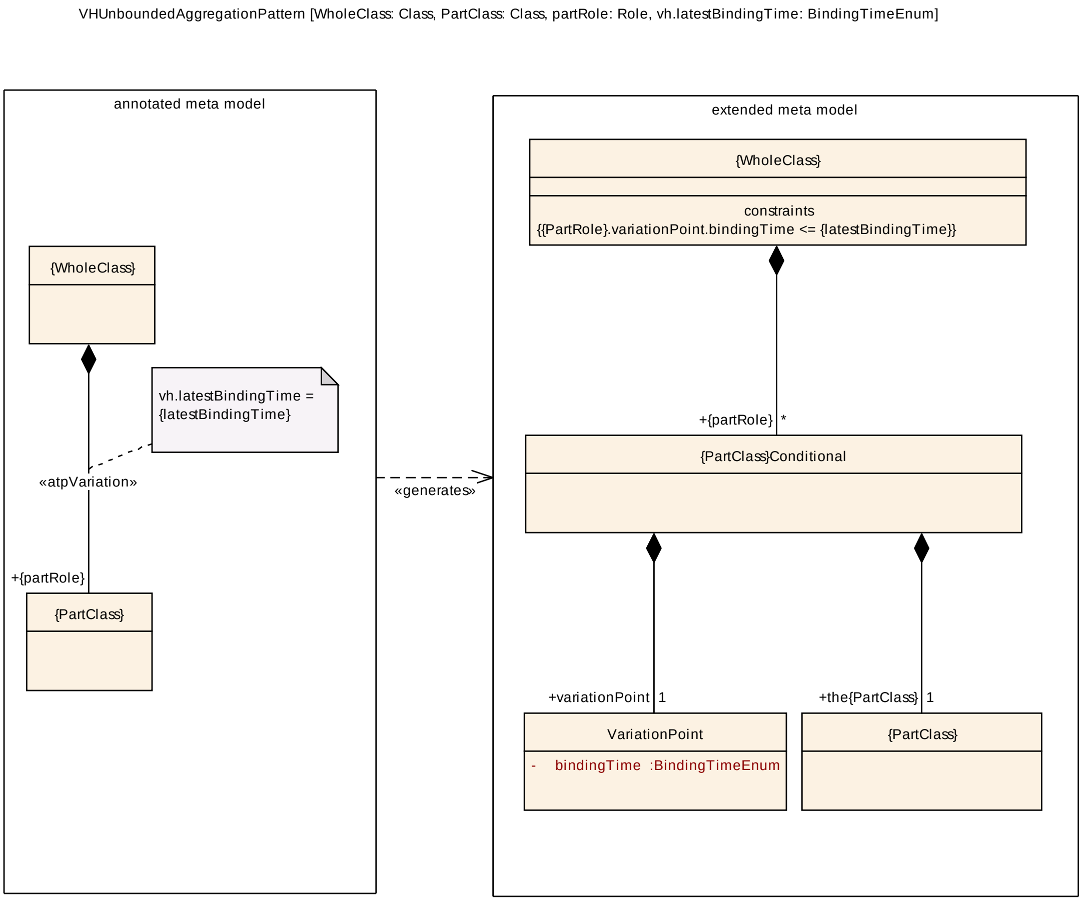


Figure 6.5: Pattern Specification Example

6.3 Model Transformations applied in the Meta-Model

The model transformation pattern mechanism is applied in the MetaModel for

- Variant Handling (chapter 7)
- Other specific purposes such as references (chapter 6.3)

6.3.1 Implementing ≪primitive≫s

This section illustrates the implementation of primitives even if it is not yet (R4.0) implemented as a true model transformation[2].

[TPS_GST_00166] Model Transformation for Primitives ⌈ A meta class of ≪primitive≫ is converted to the following elements.

1. another primitive with the same name enhanced by "_simple". For xml, this primitive results in a simple type in the generated schema and specifies the implemen-

[2]This approach is implemented in the schema generator.

tation details, such as patterns and facets. This meta-class is used for attributes tagged with `xml.attribute=true` but also as primitive type for attributes tagged with `xml.roleElement=false`, `xml.roleWrapperElement=false`, `xml.typeElement=false`, `xml.typeWrapperElement=false`.

2. a meta-class with the same name. As all other meta-classes, this meta-class inherits from ≪`atpObject`≫ (see chapter 6.3.3). Thus UML-attributes in the meta-model are finally implemented as aggregation of this meta-class unless tagged with `xml.attribute=true`.

⌋*()*

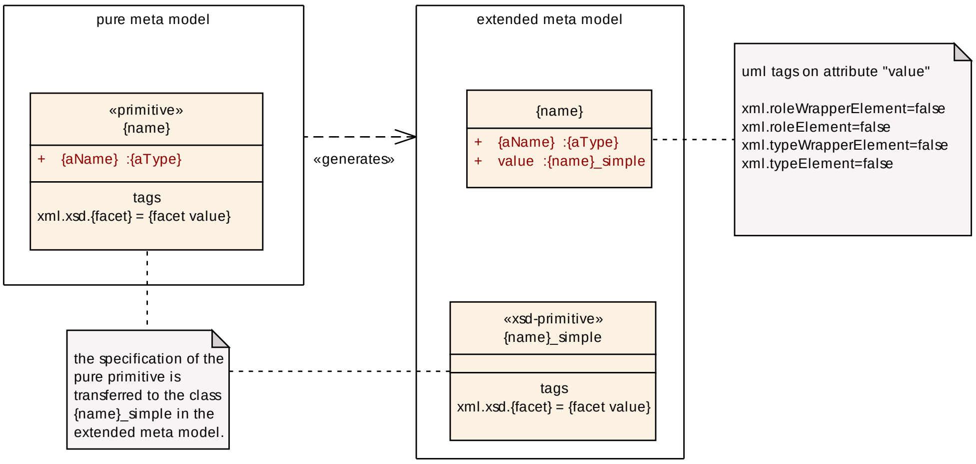


Figure 6.6: Pattern to implement Primitives

6.3.2 Implementing Associations as References

This section illustrates the implementation of associations even if it is not yet (R4.0) implemented as a true model transformation.

[TPS_GST_00020] Establishing References ⌈ References between meta-classes are represented as associations. Referenced meta-classes are derived from `Referrable`, mostly being `Identifiable`. Thereby they define a `shortName` which must be unique within its name space (see [constr_2508]). Therefore references (associations in the meta model) are expressed by

1. by specifying a **case-sensitive** path of `shortName`s (absolute or relative)
2. the destination type of the reference
3. the **case-sensitive** name of the reference base in case of a relative reference

The name space hierarchy is defined in the Meta-Model by composite association of classes derived from `Identifiable`. Each `Identifiable` is name space of its directly or indirectly associated (composite association) classes. ⌋*()*

[TPS_GST_00167] Case Sensitivity of References ⌈ Note that The term "case-sensitive" indicates that the characters in the sets

```
{a b c d e f g h i j k l m n o p q r s t u v w x y z}
{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z}
```

are respectively considered to be different. In other words case-sensitive paths `/X/Y` and `/x/y` are **not** the same.

⌋*()*

[TPS_GST_00168] Representation of Type Reference ⌈ Note that for association stereotyped with ≪`isOfType`≫ the role of the reference class is `theRoleTref`. ⌋*()*

[TPS_GST_00351] Model Transformation on Assosications ⌈ An association is transformed to an aggregation of an anonymous[3] meta-class with the property `dest`. This meta-class inherits from `Ref` after the transformation according to [TPS_GST_00166] was performed. `Ref` thus provides `value` which denotes the shortName path to the referenced object. ⌋*()* Figure 6.7 illustrates the equivalent pattern.

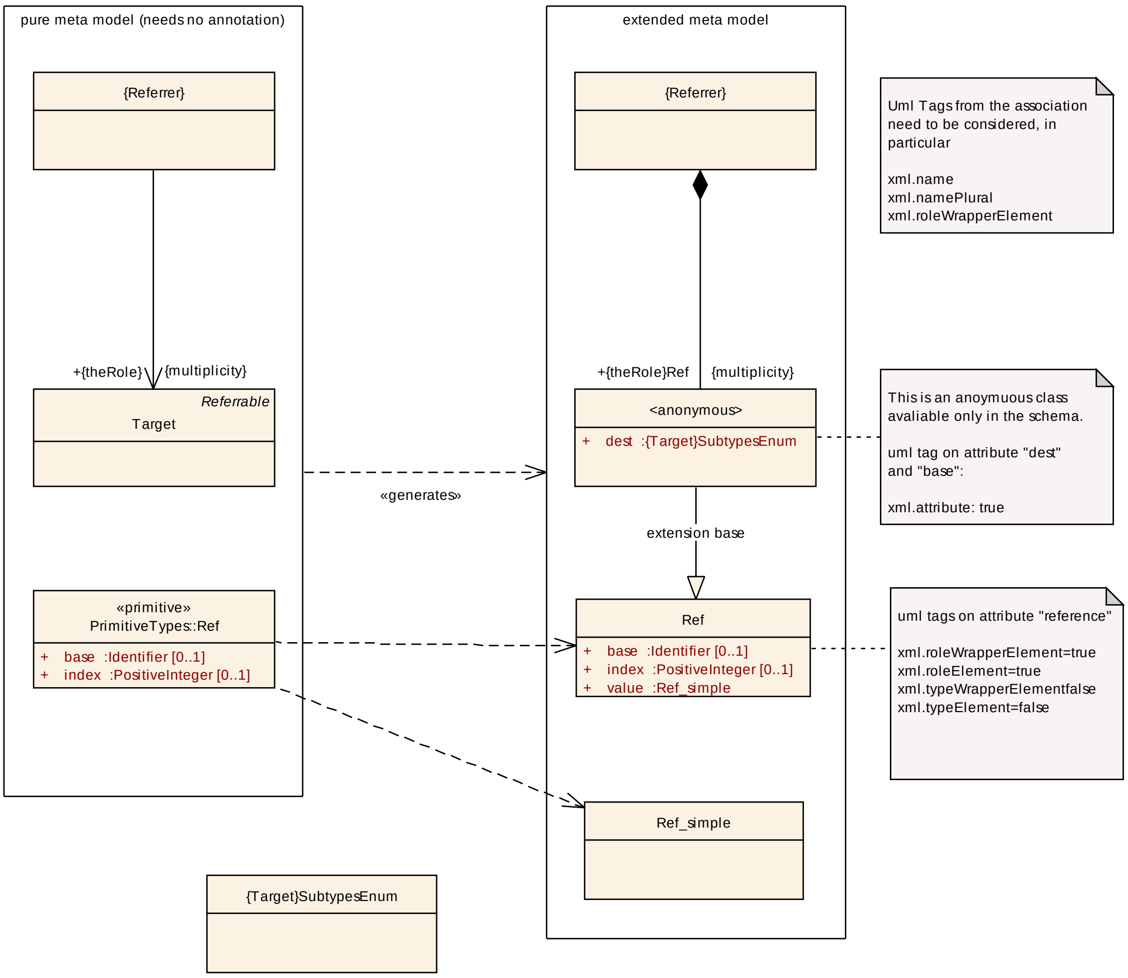


Figure 6.7: Pattern to implement references

[3]This shortcut was possible since the described approach is not implemented as a model transformation but in the schema generator. If a model transformation were applied, a particular meta-class would need to be created for each particular reference.

6.3.2.1 Absolute ShortName-path

ShortName paths are composed of sequences of shortNames separated by '/'. The following rules apply to shortName paths used in AUTOSAR:

[TPS_GST_00169] Absolute shortName-Path ⌈

1. An absolute path is calculated by collecting the shortName of the model elements on the containment path from root element of the model to the referenced element.
2. Absolute paths begin with the character '/'.
3. The attribute base is ignored in case of an absolute reference path.

⌋*()*

Note that an absolute path can be converted to a relative one by removing the shortName-path specified by the base.

6.3.2.2 Relative ShortName-path

[TPS_GST_00170] Relative shortName-path ⌈ A relative reference path does not start with the character '/'. A relative reference path can be converted to an absolute path by adding the appropriate shortName-path of the ReferenceBase in front of the relative shortName-path. ⌋*()*

[TPS_GST_00171] Identifying the ReferenceBase of a Relative Reference ⌈ The appropriate ReferenceBase is identified by

- the attribute base. This denotes the first containing ARPackage visible (the first ancestor package from the reference to the root of the model) from the reference which has a referenceBase with shortLabel equal to the base. In other words: as packages are nested the appropriate referenceBase is searched bottom up.
- alternatively the innermost package which has a referenceBase with default set to "true".

⌋*()*

[constr_2511] Named reference bases shall be available ⌈ If there is a relative references, then one of the containing packages shall have a referenceBase with a shortLabel equal to the base of the reference. ⌋*()*

[TPS_GST_00172] ReferenceBase in Partial Models ⌈ Note that ReferenceBase is ≪atpSplitable≫. Therefore it is necessary to search for the appropriate ReferenceBase in the entire model. In other words the ReferenceBase shall be searched in all partial models. ⌋*()*

Listing 6.1 illustrates the most simple form of relative references. In this case, relative references within a package shall be independent of the package name. Please note the callouts specified as xml comments `<!- 1 ->`:

1. `<!- 1 ->`: this a base of relative references. Note that `isDefault` denotes the fact that it is the default.
2. `<!- 2 ->`: this is a relative reference. Since the `base` attribute is not specified, the reference is resolved using the default base specified in `<!- 1 ->`.

Listing 6.1: Relative Reference with default base

```
<?xml version="1.0"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0␣AUTOSAR_4-1-3.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>MyComponent</SHORT-NAME>
      <REFERENCE-BASES>
        <!--  1 -->
        <REFERENCE-BASE>
          <SHORT-LABEL>default</SHORT-LABEL>
          <IS-DEFAULT>true</IS-DEFAULT>
          <IS-GLOBAL>false</IS-GLOBAL>
          <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
          <PACKAGE-REF DEST="AR-PACKAGE">/MyComponent</PACKAGE-REF>
        </REFERENCE-BASE>
      </REFERENCE-BASES>
      <ELEMENTS>
        <SENDER-RECEIVER-INTERFACE>
          <SHORT-NAME>MyInterface</SHORT-NAME>
          <DATA-ELEMENTS>
            <VARIABLE-DATA-PROTOTYPE>
              <SHORT-NAME>MyData</SHORT-NAME>
              <CATEGORY>VALUE</CATEGORY>
            </VARIABLE-DATA-PROTOTYPE>
          </DATA-ELEMENTS>
        </SENDER-RECEIVER-INTERFACE>
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>MyComponent</SHORT-NAME>
          <PORTS>
            <P-PORT-PROTOTYPE>
              <SHORT-NAME>MyPort</SHORT-NAME>
              <!-- 2 -->
              <!-- /MyComponent/MyInterface -->
              <PROVIDED-INTERFACE-TREF DEST="SENDER-RECEIVER-INTERFACE">
                 MyInterface</PROVIDED-INTERFACE-TREF>
            </P-PORT-PROTOTYPE>
          </PORTS>
        </APPLICATION-SW-COMPONENT-TYPE>
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

Listing 6.2 illustrates that there can be multiple reference bases. In this case, in addition to the previous example another base is given for CompuMethods, since those live in a separate package.

1. `<!- 1.1 ->`: this another base of relative references. Note that `isDefault` attribute is missing. It is the same as if it is specified as `false`.
2. `<!- 2.1 ->`: this is a relative reference. The attribute `base` denotes that the base with `shortLabel` `compum` (defined in `<!- 1.1 ->` shall be used fore the relative reference. The corresponding absolute reference is `/CompuMethods/MyCompu`.

Listing 6.2: Relative Reference with explicit base

```xml
<?xml version="1.0"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0␣AUTOSAR_4-1-3.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>MyComponent</SHORT-NAME>
      <REFERENCE-BASES>
        <!-- 1 -->
        <REFERENCE-BASE>
          <SHORT-LABEL>default</SHORT-LABEL>
          <IS-DEFAULT>true</IS-DEFAULT>
          <IS-GLOBAL>false</IS-GLOBAL>
          <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
          <PACKAGE-REF DEST="AR-PACKAGE">/MyComponent</PACKAGE-REF>
        </REFERENCE-BASE>
        <REFERENCE-BASE>
          <SHORT-LABEL>compum</SHORT-LABEL>
          <IS-DEFAULT>false</IS-DEFAULT>
          <IS-GLOBAL>false</IS-GLOBAL>
          <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
          <!-- 1.1 -->
          <PACKAGE-REF DEST="AR-PACKAGE">/CompuMethods</PACKAGE-REF>
        </REFERENCE-BASE>
      </REFERENCE-BASES>
      <ELEMENTS>
        <SENDER-RECEIVER-INTERFACE>
          <SHORT-NAME>MyInterface</SHORT-NAME>
          <DATA-ELEMENTS>
            <VARIABLE-DATA-PROTOTYPE>
              <SHORT-NAME>MyData</SHORT-NAME>
              <CATEGORY>VALUE</CATEGORY>
              <SW-DATA-DEF-PROPS>
                <SW-DATA-DEF-PROPS-VARIANTS>
                  <SW-DATA-DEF-PROPS-CONDITIONAL>
                    <!-- 2.1 -->
                    <!-- /CompuMethods/MyCompu -->
                    <COMPU-METHOD-REF DEST="COMPU-METHOD" BASE="compum">
                       MyCompu</COMPU-METHOD-REF>
                  </SW-DATA-DEF-PROPS-CONDITIONAL>
                </SW-DATA-DEF-PROPS-VARIANTS>
              </SW-DATA-DEF-PROPS>
```

```
            </VARIABLE-DATA-PROTOTYPE>
          </DATA-ELEMENTS>
        </SENDER-RECEIVER-INTERFACE>
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>MyComponent</SHORT-NAME>
          <PORTS>
            <P-PORT-PROTOTYPE>
              <SHORT-NAME>MyPort</SHORT-NAME>
              <!-- 2 -->
              <!-- /MyComponent/MyInterface -->
              <PROVIDED-INTERFACE-TREF DEST="SENDER-RECEIVER-INTERFACE">
                 MyInterface</PROVIDED-INTERFACE-TREF>
            </P-PORT-PROTOTYPE>
          </PORTS>
        </APPLICATION-SW-COMPONENT-TYPE>
      </ELEMENTS>
    </AR-PACKAGE>
    <AR-PACKAGE>
      <SHORT-NAME>CompuMethods</SHORT-NAME>
      <ELEMENTS>
        <COMPU-METHOD>
          <SHORT-NAME>MyCompu</SHORT-NAME>
          <CATEGORY>RATFUNC</CATEGORY>
        </COMPU-METHOD>
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

Listing 6.3 illustrates that reference bases can be nested. In this case, the base for the CompuMethods is defined relative to the default base. This allows to maintain the entire package relationships at the beginning of a package.

It further on shows that the reference base needs to be search from inside out.

1. <!- 1.1.1 ->: this another base of relative references. Note that base attribute is now explicitly specified. It would also have been possible to relate to the default mechanism here.

2. <!- 1.2 ->: This is the base for units. Note that this base is also defined relative to the default.

3. <!- 2.2 ->: this is a relative reference. The attribute base denotes that the base with shortLabel compum (defined in <!- 1.1.1 -> shall be used fore the relative reference. The corresponding absolute reference is /MyComponent/CompuMethods/MyCompu.

4. <!- 3 ->: This is the package with the CompuMethods. it now lives as nested package in /MyComponent

5. <!- 3.1 ->: This is a reference to a Unit which is relative to the base named units which is defined in <!- 1.2 ->. Note that the reference lives in an inner package which has no package bases.

This illustrates, that the relevant reference base is in one of the outer packages, but not necessarily in the directly containing package.

6. `<!- 4 ->`: This is the package with the `Unit`s. It lives in a sub package of `/MyComponent`.

Listing 6.3: Relative Reference with multiple and nested bases

```
<?xml version="1.0"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0␣AUTOSAR_4-1-3.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>MyComponent</SHORT-NAME>
      <REFERENCE-BASES>
        <!--  1 -->
        <REFERENCE-BASE>
          <SHORT-LABEL>default</SHORT-LABEL>
          <IS-DEFAULT>true</IS-DEFAULT>
          <IS-GLOBAL>false</IS-GLOBAL>
          <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
          <PACKAGE-REF DEST="AR-PACKAGE">/MyComponent</PACKAGE-REF>
        </REFERENCE-BASE>
        <!-- 1.1 -->
        <REFERENCE-BASE>
          <SHORT-LABEL>compum</SHORT-LABEL>
          <IS-DEFAULT>false</IS-DEFAULT>
          <IS-GLOBAL>false</IS-GLOBAL>
          <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
          <!-- 1.1.1 -->
          <PACKAGE-REF BASE="default" DEST="AR-PACKAGE">NestedCompuMethods<
              /PACKAGE-REF>
        </REFERENCE-BASE>
        <REFERENCE-BASE>
          <SHORT-LABEL>unit</SHORT-LABEL>
          <IS-DEFAULT>false</IS-DEFAULT>
          <IS-GLOBAL>false</IS-GLOBAL>
          <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
          <!-- 1.2 -->
          <PACKAGE-REF DEST="AR-PACKAGE">/MyUnits</PACKAGE-REF>
        </REFERENCE-BASE>
      </REFERENCE-BASES>
      <ELEMENTS>
        <SENDER-RECEIVER-INTERFACE>
          <SHORT-NAME>MyInterface</SHORT-NAME>
          <DATA-ELEMENTS>
            <VARIABLE-DATA-PROTOTYPE>
              <SHORT-NAME>MyData</SHORT-NAME>
              <CATEGORY>VALUE</CATEGORY>
              <SW-DATA-DEF-PROPS>
                <SW-DATA-DEF-PROPS-VARIANTS>
                  <SW-DATA-DEF-PROPS-CONDITIONAL>
                    <!-- 2.2 -->
                    <!-- /MyComponent/NestedCompuMethods/MyCompu  -->
```

```
                    <COMPU-METHOD-REF DEST="COMPU-METHOD" BASE="compum">
                        MyCompu</COMPU-METHOD-REF>
                  </SW-DATA-DEF-PROPS-CONDITIONAL>
                </SW-DATA-DEF-PROPS-VARIANTS>
              </SW-DATA-DEF-PROPS>
            </VARIABLE-DATA-PROTOTYPE>
          </DATA-ELEMENTS>
        </SENDER-RECEIVER-INTERFACE>
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>MyComponent</SHORT-NAME>
          <PORTS>
            <P-PORT-PROTOTYPE>
              <SHORT-NAME>MyPort</SHORT-NAME>
              <!-- 2 -->
              <!-- /MyComponent/MyInterface -->
              <PROVIDED-INTERFACE-TREF DEST="SENDER-RECEIVER-INTERFACE">
                  MyInterface</PROVIDED-INTERFACE-TREF>
            </P-PORT-PROTOTYPE>
          </PORTS>
        </APPLICATION-SW-COMPONENT-TYPE>
      </ELEMENTS>
      <AR-PACKAGES>
        <AR-PACKAGE>
          <!-- 3 -->
          <SHORT-NAME>NestedCompuMethods</SHORT-NAME>
          <ELEMENTS>
            <COMPU-METHOD>
              <SHORT-NAME>MyCompu</SHORT-NAME>
              <CATEGORY>RATFUNC</CATEGORY>
              <!-- 3.1 -->
              <!-- /MyUnits/kmh -->
              <UNIT-REF BASE="unit" DEST="UNIT">kmh</UNIT-REF>
            </COMPU-METHOD>
          </ELEMENTS>
        </AR-PACKAGE>
      </AR-PACKAGES>
    </AR-PACKAGE>
    <!-- 4 -->
    <AR-PACKAGE>
      <SHORT-NAME>MyUnits</SHORT-NAME>
      <ELEMENTS>
        <UNIT>
          <SHORT-NAME>kmh</SHORT-NAME>
        </UNIT>
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

Listing 6.4 illustrates a relative reference with a global target.

1. <!– 1 –> denotes the referenceBase. Thereby it declares that via this base Chapter and TextualConstraints are globally unique.
2. <!– 2 –> "ChR_4711" is a globally referrable target

3. <!- 3 -> refers to a textual constraint ("Constr_0815") via the base in <!- 1 ->
4. <!- 5 -> "Constr_0815" is a globally referrable TextualConstraint
5. <!- 6 -> refers to a chapter ("ChR_4711") via the base in <!- 1 ->

Listing 6.4: Relative Reference with global reference

```
<?xml version="1.0"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0␣AUTOSAR_4-1-3.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Demo</SHORT-NAME>
      <REFERENCE-BASES>
        <!--  1 -->
        <REFERENCE-BASE>
          <SHORT-LABEL>globals</SHORT-LABEL>
          <IS-DEFAULT>false</IS-DEFAULT>
          <IS-GLOBAL>true</IS-GLOBAL>
          <BASE-IS-THIS-PACKAGE>true</BASE-IS-THIS-PACKAGE>
          <GLOBAL-ELEMENTS>
            <GLOBAL-ELEMENT>TRACEABLE</GLOBAL-ELEMENT>
            <GLOBAL-ELEMENT>CHAPTER</GLOBAL-ELEMENT>
          </GLOBAL-ELEMENTS>

        </REFERENCE-BASE>
      </REFERENCE-BASES>
      <AR-PACKAGES>
        <AR-PACKAGE>
          <SHORT-NAME>mySupPackage</SHORT-NAME>
          <ELEMENTS>
            <DOCUMENTATION>
              <SHORT-NAME>myDoc</SHORT-NAME>
              <DOCUMENTATION-CONTENT>
                <!-- 2 -->
                <CHAPTER>
                  <SHORT-NAME>ChR_4711</SHORT-NAME>
                  <LONG-NAME>
                    <L-4 L="EN">More details on Requirement 4711</L-4>
                  </LONG-NAME>
                  <P>
                    <L-1 L="EN">Lorem ipsum dolor sit amet, consetetur
                        sadipscing elitr, sed diam nonumy eirmod tempor
                        invidunt ut labore et dolore magna aliquyam erat,<
                        XREF>
                      <!-- 3 -->
                      <!-- /Demo/mySubPackage/myDoc/Ch_001/Constr_0815
                           global: /Demo@/Const_0815 -->
                      <REFERRABLE-REF BASE="globals" DEST="TRACEABLE">
                        Constr_0815</REFERRABLE-REF></XREF>autem vel eum
                        iriure dolor in hendrerit in vulputate velit esse
                        molestie consequat, vel illum dolore eu</L-1>
                  </P>
                </CHAPTER>
```

```
                <CHAPTER>
                  <SHORT-NAME>Ch_001</SHORT-NAME>
                  <LONG-NAME>
                    <L-4 L="EN">an implementation</L-4>
                  </LONG-NAME>
                  <!-- 5 -->
                  <TRACE>
                    <SHORT-NAME>Constr_0815</SHORT-NAME>
                    <LONG-NAME>
                      <L-4 L="EN">This is my specific constraint</L-4>
                    </LONG-NAME>
                    <P>
                      <L-1 L="EN">Lorem ipsum dolor sit amet, consetetur
                         sadipscing elitr, sed diam nonumy eirmod tempor
                         invidunt<XREF>
                        <!-- 6 -->
                        <!-- /Demo/mySupPackage/myDoc/ChR_4711
                             global: global: /Demo@/ChR_4711 -->
                        <REFERRABLE-REF BASE="globals" DEST="CHAPTER">
                          ChR_4711</REFERRABLE-REF></XREF>autem vel eum
                          iriure dolor in hendrerit in vulputate velit
                          esse molestie consequat, vel illum dolore eu</L
                          -1>
                    </P>
                  </TRACE>
                </CHAPTER>
              </DOCUMENTATION-CONTENT>
            </DOCUMENTATION>
          </ELEMENTS>
        </AR-PACKAGE>
      </AR-PACKAGES>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

6.3.2.3 Destination Type

[TPS_GST_00173] Destination Type ⌈ The destination type (specified as attribute `dest` in the reference elements) defines the type of the referenced object. The destination type can also reference subclasses (abstract and concrete). The value of this attribute is

- If the reference in the meta model points to an abstract class, the value of `dest` is the XML-name of the abstract class or any subclass of the same. Even if `dest` is the XML-name of an abstract class, the target of the reference can be an instance of any concrete class derived from the denoted abstract class.
- If the reference in the meta model points to a concrete class, the value of `dest` is the name of this class. The target of the reference can only be an instance of the denoted class.

⌋*()*

The destination type improves the robustness of the XML descriptions such as:

- A tool can find references which refer to objects of the wrong type.
- If the referenced object is not available the, tool can indicate the correct type resp. instantiate a proper proxy.

But if the possible values of `dest` would not include abstract classes, this would cause the problem:

- It requires maintenance of the references if the reference target is changed to another subclass, even if the reference would not care about this.
- It does not propagate information of the meta model to the XML schema

Figure 6.8 illustrates the implementation of an association.

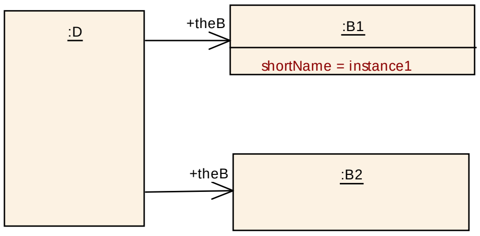


Figure 6.8: Example for linking

```
  <D>
    <THE-B-REFS>
      <THE-B-REF DEST="B-1">/package1/package2/instance1</THE-B-REF>
      <THE-B-REF DEST="B-2">/package1/package2/instance2</THE-B-REF>
    </THE-B-REFS>
</D>
```

6.3.3 ≪atpObject≫ARObject

[TPS_GST_00198] Attributes for all Meta Classes ⌈ In the Autosar Metamodel there shall be attributes which are applicable to all concrete meta-classes. This can be considered as a model transformation which applies all meta-classes of ≪atpObject≫ (in particular `ARObject`) as superclass to all base classes. ⌋*()*

See figure 6.9 for details of this transformation pattern.

Class	**ARObject (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ArObject			
Note	Implicit base class of all classes in meta-model.			
Base				
Attribute	***Type***	***Mul.***	***Kind***	***Note***

checksum	String	0..1	attr	Checksum calculated by the user's tool environment for an ArObject. May be used in an own tool environment to determine if an ArObject has changed. The checksum has no semantic meaning for an AUTOSAR model and there is no requirement for AUTOSAR tools to manage the checksum. **Tags:** xml.attribute=true; xml.name=S
timestamp	DateTime	0..1	attr	Timestamp calculated by the user's tool environment for an ArObject. May be used in an own tool environment to determine the last change of an ArObject. The timestamp has no semantic meaning for an AUTOSAR model and there is no requirement for AUTOSAR tools to manage the timestamp. **Tags:** xml.attribute=true; xml.name=T

Table 6.1: ARObject

Note that the pattern does not really require arguments.

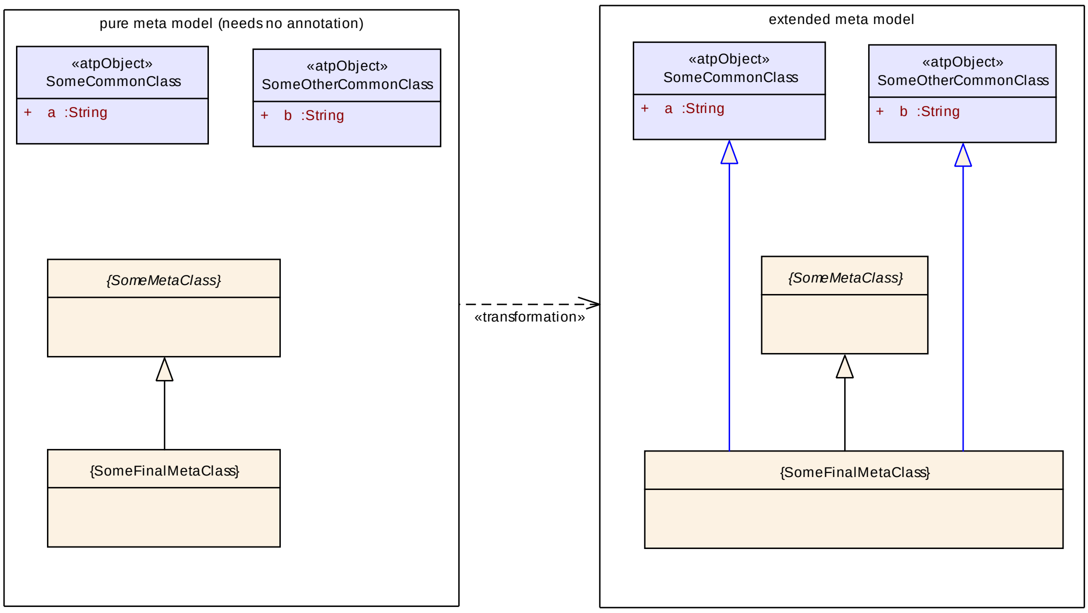


Figure 6.9: Pattern for ≪atpObject≫

7 Variant Handling

7.1 Introduction

The motivation for *Variant Handling* in AUTOSAR are to build a bridge between OEM's and suppliers, to avoid redundancy between artifacts, and to provide a basis for expressing basic product lines in AUTOSAR.

Of course, variant handling concepts do already exist at most companies, but they are typically not standardized (beyond company borders), and thus it is difficult for OEM's and suppliers to talk to each other on this subject.

Consider the following example. An OEM sends a model which contains variants to a supplier. The supplier generates code from this model, but does not resolve all variants. What the OEM gets back is object code with some variants bound, and other variants left "open" for binding at load time. This can only work if both parties speak the same language, and have the same understanding about variants. And quite often, more than two parties are involved.

Hence, variant handling in AUTOSAR is mostly about *documenting* variants:

[TPS_GST_00174] Variant Handling Terminology ⌈

- *Variation Points* are locations in the model that are variable. That is, they may not exist in all variants, or may have different characteristics in different variants.
- The *Binding Time* is the latest possible time when a variation point may be bound.
- *Binding Expressions* specify under which condition(s) a variable element exists, or determine certain variable characteristics.

⌋*()*

7.1.1 A Quick Overview

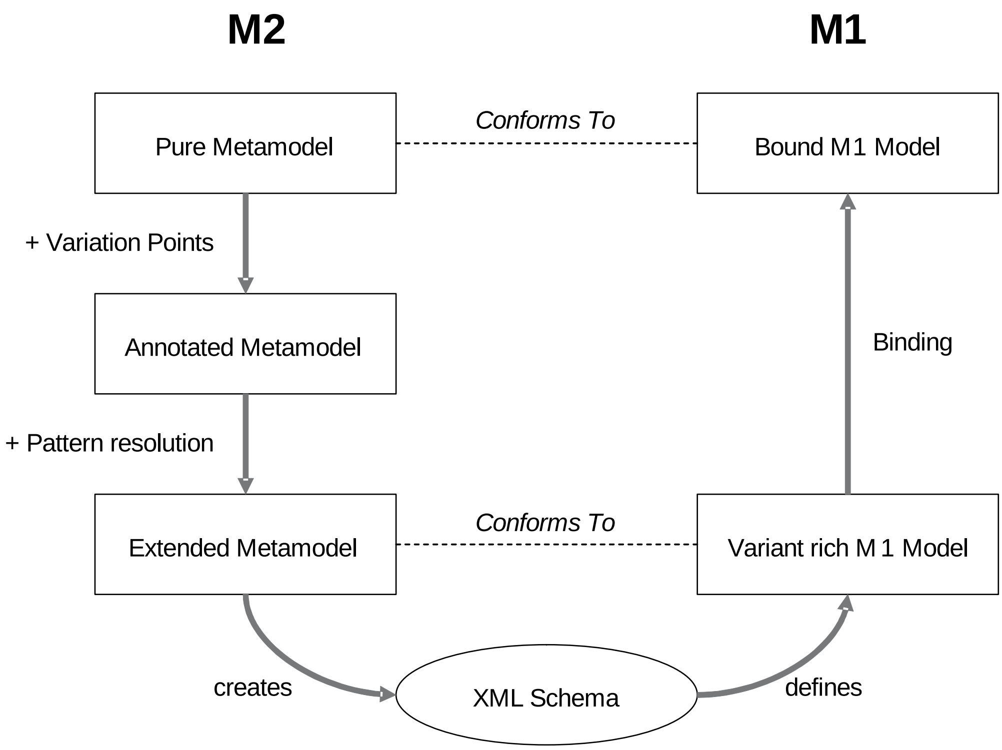


Figure 7.1: Quick Overview

In this section, we continue the meta model transformation overview from Chapter 6.

1. (Recapitulation from Chapter 6.) AUTOSAR starts with the *pure meta model*. The *annotated meta model* has the same structure, but marks those locations that are variation points with a stereotype (≪atpVariation≫). In this section, we will define patterns that show to transform those locations into a structure that has all the information that is necessary to implement variation points.

2. All this happens on the M2 model. After the XML schema has been created, the focus shifts to M1. This is where the variants are bound.

3. **[TPS_GST_00175] Variant rich M1 model** ⌈ A *variant rich M1 model* is a model (which shall conform to the rules defined by the *extended meta model* [TPS_GST_00164]) which contains all supported variants simultaneously. Variation is thereby expressed by `VariationPoint` respectively `AttributeValueVariationPoint`. ⌋*()*

4. **[TPS_GST_00176] Bound M1 model** ⌈ The bound model represents one particular variant. It is created by from the variant rich model which is transformed into one particular variant by binding the variation points. ⌋*()*

   [constr_2503] Bound model must be compliant to the pure meta model ⌈ The *completely bound M1 model*[1] must adhere to the *pure meta model* with respect

[1] Completely bound includes post build!

to consistency rules and semantic constraints defined in the related template specifications. Especially, the multiplicities in the bound model must conform to the multiplicities and the constraints of the *pure meta model*. ⌋*()*

For example, in an invariant model, ports may have either 1:n or n:1 connections. On the other hand, this rule does not apply to a variant rich model because the variants might overlap each other which results in m:n connections. After binding the variant rich model and extracting one particular variant, the rules of an invariant model apply again.

As another example, the interface compatibility rules can only be applied to a particular variant.

Note that the existence of *PostBuild* variation points implies in practice that the completely bound M1 model not necessarily exists as an artifact. The reason is that the *PostBuild* variation points are bound at startup of the ECU and obviously cannot be resolved in the M1 model. However, the resulting M0 model conforms to the bound M1 model.

[TPS_GST_00177] Remove Deselected Objects ⌈ If the bound M1 model is saved as artifact, then deselected objects shall be removed. ⌋*()*

[TPS_GST_00178] Remove Binding Function upon Binding ⌈ It is up to the process whether the `VariationPoint` for the selected objects are left in the artifacts. If they are left in, the binding function shall be removed respectively replaced by the result in `AttributeValueVariationPoint`. By this the variation point does not look like an unbound variation point). ⌋*()*

7.1.2 Variant Handling and Methodology

As shown before, variant handling takes place on different levels and in different stages in the methodology, and so may have impact on different work products. In fact, every work product can now contain variations.

[TPS_GST_00179] Scope of Variant Handling Specification ⌈ In AUTOSAR, we specify only how variations are represented in ARXML. Everything else is implementation specific and not standardized on M2 level. ⌋*()*

But in general, one could say that the methodology without variant handling can be extended to variant handling by introducing resolution of variation as first action of each activity.

For example, a variant rich software component description (represented by an ARXML file) can be preprocessed to a bound software component description by a variant resolving tool, and then handled as defined in the non-variant methodology.

[TPS_GST_00180] Resolving Variation Points along the Development Steps ⌈ Every variation point starts in the XML representation, but is not necessarily resolved in the XML representation. If it is not resolved in a particular processing step, it needs to be transferred to the output artifacts. For example, this means that generated C headers may contain `#ifdef` statements (for *PreCompile Time* variability).

Another example is PostBuild variation, where the generated object code contains conditional statements for implementing the PostBuild variation points, as specified in the XML representation. ⌋*()*

For more details on relationship of binding time and methodology please refer to [TPS_METH_00001] (tasks), [TPS_METH_00002] (artifacts), [TPS_METH_00003] (task usage) in [16].

7.1.3 How Variant Handling is implemented in the meta-model

Variant Handling in AUTOSAR consists of the following steps[2]:

1. **[TPS_GST_00181] Annotated MetaModel for Variant Handling** ⌈ In the *annotated meta model* (see [TPS_GST_00163]) – that is, on M2 level – all locations which may exhibit variability are annotated as such. This is realized by applying the stereotype ≪atpVariation≫. ⌋*()*

   There are four kinds of locations in the meta model which may exhibit variability:

   - Aggregations (see Section 7.2)
   - Associations (see Section 7.3)
   - Attribute Values (see Section 7.4)
   - Classes providing property sets (see Section 7.5)

   Each of the sections referenced above describes a *pattern* that is used to transform the stereotype ≪atpVariation≫ and its associated element into a structure which provides all the information that is necessary to describe a variation point. In other words, they describe the transformation from the *annotated meta model* to the *enhanced meta model*.

   The advantage of this approach is – besides not cluttering the meta model with lots of variant handling related information – that the stereotype ≪atpVariation≫ now also serves as a way to document all sites in the meta model where variations may occur.

   Note: at this point, we are still in the *annotated meta model*. Hence, we do only define which variations are possible, but do not provide the means to specify a condition for this variation (i.e., *when* it occurs), or means to select a particular variant.

2. **[TPS_GST_00182] Notation of Latest Binding time on M2** ⌈ In all of the variant handling related model transformation patterns, an UML tag

[2]In this section, and continuing in the reminder of this chapter, we are heavily borrowing terms from Section 6, especially Figure 6.1

vh.latestBindingTime (see [TPS_GST_00052]) is associated with the stereotype. More precisely, it is attached to the element that has the stereotype ≪atpVariation≫. In particular, this is the meta class, an attribute or an aggregation/association (not the target end of the same).

Applicable values for vh.latestBindingTime are the values defined by both BindingTimeEnum and AdditionalBindingTimeEnum. ⌋*()*

This tag is applied to M2 elements. It does *not* specify the binding time for the variation point, but puts an *upper limit* on the possible values for the binding time of the variation point.

[TPS_GST_00183] Representation of Binding Time ⌈ The binding time of an individual variation point is specified in the attribute bindingTime of its ConditionByFormula or AttributeValueVariationPoint element. Hence the name *latest* the value stated defined with vh.latestBindingTime is the latest binding time that can be assigned to this element. ⌋*()*

vh.latestBindingTime is described in more detail in Sections 7.1.6 and 7.6.4; the binding times are explained in [16].

3. **[TPS_GST_00185] Transformation on Meta Model** ⌈ Before the XML schema can be generated from the meta model (for example, by the metamodel tool), all variation points are transformed into a structure that allows to specify detailed information ([TPS_GST_00164]) for each variation point, including its actual binding time, and the conditions for when the variation occurs. ⌋*()*

   This is done by applying the patterns mentioned in step 1 to the *annotated meta model*. The result of this transformation is the *expanded meta model*.

   In other words, individual variations are defined on M1 level using the means provided on M2 level.

   Details for the individual patterns are described in the respective Sections 7.2, 7.3, 7.4, and 7.5, while the class VariationPoint is explained in Section 7.6.

4. **[TPS_GST_00186] Description of Variation on M1** ⌈ The model designer finally specifies the condition(s) and the latest binding time for this variation. This is done in the *variant rich model* on M1 level. ⌋*()*

   The condition specifies under what circumstances a particular variation becomes active. For example, it may select one of several alternatives; in this case, the conditions should better be mutually exclusive. Such a condition is, in a nutshell, an expression with system constants as operands.

   See Section 7.6.8 and Section 4.8 earlier in this document for more details on conditions.

5. The next step is to *choose* a particular variant. This may occur at any time before the binding time defined for this variation.

Conditions are, as already said in the step 4, essentially expressions using system constants as operands.

[TPS_GST_00187] Choosing a Particular Variant ⌈ Hence, a particular variant of a system is chosen by assigning values to all system constants which are referenced by all variation points which are relevant for the given binding time. ⌋ *()*

It should be noted here that not all variants are chosen at the same time. Instead, there may (and typically will) be several “waves” of binding variations, each at a different time. Similarly, not all system constants need to be determined at the same time – the only restriction here is that their values must be available at the time they are needed.

In addition, at this stage the model still contains information about possible variants. In the beginning, this are *all* variants. At a later stage, some of those variants are already bound (see Step 6) and the model only contains information on a subset of the original variants.

This step is described in detail in Section 7.8.

6. **[TPS_GST_00188] Resolving Variation Points** ⌈ When a particular variant is chosen as described in [TPS_GST_00187] the selection is implemented and the variation is resolved.

   This means that all elements which aggregate a `VariationPoint` whose condition evaluates to *false* are removed from the model, and all `AttributeValueVariationPoint` elements get their `value` attribute fixed (see [TPS_GST_00178]). ⌋ *()*

As indicated in Section 6, not *all* variations are bound at the same (binding) time. At each binding step, unbound variations may still be in existence, and can be bound at a later (binding) time[3]. In other words, Steps 5 and 6 are usually iterated several times.

7.1.4 Not every element in the meta model may be variant

[TPS_GST_00189] Variation is Restricted to Specific Elements. ⌈ The stereotype ≪`atpVariation`≫ is only allowed for specific elements. These elements are defined by the respective AUTOSAR templates. ⌋ *()*

The reason for this is that when the stereotype ≪`atpVariation`≫ is attached to an element, there are consequences for other elements. For example, when a port is variable, all the connections from and to this port are also variable. The appropriate measures have to be described precisely in the associated AUTOSAR template. Hence, only a limited number of locations in the meta model support variation.

The list of UML elements that allow variation points can be retrieved by querying the stereotypes ≪`atpVariation`≫ in the meta model (see Section C).

[3] Of course, there is no binding time after *PostBuild*.

Technically, this restriction is implemented as follows. The XML schema is equivalent to the *extended meta model*, and simply does not allow for attaching VariationPoint or other variant handling related elements to arbitrary locations. The schema makes sure that only those locations that are tagged with ≪atpVariation≫ in the *annotated meta model* may contain such elements (see [TPS_GST_00195] and [TPS_GST_00199]).

7.1.5 Variation Points are optional, even for variant elements

The stereotype ≪atpVariation≫ marks a model element on M2 level as variable. However, the element is not necessarily variable *every time* when it is used on M1 level – on the contrary, variability should only be employed when needed.

This might imply that if a model element is potentially variable, there is a significant overhead on M1 level even if the element is used in a non-variant way. However, this is not the case: the VariationPoint element that serves as a starting point for variability information is always optional. Hence, it only needs to be provided only when there is need for it – if absent, there is no variability.

7.1.6 A note on Binding Times

In AUTOSAR, we handle binding times on three different levels:

1. There is the binding time that is specified on M1 level. This the value of the attribute bindingTime of the element ConditionByFormula (see Figure 7.9) and of AttributeValueVariationPoint (see Figure 7.4).

   [TPS_GST_00190] Semantic of bindingTime ⌈ The value of bindingTime defines the *latest* binding time for this particular variation point. A variation may be chosen and bound earlier, but not later than bindingTime. In consequence, a variation may be bound as soon as all involved system constants have values. ⌋*()*

   On the other hand, a system constant must have a value at the "earliest" binding time in which it is required. If we do not have this, then it might be the case that a system constant value is changed during the development cycle which again leads to inconsistencies.

2. **[TPS_GST_00221] Attachment of Latest Binding Time** ⌈ There are the individual applications of the stereotype ≪atpVariation≫ in the annotated meta model on M2 level. For each such application, a tag vh.latestBindingTime is associated with the stereotype. ⌋*()*

   [TPS_GST_00220] Attachment of Binding Time ⌈ An element that is tagged with the stereotype ≪atpVariation≫ is transformed into a more elaborated structure which provides all the information that is necessary to define variation points. This transformation always introduces a ConditionByFormula or a AttributeValueVariationPoint, i.e., an element that has an attribute bindingTime. ⌋()

[constr_2504] Constraint to bindingTime ⌈ The tag vh.latestBindingTime *constraints* the value of the attribute bindingTime from [TPS_GST_00190]. Hence, it defines the latest point in methodology which is allowed as value for bindingTime of this particular application of ≪atpVariation≫. ⌋()

3. There are the patterns that describe how the stereotype ≪atpVariation≫ is translated into more elaborated UML constructs which provide all the information that is necessary to define variation points.

   These patterns may again restrict the potential range of values for vh.latestBindingTime. These particular restrictions are defined in Sections 7.2.2, 7.3.2, 7.4.4, and 7.5.3.

7.1.7 A note on the impact of Variant Handling on the XML Schema

Naturally, variant handling requires some changes and extensions in the XML schema for M1 AUTOSAR models. In general, those changes are kept as simple as possible. With the exception of the *Property Set Pattern* (Section 7.5), these changes do not introduce significant structural changes in the XML, but rather add and sometimes rename elements.

Pattern specific issues of the respective XML code are documented in the respective subsections of the individual patterns (Sections 7.2.4, 7.3.4, 7.4.6, and 7.5.5).

7.1.8 Patterns are independent of each other

We define four patterns for defining variation points in aggregations, associations, attribute values and property sets. These patterns describe how the ≪atpVariation≫ translates an existing UML construct – usually a relation or an attribute – into one that provides support for describing variants.

[TPS_GST_00191] Variant Handling Patterns can be Mixed ⌈ The model transformation patterns for variant handling can be combined in any fashion. For example, an element that has variant attributes may be part of a variant aggregation. Or, individual attributes in the property set pattern may be variant themselves. ⌋()

7.1.9 A note on multiplicities in the Variant Handling Patterns

[TPS_GST_00192] Variant Handling Extends Upper Multiplicity ⌈ The Variant Handling patterns need to transform the upper multiplicities for certain aggregations associations within the pattern. Typically, the upper multiplicity of an aggregation is raised to $*$.

This leads to the following constellation:

1. In the *pure meta model*, the multiplicity is $m \ldots n$.
2. In the *annotated meta model*, the multiplicity is still $m \ldots n$.
3. In the *extended meta model*, the multiplicity is increased to $m \ldots *$.

⌋*()*

Of these, the *extended meta model* is the one that adds additional structure to describe *all* possible variants. The consequence is that the *variant rich M1 model*, which corresponds to the *extended (M2) meta model*, may aggregate or associate more elements than there would be allowed in the original $m \ldots n$ multiplicity of the *pure meta model*.

In other words, the *variant rich M1 model* violates the multiplicity that is defined in the *pure meta model*.

However, it is not as serious as it sounds, because the violation only takes place before the binding is completed. The *variant rich M1 model* starts with all possible variants, but as we have described in Section 7.1.3, the "excess" variations are removed during the binding process.

After the binding has been completed – in the *bound M1 model* – the multiplicity must again be within the limit as defined in the *pure meta model*. This is ensured by semantic constraints that are part of the pattern ([constr_2503]).

7.1.10 A note on the application of the variant handling patterns

[TPS_GST_00193] Order of Pattern Resolution in Variant Handling ⌈ The variant handling patterns are resolved by the model transformation on M2(e.g. by metamodel tool) in the following order:

1. Property Set Pattern
2. Aggregation Pattern
3. Association Pattern
4. Attribute Value Pattern

⌋*()*

It should be noted that this is not the sequence in which the patterns are presented in this document; namely, the *property set pattern* comes last. This is because our descriptions start with those patterns that are easiest to understand, and then proceed to the more complex ones.

7.2 *Aggregation Pattern* for Variation Points

7.2.1 Description

Figure 7.2 illustrates how the metamodel tool transforms an aggregation into an M2 model with variation information.

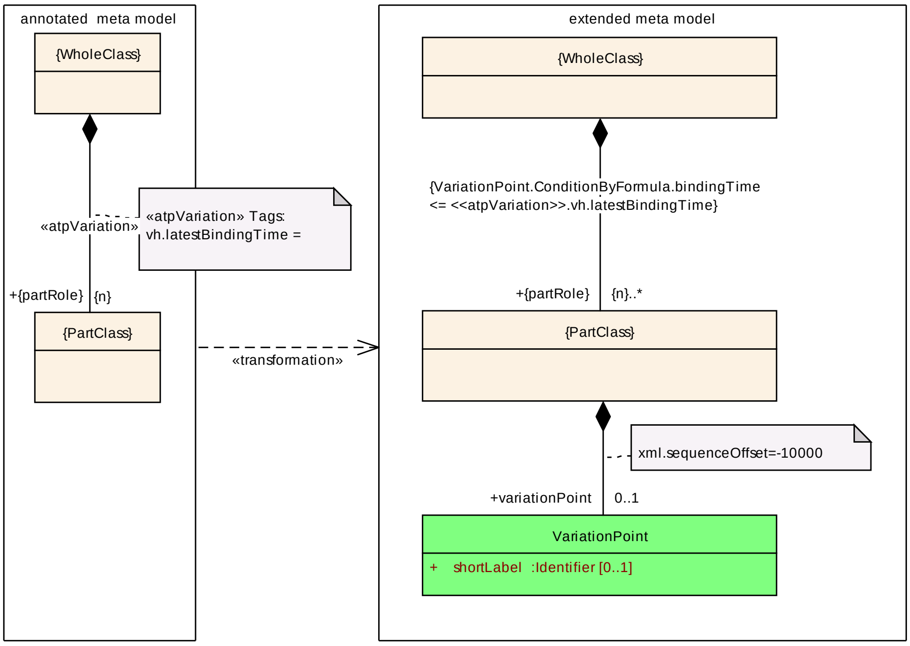


Figure 7.2: Variation Point in Aggregation

On the left side, `{WholeClass}` aggregates `{PartClass}`. This aggregation is subject to variation: the aggregation may or may not exist in the bound model. This is indicated by applying the stereotype ≪`atpVariation`≫ to the association.

Note that the left side only consists of `{WholeClass}`, ≪`atpVariation`≫ and `{PartClass}`, and does not include a condition that determines whether the variation exists. Such a condition is added as part of `VariationPoint` on the right side. In any case, it would not make sense to specify such a condition *here*, because the diagram is on M2 level, while the condition can only be filled in for a concrete variation point, e.g., on M1 level.

In a nutshell, the transformation works as follows:

[TPS_GST_00199] Transformation defined by Aggregation Pattern ⌈

1. `{WholeClass}` still aggregates `{PartClass}` directly.
2. The multiplicity of `{partRole}` changes from `{n}` to `{n}...*`.

   The reason for the change in the multiplicity is that a model that contains variants naturally will contain more `{PartClass}` elements than a model in which the variants have already been bound. Note that the "excess" `{PartClass}` elements, i.e. the "unused" variants, are deleted in the binding process.

This is indicated by the constraint [constr_2505].

3. {PartClass} aggregates a VariationPoint. As described in Section 7.6.1, VariationPoint aggregates further information about this variability, especially the binding time and the condition which guards the variation.

⌋()

[TPS_GST_00194] Variation Points are Optional ⌈ The multiplicity of VariationPoint is $0 \ldots 1$, meaning that the variation point is optional. If no variation point is given, then the aggregation from {WholeClass} to {PartClass} is invariant. This can be seen as equivalent to a variation point where the condition always evaluates to *true*. ⌋()

[constr_2599] Maximum one VariationPoints in ≪atpMixed≫ ⌈ In case an ≪atpMixed≫ meta class is aggregated as ≪atpVariation≫ there shall not be more than one VariationPoint and the VariationPoint shall be the last aggregated element. ⌋()

The reason for making VariationPoint optional is that the aggregation *may be*, but does not *have to be* variant. Hence, if the aggregation is used in a context where there is no variability – the aggregation is always there – then there is no need to add a variation point to the model (on M1 level). This helps to reduce the complexity of the resulting model, and trims the resulting XML representation.

[constr_2505] Multiplicity after binding ⌈

if Phase ≥ {partRole}.BindingTime *then* number of {partRole}'s = n

⌋()

where n is the final number of *PartRole* elements.

7.2.2 Binding Time

[constr_2577] Binding Time in Aggregation Pattern ⌈ Within VariationPoint, the class ConditionByFormula has an attribute bindingTime which defines the *latest* binding time for this variation point. This binding time is further constrained by the UML tag vh.latestBindingTime that is attached to the aggregation see [TPS_GST_00190], [TPS_GST_00220], [TPS_GST_00221]):

ConditionByFormula.bindingTime ≤ *aggregation*.vh.latestBindingTime ⌋()

This makes sure that the meta model can define a restriction on M2 level. The actual binding time is specified on M1 level (when the value for the bindingTime attribute is fixed).

7.2.3 Multiplicity of {PartClass}

Table 7.1 shows how the multiplicity of {PartClass} changes during the transformation.

{PartClass} annotated meta model	{PartClass} extended meta model
$0 \ldots 1$	$0 \ldots *$
$0 \ldots n$	$0 \ldots *$
$0 \ldots *$	$0 \ldots *$
$1 \ldots n$	$1 \ldots *$
$1 \ldots *$	$1 \ldots *$
$m \ldots n$	$m \ldots *$
n	$n \ldots *$
$*$	$*$

Table 7.1: Multiplicity in the Association Pattern

The change in the multiplicity means that after the transformation, the model is *less strict* than it had been before. A multiplicity that had a fixed upper bound (or was a constant) before the transformation is replaced by one that has an unlimited upper bound.

The reason for this is that we need to provide several alternative {PartClass} elements and then choose one or more of them. Hence, we need to relax the original multiplicity – otherwise there would be no way to add the additional elements. And since the number of additional {PartClass} elements to choose from cannot be known at this time, the upper multiplicity is always $*$.

7.2.4 XML Representation

The *aggregation pattern* has a low impact on the XML representation of a M1 model.

In fact, when a "normal" aggregation is made into a variation point, the only difference is that the XML element which corresponds to the {partRole} UML element gets an additional XML element named <VARIATION-POINT>.

An example for the XML code that is produced by the *aggregation pattern* can be found in Listing 7.2.

7.2.5 Notes and Restrictions

1. **[TPS_GST_00195] Annotated Meta Model Defines Applicable Variation Points** ⌈ If an association from {WholeClass} to {PartClass} is tagged with ≪atpVariation≫, then *any* occurrence of {PartClass} may aggregate a VariationPoint. In other words, {PartClass} may aggregate Variation-

Point even in cases where it is not at the end of an association that is tagged with ≪atpVariation≫.

However, using a variation in such a way would obviously not be compatible with the definition in the annotated meta model ⌋*()*.

An example for this situation is that InternalBehavior aggregates ParameterDataPrototype in the role constantMemory with ≪atpVariation≫. In contrast to this, PortInterface also aggregates ParameterDataPrototype but not with ≪atpVariation≫. The XML Schema allows a variation point on both aggregations, while the annotated meta model does not.

2. **[TPS_GST_00200] Schema Generator avoids duplicate VariationPoints** ⌈ if {PartClass} has a subclass (say, SubPartClass) that is aggregated elsewhere (say, AnotherWholeClass) and this other aggregation is also tagged with ≪atpVariation≫, then SubPartClass would aggregate *two* variation points.

   To avoid this, the schema generator (i.e., the metamodel tool) uses a special processing step to clean up such duplicate VariationPoints. ⌋*()*

3. **[TPS_GST_00201] Aggregation Pattern on Primitives** ⌈ The *aggregation pattern* cannot be used for ≪primitive≫ elements. This is because of the special handling of ≪primitive≫ elements, as defined in section 4.1.1 of [3]. ⌋*()*

   The obvious workaround would be to make the element non-primitive.

4. **[TPS_GST_00202] Limitation of non post build** ⌈
   If vh.latestBindingTime is earlier than PostBuild, then VariationPoint cannot have a *PostBuild* branch, i.e. it cannot aggregate a postBuildVariantCondition (see [constr_2517]). ⌋*()*

   This is explained in more detail in Section 7.6.6.

7.3 *Association Pattern* for Variation Points

Figure 7.2 shows how the metamodel tool transforms an association into an M2 model with variation information.

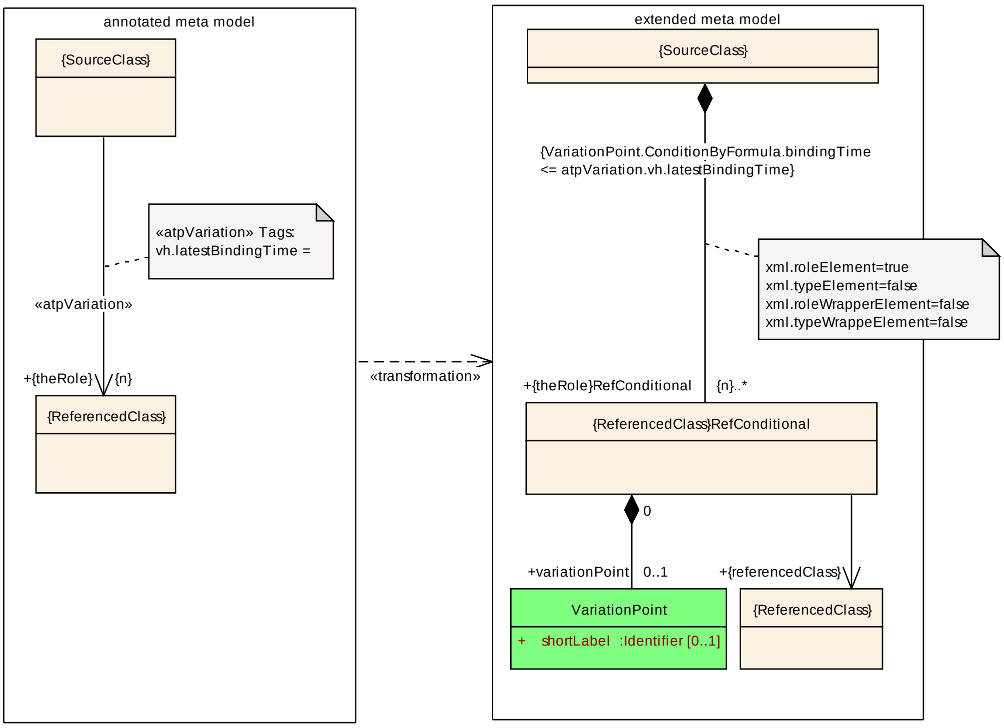


Figure 7.3: Variation Point in Association

The major difference between this pattern and the aggregation pattern (Section 7.2) is the addition of the `{ReferencedClass}RefConditional` class. The `VariationPoint` is now aggregated by `{ReferencedClass}RefConditional` instead of `{ReferencedClass}`.

7.3.1 Description

In a nutshell, the pattern for transforming an association works as follows:

[TPS_GST_00203] Transformation defined by Association Pattern ⌈

1. `{SourceClass}` aggregates a `{ReferencedClass}RefConditional` element. This is very similar to the *implementation* of nonvariant associations, which introduces a `{ReferencedClass}Ref` element that acts as a pointer (read: reference) to `{ReferencedClass}`.

2. `{ReferencedClass}RefConditional` aggregates a `VariationPoint` element. The `VariationPoint` controls whether the element `{ReferencedClass}RefConditional` exists.

   The multiplicity of this aggregation is $0 \ldots 1$. That is, `VariationPoint` is optional. If the `VariationPoint` element is omitted, then there is no variation, and `{ReferencedClass}RefConditional` always exists (this is equivalent to a variation point where the condition always evaluates to *true*.)

3. {ReferencedClass}RefConditional provides a reference to {ReferencedClass}.

   As said before, the nonvariant case would use {ReferencedClass}Ref instead, which also has a reference to {ReferencedClass}, but lacks the aggregated VariationPoint.

⌋*()*

7.3.2 Binding Time

The binding time for the *association pattern* follows the same schema as in the *aggregation pattern* (Section 7.2.2).

[constr_2578] Binding Time in Association Pattern ⌈ Within VariationPoint, the class ConditionByFormula has an attribute bindingTime which defines the *latest* binding time for this variation point. This binding time is further constrained by the UML tag vh.latestBindingTime that is attached to the association (see [TPS_GST_00190], [TPS_GST_00220],[TPS_GST_00221]):

ConditionByFormula.bindingTime $\leq$ *association*.vh.latestBindingTime

⌋*()*

7.3.3 Multiplicity of {ReferencedClass}RefConditional

The multiplicity of {ReferencedClass}RefConditional in the *association pattern* follows the same scheme as the multiplicity of {PartClass} in the *aggregation pattern* (Section 7.2.3).

7.3.4 XML Representation

The *association pattern* has a low impact on the XML representation of a M1 model.

The element {ReferencedClass}RefConditional is visible on the XML level by its role name {theRole}RefConditional. This is only a slight difference from the non-variant case, which uses the role name {theRole}Ref. Both elements serve the same purpose: they are containers for the actual reference. The only difference is that the variant case adds an optional <VARIATION-POINT>.

An example for the XML code that is produced by the *association pattern* can be found in Figure 7.4.

7.3.5 Notes and Restrictions

[TPS_GST_00204] Handling of non variant associations ⌈ The reason for making VariationPoint optional in {ReferenceClass}RefConditional is that the association *may be* variant, but does not have to be variant. Hence, if the association is used in a context where there is no variability – the association is always there – then there is no need to add a variation point to the model (on M1 level). This helps to reduce the complexity of the resulting model, and trims the resulting XML representation. ⌋*()*

7.4 *Attribute Value Pattern* for Variation Points

Our first two patterns (Sections 7.2 and 7.3) dealt with the existence of a relationship between two elements. The pattern which will be described in this section implements a different kind of variation, namely a variation in the value of one or more attributes.

7.4.1 Description

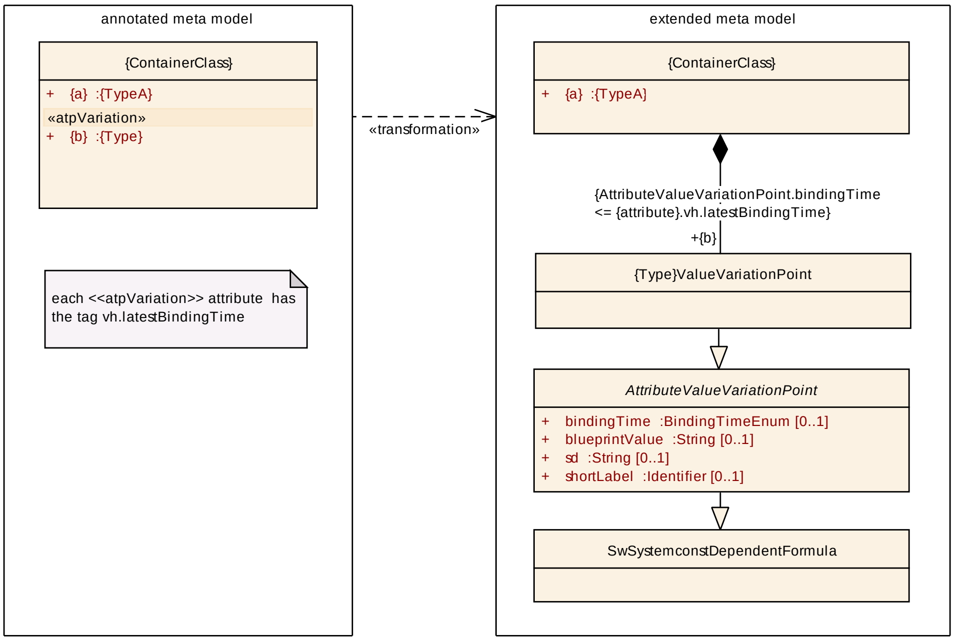


Figure 7.4: *attribute value pattern*

Class	≪atpMixedString≫ **AttributeValueVariationPoint (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents the ability to derive the value of the Attribute from a system constant (by SwSystemconstDependentFormula). It also provides a bindingTime.			
Base	ARObject, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
bindingTime	BindingTimeEnum	0..1	attr	This is the binding time in which the attribute value needs to be bound. If this attribute is missing, the attribute is not a variation point. In particular this means that It needs to be a single value according to the type specified in the pure model. It is an error if it is still a formula. **Tags:** xml.attribute=true
blueprintValue	String	0..1	attr	This represents a description that documents how the value shall be defined when deriving objects from the blueprint. **Tags:** xml.attribute=true
sd	String	0..1	attr	This special data is provided to allow synchronization of Attribute value variation points with variant management systems. The usage is subject of agreement between the involved parties. **Tags:** xml.attribute=true
shortLabel	PrimitiveIdentifier	0..1	attr	This allows to identify the variation point. It is also intended to allow RTE support for CompileTime Variation points. **Tags:** xml.attribute=true

Table 7.2: AttributeValueVariationPoint

In this pattern, the stereotype ≪atpVariation≫ marks those attributes that are variant[4]. The transformation works as follows:

[TPS_GST_00205] Transformation defined by Attribute Value Pattern ⌈

1. {ContainerClass} is stripped of all variant attributes.
2. For each variant attribute, an element {Type}ValueVariationPoint is generated. {Type} may be one of Integer, Float, Boolean, Numerical, Limit, PositiveInteger and UnlimitedInteger when the attribute is a number. If the attribute is an enumeration, {Type} shall be the name of the meta-class describing the enumeration.

[4] In Figure 7.4, all attributes that are listed *below* ≪atpVariation≫ have this particular stereotype. In other words, {a} is a non-variant attribute, while {b} has the stereotype ≪atpVariation≫.

3. {Type}ValueVariationPoint inherits from:
   - AttributeValueVariationPoint if {Type} is Integer, Float, Boolean, PositiveInteger or UnlimitedInteger,
   - AbstractNumericalVariationPoint if {Type} is Numerical or Limit,
   - AbstractEnumerationValueVariationPoint if {Type} is the name of the meta-class describing the enumeration,

   whose attribute bindingTime specifies the binding time for the variant attribute (on M1 level).
4. AttributeValueVariationPoint in turn inherits from SwSystemconstDependentFormula, which implements a formula. This formula provides the value for the variant attribute.

⌋*()*

According to the pattern shown in Figure 7.4, step 1 leaves only attribute {a}. The class {Type}ValueVariationPoint mentioned in step 3 is described in Section 7.4.3. Inheritance of binding time is described in more detail in Section 7.4.4.

7.4.2 AttributeValueVariationPoint

AttributeValueVariationPoint contains four attributes, namely bindingTime, shortLabel, sd, and blueprintValue:

- bindingTime is described in Section 7.4.4.
- The shortLabel serves the same purpose as the shortLabel attribute of VariationPoint.

  [constr_2521] The shortLabel in AttributeValueVariationPoint shall be unique ⌈ The shortLabel must be unique within the next enclosing Identifiable, and is used to individually address variation points in the *variant rich M1 model*. ⌋*()*

  See Section 7.6.2 for details.
- The sd attribute is a stripped down version of the sd member of a VariationPoint (see Section 7.6.3).

  sd is a string that may be used by an external application to add custom data.

  There are two reasons for not using a special data group like in VariationPoint. First, a variation point for an attribute value is not as structurally significant as one for full element, so it is conceivable that there less data are needed.

  Second, if AttributeValueVariationPoint would aggregate a special data group, then the resulting XML representation would require an additional wrapper

– even though the aggregation is optional. This would be a significantly higher overhead than in the *aggregation pattern* and in the *association pattern*.

- The blueprintValue is used if the variation point is part of a blueprint. It contains a description which provides instructions how to derive appropriate objects from the blueprint. For more details on variation points in blueprints, see Section 7.6.11 and [2].

  [constr_2567] Undefined Value in Attribute Value Blueprints ⌈ If a blueprintValue is specified, then the value defined by the AttributeValueVariationPoint is not used and should therefore at least contain one term undefined which is to be refined when deriving objects from this blueprint. ⌋*()*

Both shortLabel and sd are optional. bindingTime may be omitted under certain circumstances as described in Section 7.4.4.

[constr_2575] blueprintValue in blueprints only ⌈ blueprintValue is only allowed in blueprints and may not be present in a system description.

⌋*()*

7.4.3 {Type}ValueVariationPoint

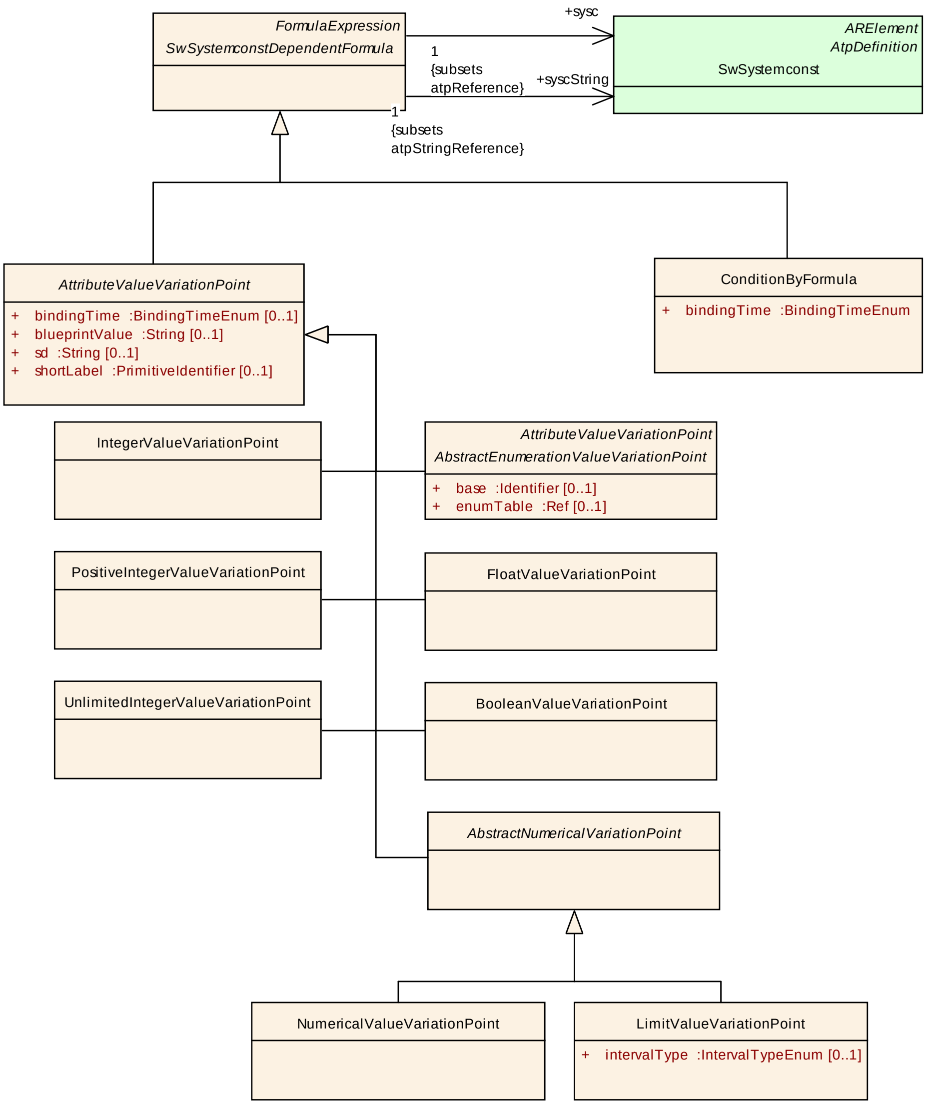


Figure 7.5: `{Type}ValueVariationPoint`

[TPS_GST_00206] Special Meta Classes for `AttributeValueVariationPoint`
⌈ The class `AttributeValueVariationPoint` comes in several different flavors, namely `IntegerValueVariationPoint`, `FloatValueVariationPoint`, `BooleanValueVariationPoint`, `LimitValueVariationPoint`, `NumericalValueVariationPoint`, `PositiveIntegerValueVariationPoint` and `UnlimitedIntegerValueVariationPoint`, as well as all concrete sub classes of the class `AbstractEnumerationValueVariationPoint`. ⌋*()*

The concrete sub classes of the class `AbstractEnumerationValueVariationPoint` are automatically generated by following the AttributeValuePattern according to the (Figure 7.6).

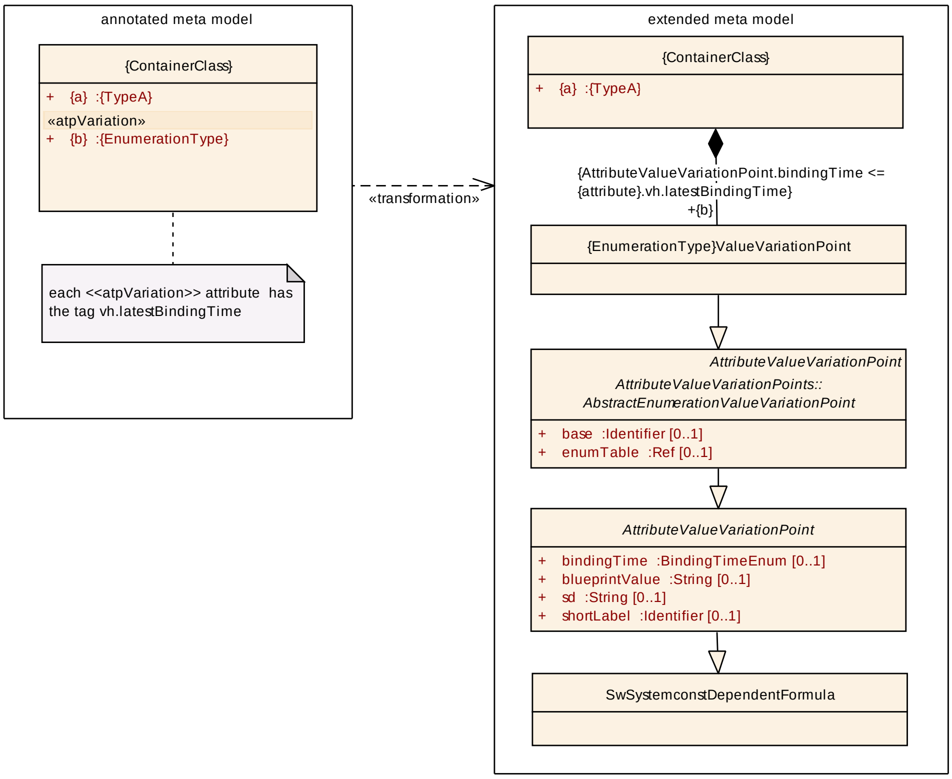


Figure 7.6: enumeration value pattern

[constr_2601] Value of AbstractEnumerationValueVariationPoint ⌈ The formula of an AbstractEnumerationValueVariationPoint shall evaluate to a value for which a mapping is defined in the EnumerationMappingTable which is referenced by the attributes base and enumTable. ⌋ *()*

Note: Typically this constraint can only be checked in a complete model during binding of variability.

[TPS_GST_00373] Default EnumerationMappingTable ⌈ If no values of base and enumTable are given for a sub class {Type}ValueVariationPoint of AbstractEnumerationValueVariationPoint then base shall be set to EnumMappingTables and enumTable shall be set to {Type}. ⌋ *()*

The default values of EnumerationMappingTable including the EnumerationMappingEntrys are available in GeneralDefinitions [17].

The reason for adding these extra classes is as follows. We could have defined the *attribute value pattern* without them, by just letting {ContainerClass} (Figure 7.4) aggregate a AttributeValueVariationPoint. But then, any trace of the *type* of the original attribute would have been lost.

7.4.4 Binding Time

[constr_2579] Binding Time in Attribute Value Pattern ⌈ The meta class AttributeValueVariationPoint has an attribute bindingTime which defines the *latest* binding time for this variation point. This binding time is further constrained by the UML tag vh.latestBindingTime that is attached to the attribute (see [TPS_GST_00190], [TPS_GST_00220], [TPS_GST_00221]):

AttributeValueVariationPoint.bindingTime ≤ *attribute*.vh.latestBindingTime ⌋*()*

The binding time for attribute values is specified in the attribute bindingTime of AttributeValueVariationPoint. Each attribute may have its own binding time.

[TPS_GST_00207] No Binding time required for Constants ⌈ The attribute bindingTime may be omitted if SwSystemconstDependentFormula specifies a single constant value for the attribute, and not an expression. That is, if the formula does not contain any references to other system constants, nor any functions or operators, just a single value. In this case, the value is fixed from the start. In all other cases, the attribute bindingTime must be present. ⌋*()*

[TPS_GST_00209] No postbuild variation for attribute values ⌈ The tag vh.latestBindingTime is limited to preCompileTime and earlier (blueprintDerivationTime, systemDesignTime, codeGenerationTime and preCompileTime) in the Attribute Value pattern. ⌋*()*

7.4.5 Multiplicity of AttributeValueVariationPoint

In an M1 AUTOSAR model, one or more {Type}ValueVariationPoint elements must be created for each variant attribute in the original {ContainerClass}. The exact number is determined as follows:

[TPS_GST_00210] Multiplicity of AttributeValueVariationPoint ⌈

- If the original attribute had a multiplicity of 1, then exactly one {Type}ValueVariationPoint is generated.
- If the original attribute was an array (i.e., it had a multiplicity of $[0 \ldots *]$, $[1 \ldots *]$ or more generally $[m \ldots n]$, then as many {Type}ValueVariationPoints must be created as there are entries in the array.

⌋*()*

In this case, the *sequential order* of the corresponding XML elements may be significant and then shall correspond to the actual succession of elements in the array.

7.4.6 XML Representation

Without variability, both the attributes {a} and {b} in Figure 7.4 would be represented in the XML schema as individual elements, each holding a constant value.

The *attribute value pattern* replaces variant attributes with a system constant expression. If this expression is just a value, then the resulting XML has the same structure as in the non-variant case (except for the binding time, but even this attribute may be omitted for such expressions). A complicated expression may of course add significant overhead compared to the non-variant case.

The shortLabel (represented as optional XML attribute SHORT-LABEL) and sd (represented as optional XML attribute SD) and bindingTime (represented as optional XML attribute BINDING-TIME) are optional and do not add any overhead to the XML representation if they are not present.

An example for the XML code that is produced by the *attribute value pattern* can be found in Figure 7.6.

7.4.7 Notes and Restrictions

1. **[TPS_GST_00211] AttributeValueVariationPoint does not support PostBuild Variation** ⌈ The binding time for an AttributeValueVariationPoint is at most *preCompileTime*. We do not support to use such a variation point with a postBuild binding time. This is because such a behavior is already covered by calibration parameters (See [TPS_GST_00209]). ⌋*()*

2. **[TPS_GST_00212] Existence of Attribute cannot be subject to Variation** ⌈ It is not possible to model the *existence* of an attribute.

   The obvious way to do this would be to move the attribute in question to a separate element, aggregate this element and then make the aggregation a variation point. ⌋*()*

   See *aggregation pattern*, Section 7.2.

3. **[TPS_GST_00213] Arrays should have the same Binding Time** ⌈ Since each element of an array is specified with a separate AttributeValueVariationPoint element, it is no longer mandatory that all array elements have the same binding times. However, it is considered good practice to use identical binding times for all array elements. ⌋*()*

4. **[TPS_GST_00214] Extending the Application of Attribute Value Pattern** ⌈ The *attribute value pattern* is only defined for attributes of type Integer, Float, Boolean, Numerical, Limit PositiveInteger and UnlimitedInteger. Any extension to other types – as long as they are covered by the expression language – would require a change in the meta model (and the meta model tool). ⌋*()*

5. **[TPS_GST_00215] Rationale for BindingTime being optional in AttributeValueVariationPoint** ⌈ The rationale for making bindingTime optional is that this makes the XML representation simpler. This is especially helpful for EvaluatedVariantSets, which use the *attribute value pattern* to define values for system constants. In a typical use case, these values are constants, not formulas. ⌋*()*

7.5 *Property Set Pattern* for Variation Points

Like the previous pattern, this one also deals with variations in attributes. However, the pattern introduced in Section 7.4 requires that every variant attribute is annotated with a stereotype ≪atpVariation≫. This also means that the M2 meta model has to decide which attribute is variant, and which is not. Such a decision is not always practical, e.g. when there are a large number of attributes, each of which may be subject to variation. The pattern which we define in this section follows a different approach.

[TPS_GST_00216] Approach on Property Set Pattern ⌈ By applying the stereotype ≪atpVariation≫ to the *meta class* that contains the attributes (and not to individual attributes of the meta class), we can define all attributes as potentially be subject to variation. Attributes are then partitioned into several sets of variant attributes, each of which has a variation point. ⌋*()*

7.5.1 Example

Consider the following example. A class named PropertiesClass has six attributes: attr1, attr2, attr3, attr4, attr5, and attr6. Of these, the first four attributes are variant, while attr5 and attr6 are invariant.

Now, one solution would be to apply ≪atpVariation≫ to the attr1, attr2, attr3, and attr4. In this case, each attribute would be its own variation point, and could be varied independently.

However, it might be that there are three different sets of values for attr1, attr2, attr3, and attr4:

	attr1	**attr2**	**attr3**	**attr4**
Set1	1	1	2	2
Set2	2	3	4	1
Set3	3	1	6	3

Table 7.3: Example for *Property Set Pattern*

The *property set pattern* allows us to specify these three sets. When the stereotype ≪atpVariation≫ is applied to PropertiesClass (in the annotated meta model), the class is transformed (in the extended meta model) into a new PropertiesClass which has *no* attributes, but aggregates one or more classes named PropertiesClassConditional which now contain the attributes[5]. Each PropertiesClassConditional aggregates a variation point, very much like {PartClass} in the aggregation pattern (see Section 7.3).

The idea is that a concrete model will contain one instance of PropertiesClass (without attributes), which aggregates *four* (not three!) instances of PropertiesClassConditional. The first three instances hold Set1, Set2, and Set3, respectively. The remaining instance of PropertiesClassConditional contains the invariant attributes, namely attr5 and attr6. Their VariationPoints must have appropriate conditions that make sure that exactly one of the first three instances PropertiesClassConditional can be selected. The last PropertiesClassConditional may omit its VariationPoint because the attributes that are defined there are invariant.

How can it be that the first three PropertiesClassConditional hold different attributes than the last one? Actually, PropertiesClassConditional contains a copy of all attributes that were in the original PropertiesClass (in the annotated meta model), but the lower multiplicity of each attribute is reduced to 0 – that is, all attributes are optional. This way, each instance of PropertiesClassConditional may hold an arbitrary subset of the original attributes. The condition is that after the variation has been bound, the *sum* of all attributes must be equal to the original set of attributes[6].

The property set pattern is actually a bit more flexible than the example shows. First, the variant attributes do not need to be in the same set; they can also be distributed over several PropertiesClassConditional classes. Second, the pattern not only applies to attributes, but also to aggregated and associated elements. Third, the pattern may be combined with the attribute value pattern (and others) to create even more powerful variant structures.

7.5.2 Description

The transformation that is involved with the *property set pattern* is more complex than the one for the previous patterns. This time, we apply the stereotype ≪atpVariation≫ to a class, not a relation or an attribute. Unlike the other patterns, a class may inherit its stereotype from another class (or may aggregate other classes), which requires special consideration.

Hence, we describe the *property set pattern* in two steps. First, we show how the transformation works for a class which is explicitly tagged in the meta model with a stereotype ≪atpVariation≫ and does not derive from a class that has the same stereotype. In a second step, we extend this description to show what happens if

[5]As we will see in the next section, the actual transformation is a bit more involved, but the general idea is the same as outlined in this example.

[6]For completeness: attributes that were optional in the pure meta model may still be omitted.

a class is not explicitly tagged with ≪atpVariation≫, but is *derived* from such a class and therefore implicitly has the stereotype.

7.5.2.1 ≪atpVariation≫ Applied Directly to a Property Set Class

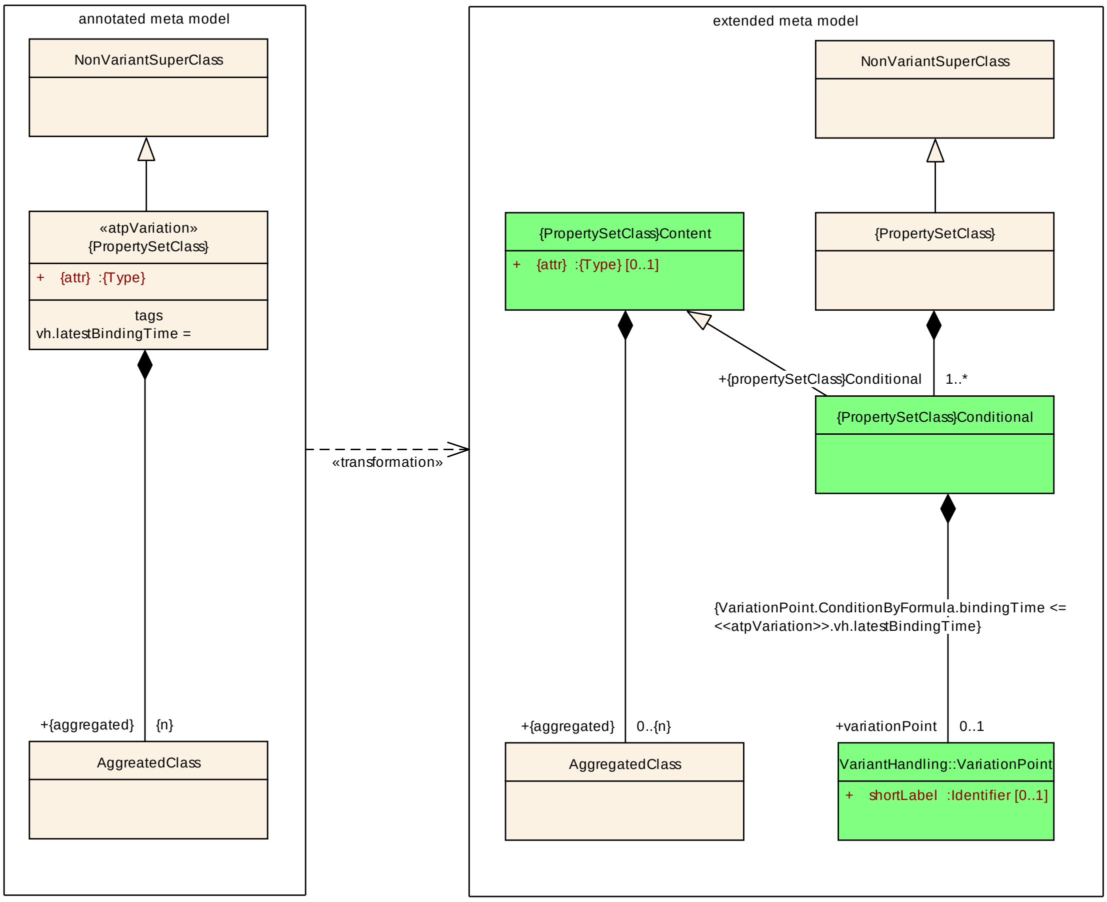


Figure 7.7: *Property Set Pattern* without inheritance in {PropertySetClass}

The annotated meta model for this transformation is centered around {PropertySetClass}:

1. {PropertySetClass} is based on NonVariantSuperClass, which will not be changed by this pattern.
2. Class {PropertySetClass} has the stereotype ≪atpVariation≫ and contains an attribute named {attr}.
3. {PropertySetClass} aggregates AggregatedClass. AggregatedClass itself is not changed when the pattern is applied, although it will be aggregated by a different class afterwards.

[TPS_GST_00217] Transformation defined by Property Set Pattern ⌈ The transformation works as follows:

1. All attributes and the stereotype ≪atpVariation≫, are removed from {PropertySetClass}.
2. The transformation generates a new class {PropertySetClass}Content which contains the original attribute(s) of {PropertySetClass}, but now with a lower multiplicity of 0.

   The change in the multiplicity stems from the fact that this class is designed to hold an arbitrary subset of the attributes that were originally in {PropertySetClass}.

   {PropertySetClass}Content can be seen as a kind of a clone of {PropertySetClass} that lacks the inheritance of NonVariantSuperClass and has a different multiplicity for its attribute.
3. A new class named {PropertySetClass}Conditional is generated. {PropertySetClass}Conditional derives from {PropertySetClass}Content, and aggregates a VariationPoint.

   Because it inherits from {PropertySetClass}Content, each instance of {PropertySetClass}Conditional holds a subset of the attributes that were originally in {PropertySetClass} in the *annotated meta model*.
4. {PropertySetClass} aggregates an arbitrary number of {PropertySetClass}Conditional elements. The idea is that a particular instance of {PropertySetClass}Conditional in the *extended meta model* contains a subset of the original attributes of {PropertySetClass} in the *annotated meta model*. But *after the binding*, the disjoint sum of all attributes given in {PropertySetClass}Conditional instances must yield the full set of attributes that were in {PropertySetClass} in the *annotated meta model*.
5. The VariationPoint finally decides whether a {PropertySetClass}Conditional is included in a particular variant. That is, the aggregation from {PropertySetClass} to {PropertySetClass}Conditional is itself subject to variation.
6. AggregatedClass is now aggregated by {PropertySetClass}Content, with a lower multiplicity of 0. The reason for the change in the multiplicity is that aggregated classes are handled in the same way as attributes.
7. (Not shown in the above diagram) References to {PropertySetClass} in the annotated meta model still point to {PropertySetClass} in the extended meta model.

⌋()

7.5.2.2 ≪atpVariation≫ Applied to Superclass of a Property Set Class

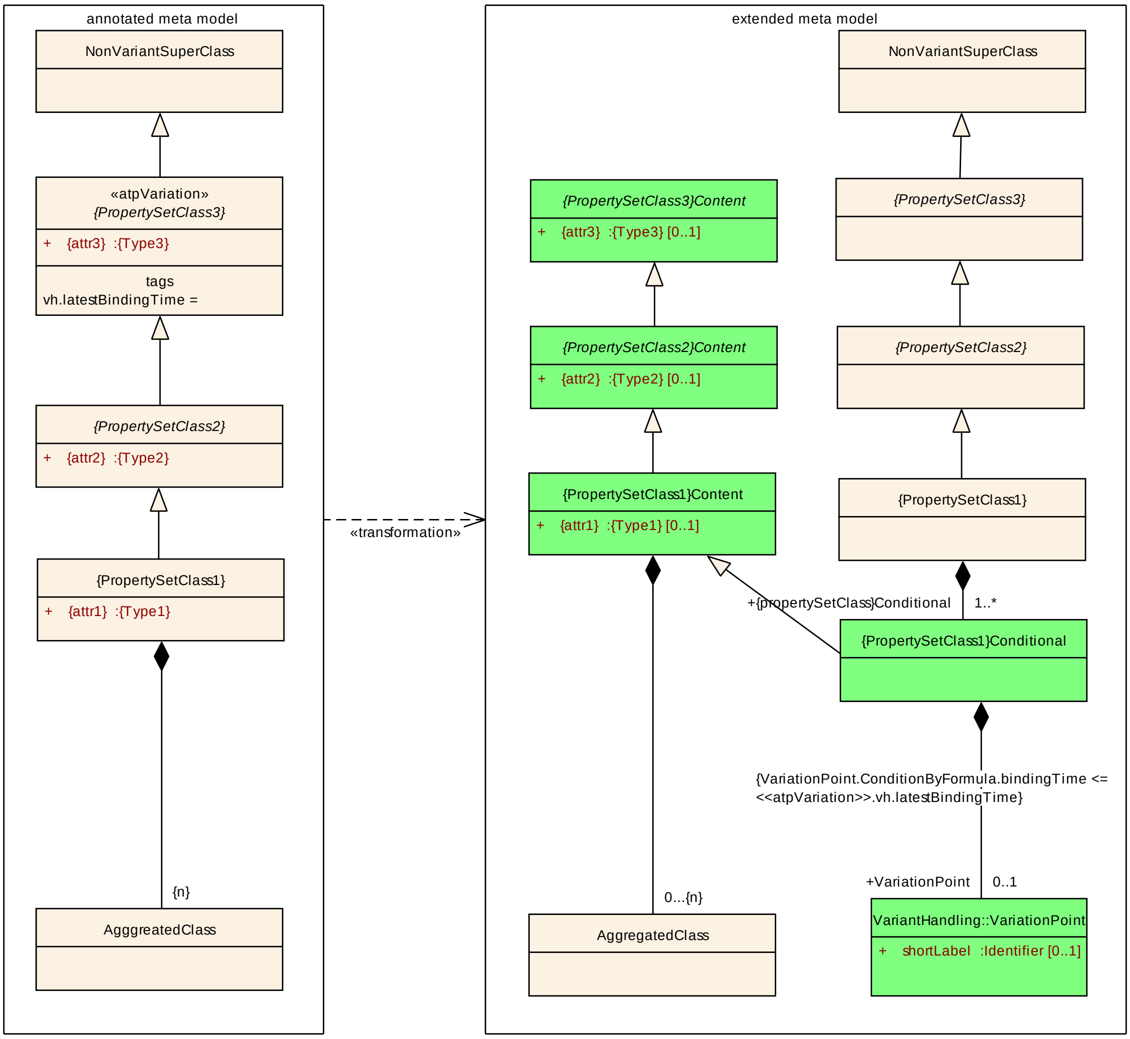


Figure 7.8: *Property Set Pattern* with inheritance in `{PropertySetClass}`

[TPS_GST_00218] Property Set pattern and Inheritance ⌈ When the stereotype ≪`atpVariation`≫ is applied to a superclass of the property set class, then the situation becomes slightly more complex:

1. `NonVariantSuperClass` and `AggregatedClass` are the same as before.
2. `{PropertySetClass1}` plays the role that was occupied by `{PropertySetClass}` in the previous section. However, `{PropertySetClass1}` now derives from a class `{PropertySetClass3}`, which is also tagged with the stereotype ≪`atpVariation`≫. `{PropertySetClass2}` sits between those two classes.

⌋ *()*

The actual transformation does not differ much between Figures 7.8 and 7.7. The only new aspect in Figure 7.8 is that for each property set class *up to* `{PropertySetClass3}`, we create a hierarchy of `{PropertySetClass}Content` classes. These classes retain the attributes of the original classes, as well as their aggregations and association relations.

7.5.2.3 Constraints

The property set pattern needs a constraint that makes sure that for any variant, the set of all attribute values defined with this method is complete *and* there are no double definitions.

[constr_2506] Attributes in property set pattern ⌈ On M1 level, let C be the set of attributes (or aggregated elements[7]) that would have been in the original[8] {PropertySetClass} object, and $C_1, \ldots, C_n$ be the respective sets of attributes in the {PropertySetClass}Conditional objects **for a given variant**. Also, let C' be the set of non-optional attributes, e.g., those with a lower multiplicity of 1.

We define the following constraints:

$$\forall C_i, C_j \text{ in the given variant} : C_i \cap C_j = \emptyset$$
$$C' \subseteq C_1 \cup C_2 \cup \ldots C_n \subseteq C$$

⌋*()*

One might wonder why there is no class named PropertySetClass_invariant for those attributes that never change. The reason is that such a class can easily be realized by using a {PropertySetClass}Conditional which does *not* aggregate VariationPoint. Such a {PropertySetClass}Conditional is nonvariant, i.e. it always exists.

7.5.3 Binding Time

[constr_2580] Binding Time in Property Set Pattern ⌈ The meta class VariationPoint has an attribute bindingTime which defines the *latest* binding time for this variation point. This binding time is further constrained by the UML tag vh.latestBindingTime that is attached to the meta class which is marked as ≪atpVariation≫ (see [TPS_GST_00190], [TPS_GST_00220], [TPS_GST_00221]):

VariationPoint.bindingTime ≤ *meta class*.vh.latestBindingTime ⌋*()*

[TPS_GST_00219] Binding Time for Property Set Pattern ⌈ The latest binding time for the *property set pattern* is *PostBuild*. ⌋*()*

[7]The constraints defined in this section apply to attributes as well as aggregates elements, due to the close relationship of the two in the AUTOSAR meta model. For simplicity, the rest of this section talks about “attributes” only.

[8]In this context, “original” means {PropertySetClass} without the stereotype ≪atpVariation≫. In other words, “original” means “as in the pure meta model”.

7.5.4 Multiplicity of Attributes and aggregated elements

[TPS_GST_00222] Multiplicity in Property Set Pattern ⌈ In the *property set pattern*, attributes (and aggregated elements) are moved from `{PropertySetClass}` in the *annotated meta model* to `{PropertySetClass}Conditional` in the *extended meta model*.

With this move, the lower multiplicity always changes to 0. ⌋*()*

7.5.5 XML Representation

An example for the XML code that is produced by the *property set pattern* can be found in Figure 7.7.

Despite the perceived complexity of the pattern in Figures 7.7 and 7.8, the impact of the *property set pattern* on the XML code is rather limited. As Example 7.7 shows, the property set pattern adds a `-VARIANTS` wrapper around the attributes, and a `-CONDITIONAL` element for each (sub)set of attribute values. `-CONDITIONAL` also contains a `VARIATION-POINT` element.

So, the main impact on the XML code is the duplication of attribute values, but the overhead introduced by variant handling should only add a few elements.

7.5.6 Comparison with Other Patterns

Both this and the *attribute value pattern* (Section 7.4) are aimed at attributes, but with several differences:

- The *prototype set pattern* provides a way to *group* attributes that belong together.
- The *property set pattern* is more flexible in that variability is not restricted to those attributes for which the M2 meta model "allows" variability. There is however a catch: because of the higher flexibility, it is not a priori clear which attributes will be invariant, and which not.
- The *attribute value pattern* may use an expression to define the value of an attribute, while the *property set pattern* can only use a fixed value (more precisely, a fixed value *per variant*). However, the *property set pattern* may be combined with the *attribute value pattern* to achieve this effect.
- The *attribute value pattern* is available for a limited number of data types only, namely `Integer`, `Float`, `Boolean`, `Numerical`, `PositiveInteger` and `UnlimitedInteger`. The *property set pattern* has no such limitation.
- If an attribute is optional, then the *property set pattern* may also decide whether an attribute exists or not. This is different from the *attribute value pattern*, which can only change the value of an attribute.

Furthermore, the *Property Set Pattern* differs from the *Aggregation Pattern* and the *Association Pattern* in that the former pattern works on a number of attributes, aggregations and associations at once, while the latter patterns determine the existence of a single aggregation or aggregation only.

7.5.7 Combining the *attribute value pattern* and the *property set patterns*

In the previous section, we said that the *property set pattern* cannot specify an expression to define the value of an attribute. While this is true, there is a way to avoid this restriction, namely by combining the *property set pattern* with the *attribute value pattern*.

In this case, the *property set pattern* would allow to partition the complete set of attributes into several disjoint subsets. Each of these individual attributes may have the stereotype ≪atpVariation≫, which means that the *attribute value pattern* is applied, and the value of the attribute may be determined by an expression.

Furthermore, since an attribute may occur in multiple sets (on M1 level), there may be multiple expressions for determining the value of a particular attribute, each tailored for a particular variant.

7.6 VariationPoint

The structure of a VariationPoint is illustrated in Figure 7.9.

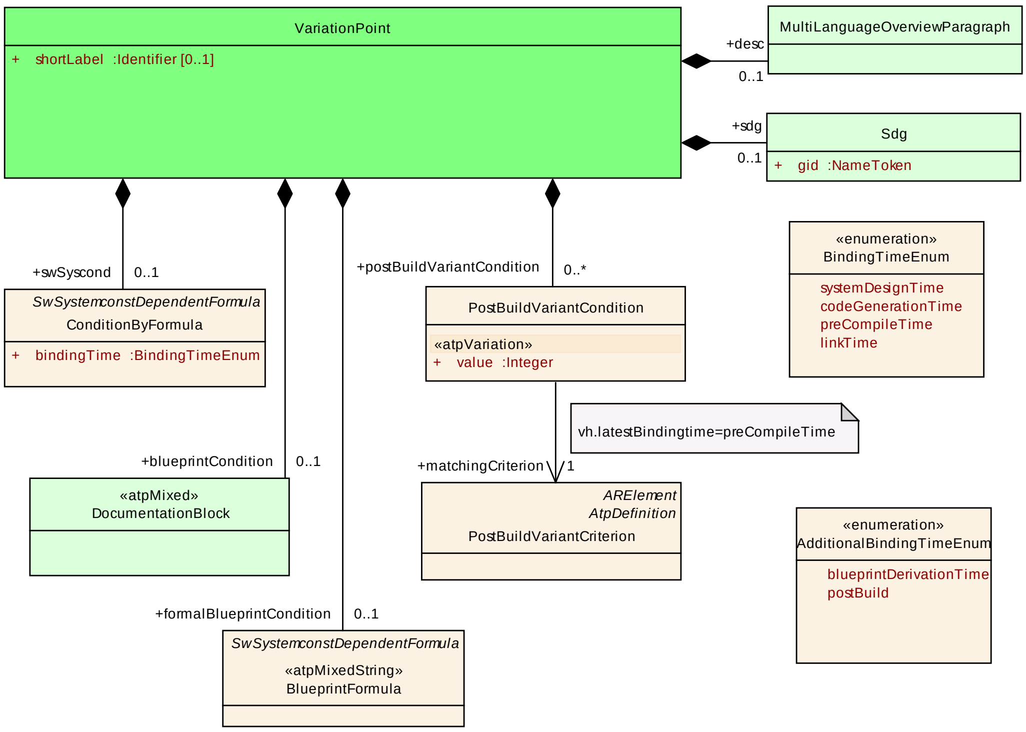


Figure 7.9: Variation Point

Class	**VariationPoint**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class represents the ability to express a "structural variation point". The container of the variation point is part of the selected variant if swSyscond evaluates to true and each postBuildVariantCriterion is fulfilled.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
desc	MultiLanguageOverviewParagraph	0..1	aggr	This allows to describe shortly the purpose of the variation point. **Tags:** xml.sequenceOffset=20
blueprintCondition	DocumentationBlock	0..1	aggr	This represents a description that documents how the variation point shall be resolved when deriving objects from the blueprint. Note that variationPoints are not allowed within a blueprintCondition. **Tags:** xml.sequenceOffset=28
formalBlueprintCondition	BlueprintFormula	0..1	aggr	This denotes a formal blueprintCondition. This shall be not in contradiction with blueprintCondition. It is recommanded only to use one of the two. **Tags:** xml.sequenceOffset=29
postBuildVariantCondition	PostBuildVariantCondition	*	aggr	This is the set of post build variant conditions which all shall be fulfilled in order to (postbuild) bind the variation point. **Tags:** xml.sequenceOffset=40
sdg	Sdg	0..1	aggr	An optional special data group is attached to every variation point. These data can be used by external software systems to attach application specific data. For example, a variant management system might add an identifier, an URL or a specific classifier. **Tags:** xml.sequenceOffset=50
shortLabel	Identifier	0..1	attr	This provides a name to the particular variation point to support the RTE generator. It is necessary for supporting splitable aggregations and if binding time is later than codeGenerationTime, as well as some RTE conditions. It needs to be unique with in the enclosing Identifiables with the same ShortName. **Tags:** xml.sequenceOffset=10
swSyscond	ConditionByFormula	0..1	aggr	This condition acts as Binding Function for the VariationPoint. Note that the mulitplicity is 0..1 in order to support pure postBuild variants. **Tags:** xml.sequenceOffset=30

Table 7.4: VariationPoint

7.6.1 The structure of class VariationPoint

The class VariationPoint holds information about a variation point in the *aggregation pattern* (Section 7.2), the *association pattern* (Section 7.3), and the *property set pattern* (Section 7.5)[9].

A VariationPoint aggregates a ConditionByFormula, a PostBuildVariantCondition and a DocumentationBlock in the role blueprintCondition. These three "branches" are independent of each other. As the multiplicities in Figure 7.9 shows, they are also all optional:

- **[TPS_GST_00245] PreBuild variation point** ⌈ If a variation point aggregates ConditionByFormula, then this variation point is a *PreBuild* variation point. ⌋ *()* See Section 7.6.5 for details.
- **[TPS_GST_00246] PostBuild Variation Point** ⌈ If a variation point aggregates a PostBuildVariantCondition, then this variation point is a *PostBuild* variation point. ⌋ *()* See Section 7.6.6 for details.
- **[TPS_GST_00247] BlueprintDerivation Variation Point** ⌈ If a variation point aggregates a DocumentationBlock in the role blueprintCondition, then this variation shall be resolved when deriving objects. ⌋ *()*Refer to [2] for details.
- **[TPS_GST_00248] Combined PreBuild and PostBuild Variation Point** ⌈ A variation point may also aggregate *both* ConditionByFormula and PostBuildVariantCondition. In this case, it is both a *PreBuild* and a *PostBuild* variation point. ⌋ *()* See Section 7.6.5 for details.
- **[TPS_GST_00249] Variation Point without Conditions** ⌈ Technically, a variation point may also aggregate *none* of the above classes. In this case, there is no variation at all, and the element to which the variation point is attached to always exists. ⌋ *()*

  This is equivalent to a *PreBuild*-only variation point where ConditionByFormula has binding time systemDesignTime, and who's formula always evaluates to *true*.

[TPS_GST_00250] Multiplicity of VariationPoint ⌈ In all patterns, the VariationPoint element has a multiplicity of $[0 \ldots 1]$, that is, it is optional. If the variation point is omitted, then there is no variation and the respective element always exists. ⌋ *()*

[constr_2557] No VariationPoints where vh.latestBindingTime set to BlueprintDerivationTime in system configurations ⌈ Blueprints are **not** part of a system configuration. In consequence of this, in a system configuration there shall be no VariationPoint where vh.latestBindingTime is restricted to BlueprintDerivationTime by the meta model. ⌋ *()*

[9] The *attribute value pattern* (Section 7.4) is simpler and does not make use of the class VariationPoint. Furthermore, its latest binding time is CompileTime, so many of the issues discussed in this section do not apply to this pattern.

[constr_2558] If `vh.latestBindingTime` is `BlueprintDerivationTime` then there shall only be `blueprintCondition`/`blueprintValue` ⌈ VariationPoints with vh.latestBindingTime restricted to BlueprintDerivation shall not have swSysCond nor postbuildVariantCondition. ⌋*()*

[constr_2559] No nested `VariationPoint` ⌈ As blueprintCondition is a DocumentationBlock it could again contain VariationPoints and therefore would allow nesting of VariationPoints. This is not intended and shall not be used. ⌋*()*

7.6.2 `shortLabel` in `VariationPoint`

VariationPoint has a single optional attribute shortLabel that implements a name for the variation point.

[constr_2514] `shortLabel` in `VariationPoint` must be unique ⌈ The combination of shortName and shortLabel shall be unique within the next enclosing Identifiable {WholeClass}. In case the shortName does not exist on the {PartClass} the shortLabel is unnecessary. In case the shortName of the {PartClass} is unique in the context of the {WholeClass} the shortLabel is unnecessary. ⌋*()*

For example, in the aggregation pattern (Section 7.2), this enclosing Identifiable as usually {WholeClass}.

[TPS_GST_00251] Variant Rich Model Violates [constr_2508] ⌈ According to [TPS_GST_00097], AUTOSAR would use the attribute shortName of the next enclosing Identifiable as a unique name. This does not work with variation points. The reason for this is rooted in the difference between the *variant rich M1 model* and the *bound M1 model*.

The *variant rich M1 model* may define several alternative variants for one aggregation. As the term "alternatives" implies, only one of them is left in the *bound M1 meta model* but all have the same shortName.

Therefore a (not-yet-bound) *variant rich M1 model violates* AUTOSAR's consistency conditions ([constr_2508]) by having multiple elements with the same shortName. This is only feasible because we require that the *bound M1 model* (and the associated code) will eventually adhere to those consistency rules ([constr_2503]).

[constr_2508] is substituted by [constr_2512] for variant rich models. ⌋*()*

There are several situations where it is necessary to individually address variations in the *variant rich M1 model* that have the same shortName:

- **[TPS_GST_00252] Split/Merge of Variant Rich Model** ⌈ If an aggregation has the stereotype ≪atpSplitable≫. The use case for this is that particular variants are held in a separate artifact. In order to merge such separate artefacts, it is necessary not only to consider shortName but also the shortLabel of the particular variants of an Identifiable ([constr_2512]). ⌋() For more details about splitable elements refer to Section 2.3.2.

- **[TPS_GST_00253] Distinguish codeGenerationTime Variation Points in RTE** ⌈ If binding time is codeGenerationTime or later, the RTE needs to distinguish between the individual variants if preCompileTime variability is implemented.⌋*()*
- **[TPS_GST_00254] Referring to Variation Points from Outside** ⌈ It is often necessary to refer to individual variation point from the *outside*. For example, a configuration management system might need to identify individual variation points for traceability. ⌋*()*

Also, since shortLabel is an optional element, it has no impact on the size or complexity of the XML if it is not present.

[constr_2512] shortName uniqueness constraint for variants ⌈ shortName + shortLabel of a variant element must be unique within the name space established by the surrounding Identifiable. ⌋*()*

The shortLabel in the VariationPoint is technically only required when VariationPoints are used to switch between Identifiables with identical shortNames, see listing F.1 and F.3. If additionally those Identifiables are described in partial models the shortLabels in the partial models indicates which elements belong together, see listing F.1 and F.2.

If the shortLabel in the Identifiable is used to vary the existence of the Identifiable without an equally named alternative the shortLabel in the VariationPoint is not required but may exists. If the shortLabel is defined and the Identifiable is described in partial models it is required to repeat the shortLabel consistently, see listing F.2. If the shortLabel is not defined it shall not occur in any of the partial models.

7.6.3 sdg in VariationPoint

The class VariationPoint aggregates an optional sdg object (see Section 4.5.1) which can be used by external software systems to attach application specific data to a variation point. For example, a variant management system might add an identifier, an URL or a specific classifier to a variation point.

Since such data is highly application and vendor specific, it cannot be standardized, and a special data group is necessary instead.

Also, since sdg is an optional element, it has not impact on the size or complexity of the XML representation if it is not present.

7.6.4 (Latest) Binding Time

In Section 7.1, we have seen that each variation point has a binding time. Binding times (see [16]) can be further categorized as *PreBuild* and *PostBuild* binding times:

- **[TPS_GST_00255] Definition of *PreBuild* Variation Point** ⌈ This category contains the following binding times: systemDesignTime, codeGenerationTime, preCompileTime, and linkTime.

  A concrete variation point (i.e., on M1 level) is subject to *PreBuild* variation if it contains a ConditionByFormula element. Its binding time is specified in the bindingTime attribute of the ConditionByFormula element. ⌋*()* For more details see Section 7.6.5.

- **[TPS_GST_00360] Definition of *PreBuild* Variation Point with Blueprint conditions** ⌈ This category contains only a single binding time, namely blueprintDerivationTime.

  A concrete variation point (i.e., on M1 level) is subject to *PreBuild* variation with blueprintDerivationTime if it contains a blueprintCondition and / or formalBlueprintCondition attribute. ⌋*()* For more details see Section 7.6.11.2.

- **[TPS_GST_00256] Definition of *PostBuild* Variation Point** ⌈ This category contains only a single binding time, namely PostBuild.

  A concrete variation point (i.e., on M1 level) is *PostBuild* if it contains a PostBuildVariantCondition element. Since there is only one binding time for *PostBuild*, no particular attribute for specifying the binding time is necessary. ⌋*()* For more details see Section 7.6.6.

The binding time is further constrained by the tag vh.latestBindingTime that was introduced in the patterns earlier in sections 7.2 to 7.5:

[TPS_GST_00257] BindingTime constrained by vh.latestBindingTime ⌈

- If vh.latestBindingTime = PostBuild, then a variation point on M1 level may have any binding time. It may be a *PreBuild* or a *PostBuild* variation point (or both, and may aggregate ConditionByFormula or PostBuildVariantCondition.

- If vh.latestBindingTime < PostBuild, then a variation point on M1 level can only be a *PreBuild*, but *not* a *PostBuild* variation point. Obviously, it may only aggregate a ConditionByFormula in this case.

- If vh.latestBindingTime = BlueprintDerivationTime, then a variation point on M1 level may only aggregate a DocumentationBlock in the role blueprintCondition and / or formalBlueprintCondition.

  See also [constr_2557] and [constr_2558].

⌋*()*

It is obvious that the binding time of a *PreBuild* variation point (that is, the value of the attribute `bindingTime` of `ConditionByFormula`), must never exceed `vh.latestBindingTime`.

7.6.5 *PreBuild* Variation Points

Class	≪atpMixedString≫ **ConditionByFormula**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class represents a condition which is computed based on system constants according to the specified expression. The expected result is considered as boolean value. The result of the expression is interpreted as a condition. • "0" represents "false"; • a value other than zero is considered "true"			
Base	ARObject, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
bindingTime	BindingTimeEnum	1	attr	This attribute specifies the point in time when condition may be evaluated at earliest. At this point in time all referenced system constants shall have a value. **Tags:** xml.attribute=true

Table 7.5: ConditionByFormula

All the information that is necessary to implement a *PreBuild* variation point is provided by the class `ConditionByFormula`:

- `ConditionByFormula` derives from `SwSystemconstDependentFormula`. This class implements the (boolean) formula that determines whether the variation point is “on” or “off”.

  The formula language is defined in Section 4.8. See also Section 7.6.8 for further explanation how formulas are used in the variant handling concept.

- `ConditionByFormula` has a single attribute, `bindingTime`, which defines the latest binding time for this variation point. The binding times are described in more detail in [16].

[TPS_GST_00258] Binding `VariationPoint`s early ⌈ A concrete software system *may* bind a variation point at an earlier binding time if this is technically feasible, and within contractual limits[10]. We define the additional restriction

```
Variation Point Binding Times later than System
Design Time are part of the contract.
```

[10]For a definition of contract phases, see Chapter 3.1 in the RTE specification [18].

According to this restriction, the RTE Generator is not allowed to resolve the variability in the application header file even if the variability is already chosen in the input of the RTE.

If the binding time is *systemDesignTime*, then the variability is not considered part of the contract phase, and it must be bound properly during *systemDesignTime* before the contract. ⌋*()*

7.6.6 *PostBuild* Variation Points

Class	**PostBuildVariantCondition**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class specifies the value which must be assigned to a particular variant criterion in order to bind the variation point. If multiple criterion/value pairs are specified, they shall all match to bind the variation point. In other words binding can be represented by `(criterion1 == value1) && (condition2 == value2) ...`			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
matchingCriterion	PostBuildVariantCriterion	1	ref	This is the criterion which needs to match the value in order to make the PostbuildVariantCondition to be true.
value	Integer	1	attr	This is the particular value of the post-build variant criterion. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime

Table 7.6: PostBuildVariantCondition

Class	**PostBuildVariantCriterion**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class specifies one particular PostBuildVariantSelector. **Tags:** atp.recommendedPackage=PostBuildVariantCriterions			
Base	ARElement, ARObject, AtpDefinition, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
compuMethod	CompuMethod	1	ref	The compuMethod specifies the possible values for the variant criterion serving as an enumerator.

Table 7.7: PostBuildVariantCriterion

A *PostBuild* variation point contains multiple `PostBuildVariantCondition`s in the role `postBuildVariantCondition`, which in turn has a reference to a `PostBuildVariantCriterion`. Unlike a *PreBuild* variation point, which is governed by a formula defined in ConditionByFormula, a *PostBuild* variation point is governed by the combination of postBuildConditions.

[constr_2517] postbuildVariantCondition only for PostBuild ⌈ Aggregation of PostBuildVariantCondition in VariationPoint is only allowed if the annotated model states vh.latestBindingTime to PostBuild. ⌋*()*

[TPS_GST_00260] PreBuild configuration of PostBuild criteria ⌈ The attribute value of PostBuildVariantCondition is subject to *PreBuild* variation. It uses the *attribute value pattern*, hence its latest binding time is preCompileTime. That is, the value which will be compared with the contents of PostBuildVariantCriterion is computed[11] at preCompileTime (at most).

The actual comparison with the contents of PostBuildVariantCriterion, however, is done based on the result at startup of the ECU.⌋*()*

[TPS_GST_00259] Evaluating PostBuildVariantCondition ⌈ A VariationPoint element may aggregate any number of PostBuildVariantCondition in the role postBuildVariantCondition. A logical *and* is implied between all these elements: The *PostBuild* variation point is "enabled" if for all postBuildVariantConditions the value defined in PostBuildVariantCondition matches the value provided by RTE for PostBuildVariantCriterion (see [SWS_Rte_06612]) ⌋*()*

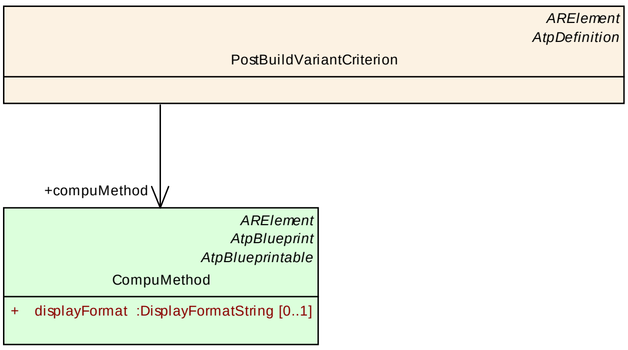


Figure 7.10: PostbuildVariantCriterion

[TPS_GST_00261] Possible Values for PostBuildVariantCriterion ⌈ A PostBuildVariantCriterion also refers to a compuMethod which specifies the possible values for the criterion and the conversion between the physical and the internal representation of data (see the *Software Component Template* [19] [TPS_SWCT_01243], [TPS_SWCT_01278] for details).⌋*()*

The RTE is responsible for managing the PostBuildVariantCriterion values ([SWS_Rte_06612]).

[11] It may be an expression rather than a constant value or a single system constant.

7.6.7 System Constants

For *PreBuild* variation points, the binding function depends on SwSystemconst. Such a system constant is basically a name/value pair. shortName, dataConstr and compuMethod for a system constant are defined in SwSystemconst.

[TPS_GST_00262] Representation of SwSystemconst ⌈ compuMethod in the SwDataDefProps of SwSystemconst is intended only to support appropriate representation of the values in tools and documentation. The values shall always be set as internal representation. ⌋*()*

For more details please refer to [19].

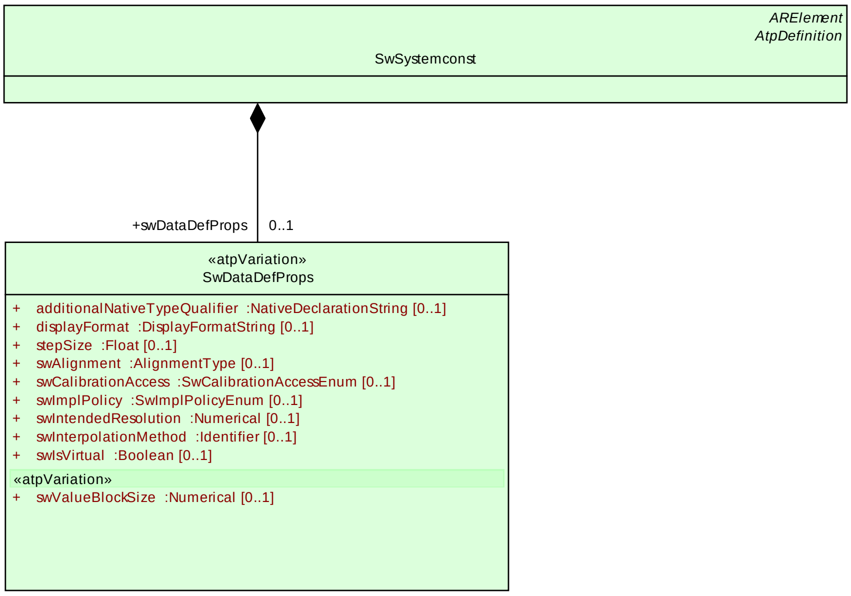


Figure 7.11: Defintion of a SwSystemconst

Class	**SwSystemconst**			
Package	M2::MSR::DataDictionary::SystemConstant			
Note	This element defines a system constant which serves an input to select a particular variation point. In particular a system constant serves as an operand of the binding function (swSyscond) in a Variation point. Note that the binding process can only happen if a value was assigned to to the referenced system constants. **Tags:** atp.recommendedPackage=SwSystemconsts			
Base	ARElement, ARObject, AtpDefinition, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
swDataDefProps	SwDataDefProps	0..1	aggr	This denotes the data defintion properties of the system constant. In particular it is the limits and - in case the system constant is an enumeration - the compu method. **Tags:** xml.sequenceOffset=40

Table 7.8: SwSystemconst

[TPS_GST_00263] Assigning values to SwSystemconst ⌈ In order to choose variants, values need to be assigned to SwSystemconst. Note that the values shall always be specified as "internal values". This is done in SwSystemconstValue.⌋*()*

[constr_2594] Cyclic value assignments to SwSystemconst is not allowed ⌈ It is explicitly forbidden to assign values to SwSystemconst which in turn depend directly or indirectly on this value assignment. ⌋*()*

Cyclic value assignment to SwSystemconst can not be resolved due to the cyclic dependency of the values.

For more details refer to Section 7.8.

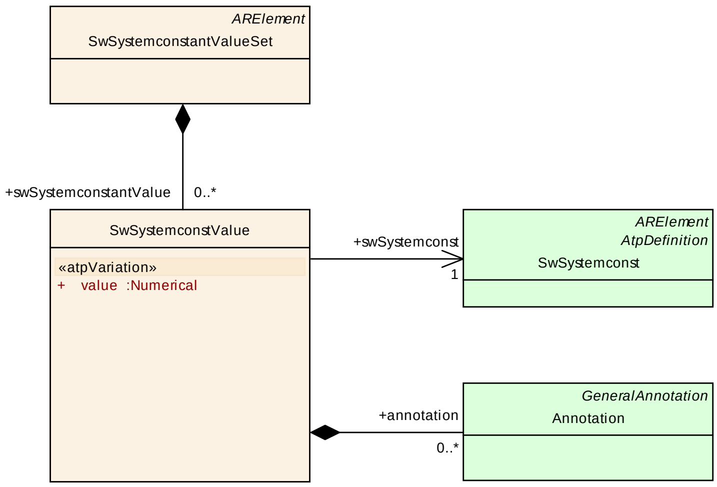


Figure 7.12: Assigning a value to a SwSystemconst

Class	**SwSystemconstValue**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class assigns a particular value to a system constant.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
annotation	Annotation	*	aggr	This provides the ability to add information why the value is set like it is. **Tags:** xml.sequenceOffset=30
swSystem const	SwSystemconst	1	ref	This is the system constant to which the value applies. **Tags:** xml.sequenceOffset=10

value	Numerical	1	attr	This is the particular value of a system constant. It is specified as Numerical. Further restrictions may apply by the definition of the system constant. The value attribute defines the internal value of the SwSystemconst as it is processed in the Formula Language. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime xml.sequenceOffset=20

Table 7.9: SwSystemconstValue

7.6.8 Application of Formulas in Variation Points

Binding of variation points is performed by evaluating the formula in the variation point. These formula can be one of the subclasses according to Figure 7.13.

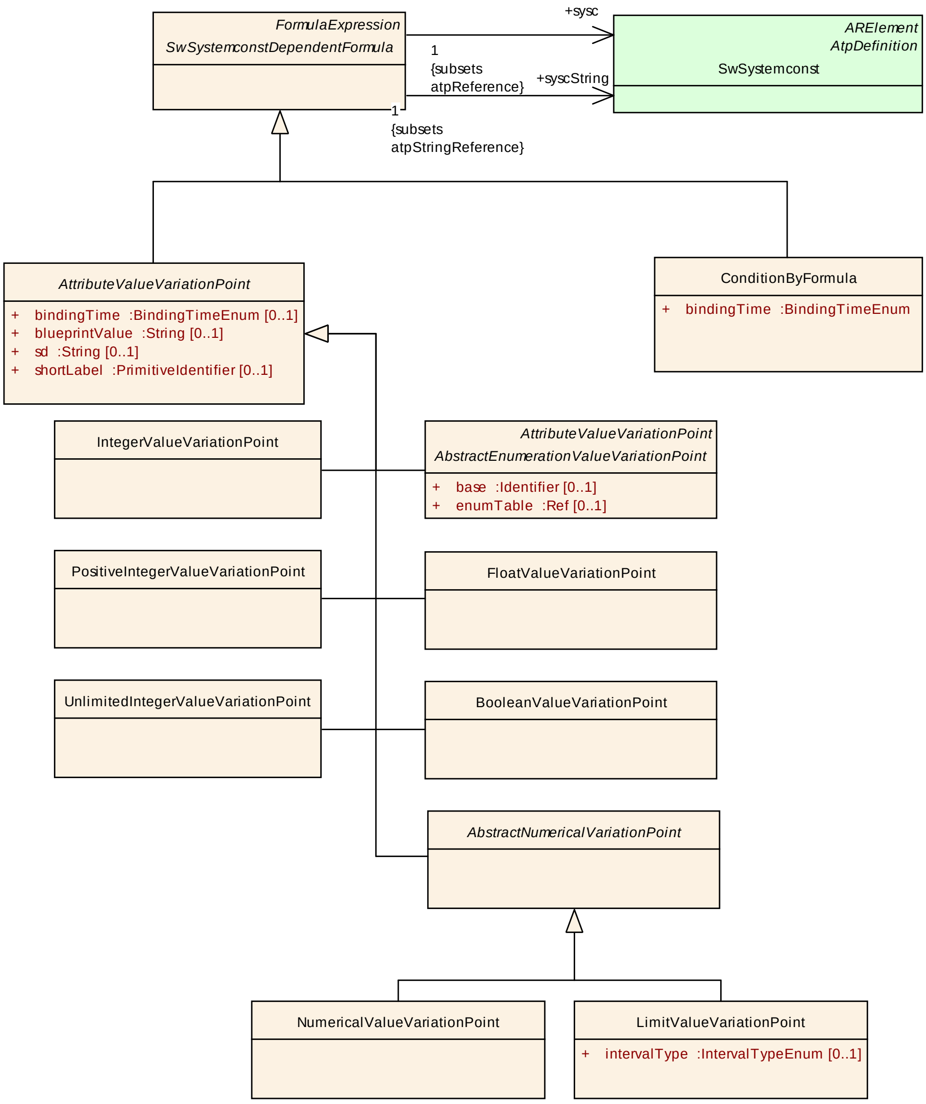


Figure 7.13: SwSystemconstDependentFormula

[TPS_GST_00264] Purpose of SwSystemconstDependentFormula ⌈ A SwSystemconstDependentFormula element is a formula which uses system constants by the reference sysc to SwSystemconst) as operands. Note that the multiplicity of 1 in the diagram is a technicality (see [TPS_GST_00032]); a formula may actually use more than one system constants. ⌋*()* (See Figure 7.13)

[TPS_GST_00265] System Constants in Formula ⌈ SwSystemconstDependentFormula.sysc reflects the internal value of the SwSystemconst.

SwSystemconstDependentFormula.syscString reflects the string representation value of the SwSystemconst. This is in particular the symbol for representation of a CompuScale in C determined according to [TPS_SWCT_01431]. ⌋*()*

Examples of correct expressions with references are:

```
<APPLICATION-VALUE-SPECIFICATION>
  <SW-VALUE-CONT>
    <SW-VALUES-PHYS>
```

```
      <VF>
        <SYSC-REF DEST="SW-SYSTEMCONST">/S/SY_ZYLZA</SYSC-REF>
      </VF>
    </SW-VALUES-PHYS>
  </SW-VALUE-CONT>
</APPLICATION-VALUE-SPECIFICATION>
```

The Formula Language, which is serialized above inside the <VF>-Tag, is defined after the replacement of ARXML references, i.e. the ARXML above will be transformed into the following expression:

```
reference("SW-SYSTEMCONST:/S/SY_ZYLZA")
```

which is then accepted as correct SwSystemconstDependentFormula.

```
...
      <VF>
        <SYSC-REF DEST="SW-SYSTEMCONST">/S/SY_ZYLZA</SYSC-REF>
      + <SYSC-REF DEST="SW-SYSTEMCONST">/S/SY_TURBO</SYSC-REF>
      </VF>
...
```

is transformed into:

```
reference("SW-SYSTEMCONST:/S/SY_ZYLZA") + reference("SW-SYSTEMCONST:/S/SY_TURBO")
```

```
...
      <VF>defined(<SYSC-REF DEST="SW-SYSTEMCONST">/S/SY_ZYLZA</SYSC-REF>)</VF>
...
```

is transformed into:

```
defined(reference("SW-SYSTEMCONST:/S/SY_ZYLZA"))
```

```
...
      <VF>1 / <SYSC-REF DEST="SW-SYSTEMCONST">/S/SY_ZYLZA</SYSC-REF></VF>
...
```

is transformed into:

```
1 / reference("SW-SYSTEMCONST:/S/SY_ZYLZA")
```

```
<VARIATION-POINT>
  <SW-SYSCOND>
   defined(<SYSC-REF DEST="SYSTEM-CONSTANT">SY_COUNT<SYSC-REF>)
   &amp;&amp; <SYSC-REF DEST="SYSTEM-CONSTANT">SY_COUNT<SYSC-REF> &lt; 10
  </SW-SYSCOND>
<VARIATION-POINT>
```

Please note, that this example shows that markup characters ("<" and "&") need to be represented as XML entities when the formula is serialized as ARXML. The above formula is transformed into:

```
defined(reference("SW-SYSTEMCONST:SY_COUNT") &&
        reference("SW-SYSTEMCONST:SY_COUNT") < 10
```

The formula language is described in detail in Section 4.8. In this section, we concentrate on the variant handling related classes that are derived from SwSystemconstDependentFormula, namely AttributeValueVariationPoint and ConditionByFormula:

ConditionByFormula is aggregated by VariationPoint and decides whether the element to which the VariationPoint is attached actually exists. This is used in all patterns except the *attribute value pattern*.

The return value of this formula is always interpreted as a boolean: 0 equals *false*, any other value is interpreted as *true*.

AttributeValueVariationPoint is primarily used to provide values in the *attribute value pattern* (Section 7.4). Since the *attribute value pattern* is implicitly used to define the condition of a *PostBuild* variation point, it may also be used in every other pattern.

AttributeValueVariationPoint further splits into six subclasses, namely NumericalValueVariationPoint, FloatValueVariationPoint, IntegerValueVariationPoint, BooleanValueVariationPoint, PositiveIntegerValueVariationPoint and UnlimitedIntegerValueVariationPoint.

These subclasses provide information on the expected return type of the formula (see Chapter 4.8.2.2, and correspond to the AUTOSAR primitive types Numerical, Float, Integer, Boolean, PositiveInteger and UnlimitedInteger.

[constr_2516] Return type of an AttributeValueVariationPoint ⌈When such a formula is evaluated by a software tool, and the return value of the formula is shall be compatible to the type of the attribute in the pure meta-model.⌋*()*

Class	≪**atpMixedString**≫ **SwSystemconstDependentFormula (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class represents an expression depending on system constants.			
Base	ARObject, FormulaExpression			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
sysc	SwSystemconst	1	ref	This refers to a system constant. The internal (coded) value of the system constant shall be used. **Tags:** xml.sequenceOffset=50
syscString	SwSystemconst	1	ref	syscString indicates that the referenced system constant shall be evaluated as a string according to [TPS_SWCT_01431].

Table 7.10: SwSystemconstDependentFormula

Class	≪atpMixedString≫ **ConditionByFormula**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class represents a condition which is computed based on system constants according to the specified expression. The expected result is considered as boolean value. The result of the expression is interpreted as a condition. • "0" represents "false"; • a value other than zero is considered "true"			
Base	ARObject, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
bindingTime	BindingTimeEnum	1	attr	This attribute specifies the point in time when condition may be evaluated at earliest. At this point in time all referenced system constants shall have a value. **Tags:** xml.attribute=true

Table 7.11: ConditionByFormula

Class	≪atpMixedString≫ **AttributeValueVariationPoint (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents the ability to derive the value of the Attribute from a system constant (by SwSystemconstDependentFormula). It also provides a bindingTime.			
Base	ARObject, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
bindingTime	BindingTimeEnum	0..1	attr	This is the binding time in which the attribute value needs to be bound. If this attribute is missing, the attribute is not a variation point. In particular this means that It needs to be a single value according to the type specified in the pure model. It is an error if it is still a formula. **Tags:** xml.attribute=true
blueprintValue	String	0..1	attr	This represents a description that documents how the value shall be defined when deriving objects from the blueprint. **Tags:** xml.attribute=true
sd	String	0..1	attr	This special data is provided to allow synchronization of Attribute value variation points with variant management systems. The usage is subject of agreement between the involved parties. **Tags:** xml.attribute=true

shortLabel	PrimitiveIdentifier	0..1	attr	This allows to identify the variation point. It is also intended to allow RTE support for CompileTime Variation points. **Tags:** xml.attribute=true

Table 7.12: AttributeValueVariationPoint

Class	≪**atpMixedString**≫ **AbstractNumericalVariationPoint (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This is an abstract NumericalValueVariationPoint. It is introduced to support the case that additional attributes are required for particular purposes.			
Base	ARObject, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 7.13: AbstractNumericalVariationPoint

Class	≪**atpMixedString**≫ **BooleanValueVariationPoint**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents an attribute value variation point for Boolean attributes. Note that this class might be used in the extended meta-model on			
Base	ARObject, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 7.14: BooleanValueVariationPoint

Class	≪**atpMixedString**≫ **FloatValueVariationPoint**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents an attribute value variation point for Float attributes. Note that this class might be used in the extended meta-model only			
Base	ARObject, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 7.15: FloatValueVariationPoint

Class	≪atpMixedString≫ **IntegerValueVariationPoint**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents an attribute value variation point for Integer attributes. Note that this class might be used in the extended meta-model only.			
Base	ARObject, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table 7.16: IntegerValueVariationPoint

Class	≪atpMixedString≫ **LimitValueVariationPoint**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents the ability to express a numerical limit. Note that this is in fact a NumericalValuationPoint but has the additional attribute intervalType. Note that the xml.name is "LIMIT" for backward compatibility reasons. **Tags:** xml.name=LIMIT			
Base	ARObject, AbstractNumericalVariationPoint, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
intervalType	IntervalTypeEnum	0..1	attr	This specifies the type of the interval. If the attribute is missing the interval shall be considered as "CLOSED". **Tags:** xml.attribute=true

Table 7.17: LimitValueVariationPoint

Class	≪atpMixedString≫ **NumericalValueVariationPoint**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents an attribute value variation point for Numerical attributes. Note that this class might be used in the extended meta-model only.			
Base	ARObject, AbstractNumericalVariationPoint, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table 7.18: NumericalValueVariationPoint

Class	≪atpMixedString≫ PositiveIntegerValueVariationPoint			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents an attribute value variation point for positive Integer attributes. Note that this class might be used in the extended meta-model only.			
Base	ARObject, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	Type	Mul.	Kind	Note
–	–	–	–	–

Table 7.19: PositiveIntegerValueVariationPoint

Class	≪atpMixedString≫ UnlimitedIntegerValueVariationPoint			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This class represents an attribute value variation point for unlimited Integer attributes. Note that this class might be used in the extended meta-model only.			
Base	ARObject, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	Type	Mul.	Kind	Note
–	–	–	–	–

Table 7.20: UnlimitedIntegerValueVariationPoint

7.6.9 Combining *PreBuild* and *PostBuild* Variation Points

If `vh.latestBindingTime` is set to `PostBuild` ([constr_2517]) for a particular variation point, then this variation point may have a *PostBuild* branch represented by `PostBuildVariantCondition`[12]. However, it may also contain a *PreBuild* branch. This is because the *PreBuild* and *PostBuild* branches of `VariationPoint` are not mutually exclusive.

[TPS_GST_00266] PreBuild Disabling PostBuild support ⌈ It is possible to define a variation point as *both PreBuild and PostBuild*. If the PreBuild condition is false, it is not expected that the variant object (including the PostBuild condition) will be implemented.

In other words, a system constant expression in a variation point may be used to disable the *PostBuild* variability even at *PreBuild* time. ⌋*()*

Table 7.21 summarizes the options provided by [TPS_GST_00266].

PreBuild	PostBuild	
No Condition at all	No Condition at all	The element to which the VP is attached is always selected

[12] Vice versa, whether that a variation point is *PostBuild* can be recognized from the fact that it contains `PostBuildVariantCondition`.

No Condition at all	Unbound Condition	Pure PostBuild Variation Point
No Condition at all	Condition bound to true	Bound, selected PostBuild Variation Point (not visible in XML)
No Condition at all	Condition bound to false	Bound, deselected PostBuild Variation Point (not visible in XML)
Unbound Condition	No Condition at all	Pure PreBuild Variation Point
Unbound Condition	Unbound Condition	PreBuild selectable Postbuild Variation Point
Unbound Condition	Condition bound to true	PreBuild selectable Postbuild Variation Point (not visible in XML)
Unbound Condition	Condition bound to false	PreBuild selectable Postbuild Variation Point (not visible in XML)
Condition bound to true	No Condition at all	The element to which the VP is attached is always selected
Condition bound to true	Unbound Condition	Pure PostBuild Variation Point
Condition bound to true	Condition bound to true	Bound, selected PostBuild Variation Point (not visible in XML)
Condition bound to true	Condition bound to false	Bound, deselected PostBuild Variation Point (not visible in XML)
Condition bound to false	No Condition at all	Deselected PreBuild Variation Point, no Post-Build Variation Point
Condition bound to false	Unbound Condition	Deselected PreBuild Variation Point, no Post-Build Variation Point
Condition bound to false	Condition bound to true	Deselected PreBuild Variation Point, no Post-Build Variation Point
Condition bound to false	Condition bound to false	Deselected PreBuild Variation Point, no Post-Build Variation Point

Table 7.21: Combining *PreBuild* and *PostBuild* Variation Points

7.6.10 Notes and Restrictions

1. It is not supported ([TPS_GST_00199], [TPS_GST_00200]) to aggregate more than one `VariationPoint` at the same location. It is however possible to define both *PreBuild* and *PostBuild* conditions for a single variation point.

2. **[TPS_GST_00267] Only one BindingTime** ⌈ It is not possible to state multiple binding times for a single variation point. The rationale for restriction is that if multiple binding times would really be used at the same location, then their conditions are likely to differ anyway. That is, there would not be a single variation point with multiple binding times, but several variation points instead. ⌋ *()*.

3. Due to the very nature of dealing with variants, it is possible to have multiple elements with the *same* `ShortName` until all *PreBuild* variants are resolved.

   This also means that the checking the model for consistency might not be fully possible until after all variants are resolved. This is because one purpose of variant handling is to model several incompatible variants and provide means to select one of the and discard the others, but this implies that the model cannot be fully consistent until this selection has been made.

   See also Section 7.6.2 ([constr_2512]) for more details on this issue.

4. **[TPS_GST_00268] Rationale for Different Approach for PreBuild and Post-Build Variation** ⌈ The reason for handling *PreBuild* and *PostBuild* variation points differently is that if we would use only a ConditionByFormula (i.e., only the *PreBuild* branch) in both cases, then this condition would have to be evaluated at startup time. However, this would impose a performance penalty that is generally not acceptable. Hence, we use a simpler approach for *PostBuild* variation points which requires only a comparison. ⌋*()*

5. **[TPS_GST_00269] Reference from invariant to variant parts.** ⌈ References within an AUTOSAR Model may also be from invariant (respectively *PreBuild* variant) elements to post build variant elements if all variants of the variant element do have a meaning for the invariant elements (see [constr_2503]) ⌋*()*

   An sample use case is conditionaly existing SwComponentPrototype, with LatestBindingTime = postBuild. The runnable to task mapping of the variant SwComponentPrototype is a preCompileTime ECUC parameter. But this mapping has a meaning for all variants of the variant SwComponentPrototype, because it is resolved before and does not need any additional condition.

6. A shortLabel could also be implemented by making a VariationPoint an Identifiable (see Section 4.3). However, Identifiable would be expensive for our purposes:

   - Identifiable has a significantly higher XML footprint than the shortLabel attribute.
   - A shortLabel is always optional while Identifiable adds a required shortName.

   In addition, shortLabel is intended for local identification (within the next enclosing Identifiable), while Identifiable is intended for reference purposes.

7.6.11 Using Variation Points for Blueprinting

As specified in [2] [TPS_STDT_00028], VariationPoint and AttributeValueVariationPoint are also used to specify details of deriving objects from blueprints.

[TPS_GST_00270] Variation Point in Blueprints ⌈ Variation handling in Blueprints works differently from AUTOSAR variant handling elsewhere:

- Processing Blueprints can be seen as a separate binding time that occurs before systemDesignTime.
- The model does not give precise instructions how to handle the variation. Instead, only a textual description of what needs to be done is available.
- Variation points may occur for all elements in the blueprint that are subclasses of ARElement; [constr_2537] states that it does not apply for Blueprints.

⌋()

7.6.11.1 When is a variation point a Blueprint variation point?

The class VariationPoint (see Figure 7.9) aggregates a DocumentationBlock in the role blueprintCondition. This object may only be aggregated in blueprints – that is, it may only be present if the VariationPoint lives in an AUTOSAR package of category BLUEPRINT. It may not be present In a system configuration.

If such an DocumentationBlock is present, then it contains instructions how to further process this variation point. The specific format of these instructions is not prescribed in detail, as the instructions are meant for humans or specialized (probably proprietary) tools.

Similarly, AttributeValueVariationPoint has an attribute blueprintValue that serves the same purpose as a DocumentationBlock in the role blueprintCondition.

[TPS_GST_00271] blueprintCondition cannot be variant ⌈ As consequence of [constr_2559], a VariationPoint within a DocumentationBlock that is aggregated by VariationPoint is not allowed. The rationale for this is that such variations would have to be resolved at systemDesignTime or later, which comes *after* the blueprint has been processed.⌋()

7.6.11.2 BlueprintDerivationTime

[TPS_GST_00272] Semantics of BlueprintDerivationTime ⌈ To support blueprints, the tag vh.latestBindingTime may have the value BluePrintDerivationTime. Such a variation point may only be present in a blueprint and may *not* be copied to a system configuration.

In this case, a variation point cannot have a swSysCond nor postbuildVariantCondition (as defined by [constr_2558] in [2]) because the information contained in these fields cannot be processed at BluePrintDerivationTime.

Similarly, the value an AttributeValueVariationPoint has no meaning in this case. Therefore it shall not be evaluated and the value shall be undefined. ⌋() See also Section 7.4.2.

7.6.11.3 Which AUTOSAR model elements can be blueprint variation points?

Non-blueprint variation points – that is, variation points which are resolved at SystemDesignTime or later – may not be used everywhere in a model. Their applicability is restricted by the metamodel to those locations that carry the stereotype ≪atpVariation≫. There are good reasons to do this; for example, the RTE must be able to cope with the variation point at this location and must be able to generate appropriate code.

The AUTOSAR elements PackageableElement and ARElement – which derives from it – form a special case. Since PackageableElement is variable with a latest binding time of systemDesignTime, *any* ARElement could be variable, which is clearly not intended. Hence, [constr_2537] restricts that to certain elements.

In Blueprints, [constr_2537] has been relaxed, and any ARElement may be a variation point.

[TPS_GST_00273] Resolve BlueprintVariationPoints on time ⌈ When elements are copied from a variation point to a system configuration, then only those variation points may be transferred that are allowed to be variation points at systemDesignTime or later.

Hence, any variation of an ARElement (or something derived from it) in a blueprint that would be prohibited by [constr_2537] (which limits variation points to certain elements) has an implicit latest binding time of BluePrintDerivationTime. ⌋*()*

7.7 Evaluated Variants

7.7.1 Motivation

Variant handling does not end with a description of *where* variation occurs (that is, the patterns we described in the previous sections of this chapter). Quite often, this description implies a huge number of variants[13], but only a subset of those is actually used.

This may be because the software is built to support a wider range of options than those of one particular OEM. But since the supplier has several OEM's as customer, he might design the software in such a way that it satisfies all variants. What is shipped to the OEM may only contain artifacts for his particular variants[14], or is at least certified for only those.

The variations are described by sets of system constant values. Hence, there is a need to describe which combinations of system constant values are valid. This provides the basis for OEMs and suppliers to exchange information on this subject in a standardized way.

7.7.2 Example

“APPROVED”	Basic	**Economy**	**Senior**	Sportive	Junior

[13]Just five alternatives with three mutually exclusive options each yield a total of $3^5 = 243$ options.
[14]Especially if the variability is at systemDesignTime or preCompileTime; although this is generally not possible for *PostBuild* variations.

Turbocharge	0	**0**	**1**	1	0
Automatic Transmission	0	**1**	**0**	1	0
Headlight	0	**1**	**2**	3	0
Sunroof	0	**0**	**0**	1	1

Table 7.22: Evaluated Variant Example, full table

Table 7.22 illustrates a example where we have four system constants (*Turbocharge*, *Automatic Transmission*, *Headlight* and *Sunroof*) which can assume integer values. In this example five variants were evaluated and named *Basic*, *Economy*, *Senior*, *Sportive*, *Junior*.

Basic, *Economy*, *Senior*, *Sportive*, *Junior* are called **predefined variants**. Each predefined variant is a combination of system constant values[15]. In other words, a `PredefinedVariant` is a column in the table above representing all evaluated variants.

The result of the evaluation is stated by the attribute `approvalStatus` in `EvaluatedVariantSet`. Corresponding to the example above the bold columns can be represented by an `EvaluatedVariantSet` with `approvalStatus` set to “APPROVED” as shown in table 7.23.

Furthermore, let us assume that a supplier is able to provide all five combinations (internally), but a fictitious OEM is interested in buying only *Economy* and *Senior*, as indicated by the bold column in Table 7.22.

In this case, the table that is exchanged between OEM and supplier will contain only the two columns (predefined variants) *Economy* and *Senior*.

”APPROVED”	**Economy**	**Senior**
Turbocharge	0	1
Automatic Transmission	1	0
Headlight	1	2
Sunroof	0	0

Table 7.23: Table that is exchanged between supplier and OEM

Table 7.23 shows the table that is exchanged between OEM and supplier. This table is also the basis for the XML example in Section 7.7.5.

7.7.2.1 Beyond the example

There are four more aspects in the concept for *evaluated variants* which are not shown in the above example:

1. An evaluated variant may refer to a specific component (or other element) for which the approval status in table applies.

[15]A predefined variant also includes values for *PostBuild* variation points, which are omitted in Table 7.22 for clarity.

2. A predefined variant may not only define values for system constants, but also for PostBuild variant criteria.
3. Columns in the table – even sub-columns – may be re-used by other tables. This is done by implementing the table through references, not aggregations. Both features are helpful if the data for a table of evaluated variants gets reused, or comes from different sources.
4. An evaluated variant may have an approval status which further details the meaning of the table. An evaluated variant may be “approved’, in which case the table contains predefined variants that are known to work, or it may be “rejected”, in which cases the predefined variants are known *not* to work.
5. A `PredefinedVariant` can include other `PredefinedVariant`s with a `includedVariant` association.

7.7.2.2 Use Cases covered in the example

The example above covers the following use cases:

- An integrator can use a table of evaluated variants to check whether a certain non-variant system (i.e. one where the variants have been resolved) is based on a predefined variant.
- A system designer can import preconfigured settings to build a particular variant.
- A component provider can use this mechanism to deliver a set of valid variants to a user of a component. This does not need to be the whole set of valid variants; for example the user may only be entitled to see (i.e., get information on) a certain subset.

7.7.3 Description

[TPS_GST_00277] Purpose of Evaluated Variants ⌈ An `EvaluatedVariantSet` provides a way to describe a particular product variant and its approval status (approved/rejected) with respect to particular set of `CollectableElement`. This allows to state if a particular element is approved/rejected for a given variant. ⌋*()*

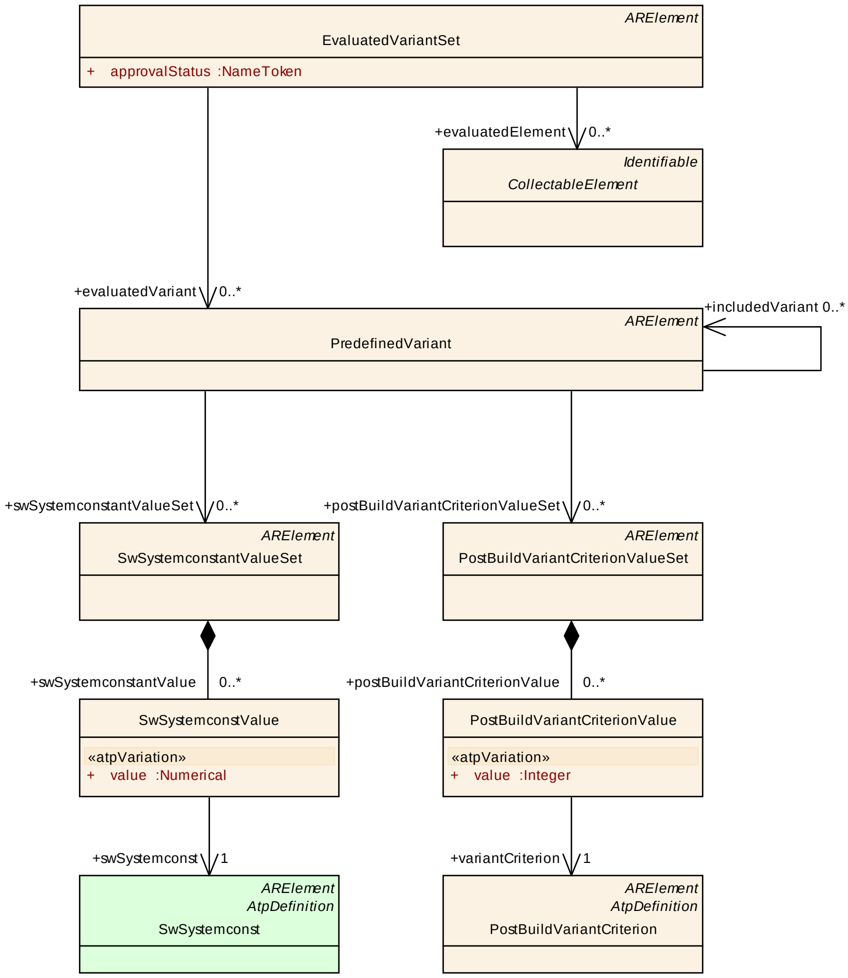


Figure 7.14: EvaluatedVariantSet

Tables 7.22 and 7.23 translate to Figure 7.14 as follows:

EvaluatedVariantSet The whole table is represented by the class EvaluatedVariantSet. EvaluatedVariantSet is an ARElement, so it has its own shortName, which is the name of the table.

[TPS_GST_00278] Establishing Multiple Validities with EvaluatedVariantSet for Different Aspects ⌈ It is possible to have multiple EvaluatedVariantSets. If there are several such sets, each set establishes a validity for a particular aspect. Individual aspects may be addressed by shortName.⌋*()* For example, unit tests may use their own specialized EvaluatedVariantSets. Individual sets may be addressed by shortName.

PredefinedVariant An EvaluatedVariantSet contains a number of PredefinedVariants. Each PredefinedVariant plus its included variants are a column in the table. The name of the column is the shortName of the PredefinedVariant.

[TPS_GST_00279] Definition of a Predefined Variant ⌈ A PredefinedVariant represents a particular variant as a given combination of settings of variant selectors represented by SwSystemconstValue respectively PostBuildVariantCriterionValue. ⌋()

The selection of Predefined Variants with SwSystemconstantValueSets applicable for ECU Configuration is done by the ECUC Variation Resolver (see 3.3.3 Variation Resolver Description in ECU Configuration).

The handling of PredefinedVariants with PostBuildVariantCriterionValueSets is described in [18] (see [SWS_Rte_06638]).

SwSystemconstantValueSet A PredefinedVariant contains a number of SwSystemconstantValueSet objects. In the simplest case, there is only one such object, which represents the entries of the column. More precisely, the PredefinedVariant represents the column including the header, while the SwSystemconstantValueSet is all that is below the header.

[TPS_GST_00280] SwSystemConstantValueSets from different sources ⌈ It is also possible to distribute the entries of a column over several SwSystemconstantValueSet objects. The reason behind using several SwSystemconstantValueSets is to allow a predefined variant to be composed of system constant assignments that come from different sources.⌋ *()*

To remain with the picture that was drawn in Figure 7.22, each column is then composed of several SwSystemconstantValueSets, whose contents are concatenated.

[constr_2519] PredefinedVariants need to be consistent ⌈ If a PredefinedVariant plus its includedVariants references more than one SwSystemconstantValueSet all value attributes in SwSystemconstValues for a particular SwSystemconst must be identical. ⌋*()*

By constraint [constr_2519] contradicting value assignment are positively avoided.

SwSystemconstValue A SwSystemconstantValueSet contains a number of SwSystemconstValue objects, each of which represents a cell in the table, and implements – as the name says – a value for a single system constant.

The value that is stored in the cell is represented by the attribute value, which in turn subject to variation through *attribute value pattern* (see Section 7.4).

[TPS_GST_00281] Indirect value assignment for system constants ⌈ The primary motivation for using a variation point here is convenience: the value is determined by an expression, and this is exactly what an attribute value variation point does. In practice, the expression should consist of a single system constant, most of the time. ⌋*()*

SwSystemconst Each SwSystemconstValue provides a reference to a SwSystemconst. This is the system constant whose value is defined by SwSystemconstValue.

SwSystemconstantValueSet, SwSystemconstValue and SwSystemconst define *prebuild* variants. There is a second branch for PostBuild variants:

[TPS_GST_00282] Analogy between Predefined Variant for Pre Build and Post Build branch ⌈

PostBuildVariantCriterionValueSet is the *postbuild* analogue for SwSystemconstantValueSet.

PostBuildVariantCriterionValue is the *postbuild* analogue for SwSystemconstValue.

PostBuildVariantCriterion is the *postbuild* analogue for SwSystemconst.

⌋*()*

[TPS_GST_00283] Validity of Post Build combined with Pre Build Variant ⌈ When both *prebuild* and *postbuild* variants are defined, then the *postbuild* variants apply to *all prebuild* variants.⌋*()*

Furthermore, PredefinedVariant, SwSystemconstantValueSet and PostBuildVariantCriterionValueSet are referenced, rather than aggregated, to enable reuse of variants. For example, a vendor might have several PredefinedVariant collections – one for each OEM – and reuse them in separate EvaluatedVariantSets (see [TPS_GST_00280]).

7.7.3.1 evaluatedElement

A EvaluatedVariantSet provides a reference to one or more CollectableElements (see chapter 12). This is used to identify the packages and elements that are covered by the PredefinedVariant. Note that EvaluatedVariantSet is also CollectableElement.

[constr_2507] EvaluatedVariantSet shall not refer to itself ⌈ An EvaluatedVariantSet shall not refer to itself directly or via other EvaluatedVariantSet. ⌋*()*

For more details refer to Section 7.7.4.

7.7.3.2 approvalStatus

[TPS_GST_00284] Semantics of approvalStatus ⌈ The attribute approvalStatus of an EvaluatedVariantSet further details the status of the evaluated variant. The following values are standardized:

1. APPROVED An “approved” variant is known to work.
2. REJECTED An “rejected” variant is known *not* to work.

Note that all other values are use case specific. Hence EvaluatedVariantSet with approvalStatus other than APPROVED or REJECTED is not defined by the standard and therefore shall be ignored when evaluating a system. ⌋*()* See chapter 7.7.4).

7.7.3.3 includedVariant

[TPS_GST_00285] Purpose of includedVariant in PredefinedVariant ⌈ The association includedVariant defines that settings of the referenced Predefined-Variants are handled as part of the settings of the referencing PredefinedVariant.⌋*()*

Suppose a variant rich system is composed out of variant rich sub systems delivered by several parties. In this case the providers of the subsystems need to define appropriate EvaluatedVariantSet for their delivery. Additionally the responsible party for the system needs to specify EvaluatedVariantSet for the entire system.

In order to do this he can use the includedVariants to refer to the definition of the PredefinedVariants of the sub system. Without this he would need to repeat those definitions. This would require a knowledge about the sub system and reduce the maintainablility of the system. By using includedVariants the creator of the system does not need any knowledge about the SwSystemconstantValueSets and PostBuildVariantCriterionValueSet used in the sub system.

7.7.4 Consistency

A particular EvaluatedVariantSet refers to CollectableElements in order to express their approval status. As EvaluatedVariantSet is also a CollectableElement, a hierarchy of EvaluatedVariantSets can occur.

On the other hand the meta model establishes another hierarchy by aggregation of objects. It is important to clearly distinguish these two hierarchies when considering evalutated variants.

This section defines the details regarding consistency of such hierarchies.

[TPS_GST_00286] REJECTED precedes APPROVED ⌈ Generally the status REJECTED takes precedence over the status APPROVED. That is, if e.g. an “approved” package contains a “rejected” software component, the whole package shall be regarded as REJECTED for this EvaluatedVariantSet.⌋*()*

[TPS_GST_00287] APPROVED for CollectableElement ⌈ A CollectableElement (see chapter 3) is *rejected* for a given variant if

- it is referenced by at least one appropriate EvaluatedVariantSet withapprovalStatus set to *REJECTED*

- or aggregates (possibly over many levels) a CollectableElement which is referenced in an appropriate EvaluatedVariantSet with approvalStatus set to *REJECTED*.

⌋*()*

[TPS_GST_00288] **REJECTED for CollectableElement** ⌈ A CollectableElement (see chapter 3) is *approved* for a given variant if

- it is referenced by at least one appropriate EvaluatedVariantSet with approvalStatus set to *APPROVED* or is not a *rejected* EvaluatedVariantSet. This makes sure that EvaluatedVariantSet are considered approved by default.
- and is not a *rejected* CollectableElement.

⌋*()*

7.7.5 XML Example for EvaluatedVariantSet

The following listing illustrates how an EvaluatedVariantSet is expressed in XML:

Listing 7.1: Example for evaluated variant in ARXML

```
<AR-PACKAGE>
  <SHORT-NAME>Variants</SHORT-NAME>
  <ELEMENTS>
    <PREDEFINED-VARIANT>
      <SHORT-NAME>Basic</SHORT-NAME>
      <SW-SYSTEMCONSTANT-VALUE-SET-REFS>
        <SW-SYSTEMCONSTANT-VALUE-SET-REF DEST="SW-SYSTEMCONSTANT-VALUE-
            SET">/SystemConstantValues/V1</SW-SYSTEMCONSTANT-VALUE-SET-
            REF>
        <SW-SYSTEMCONSTANT-VALUE-SET-REF DEST="SW-SYSTEMCONSTANT-VALUE-
            SET">/SystemConstantValues/V2</SW-SYSTEMCONSTANT-VALUE-SET-
            REF>
      </SW-SYSTEMCONSTANT-VALUE-SET-REFS>
    </PREDEFINED-VARIANT>
    <PREDEFINED-VARIANT>
      <SHORT-NAME>Economy</SHORT-NAME>
      <SW-SYSTEMCONSTANT-VALUE-SET-REFS>
        <SW-SYSTEMCONSTANT-VALUE-SET-REF DEST="SW-SYSTEMCONSTANT-VALUE-
            SET">/SystemConstantValues/V1</SW-SYSTEMCONSTANT-VALUE-SET-
            REF>
        <SW-SYSTEMCONSTANT-VALUE-SET-REF DEST="SW-SYSTEMCONSTANT-VALUE-
            SET">/SystemConstantValues/V3</SW-SYSTEMCONSTANT-VALUE-SET-
            REF>
      </SW-SYSTEMCONSTANT-VALUE-SET-REFS>
    </PREDEFINED-VARIANT>
    <PREDEFINED-VARIANT>
      <SHORT-NAME>Senior</SHORT-NAME>
      <SW-SYSTEMCONSTANT-VALUE-SET-REFS>
```

```
          <SW-SYSTEMCONSTANT-VALUE-SET-REF DEST="SW-SYSTEMCONSTANT-VALUE-
             SET">/SystemConstantValues/V4</SW-SYSTEMCONSTANT-VALUE-SET-
             REF>
        </SW-SYSTEMCONSTANT-VALUE-SET-REFS>
      </PREDEFINED-VARIANT>
      <PREDEFINED-VARIANT>
        <SHORT-NAME>Sportive</SHORT-NAME>
        <SW-SYSTEMCONSTANT-VALUE-SET-REFS>
          <SW-SYSTEMCONSTANT-VALUE-SET-REF DEST="SW-SYSTEMCONSTANT-VALUE-
             SET">/SystemConstantValues/V5</SW-SYSTEMCONSTANT-VALUE-SET-
             REF>
        </SW-SYSTEMCONSTANT-VALUE-SET-REFS>
      </PREDEFINED-VARIANT>
    </ELEMENTS>
  </AR-PACKAGE>

  <!--  now we have the systemconstant value sets -->
  <AR-PACKAGE>
    <SHORT-NAME>SystemConstantValues</SHORT-NAME>
    <ELEMENTS>
      <SW-SYSTEMCONSTANT-VALUE-SET>
        <SHORT-NAME>V1</SHORT-NAME>
        <SW-SYSTEMCONSTANT-VALUES>
          <SW-SYSTEMCONST-VALUE>
            <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
               Turbocharge</SW-SYSTEMCONST-REF>
            <VALUE>0</VALUE>
          </SW-SYSTEMCONST-VALUE>
          <SW-SYSTEMCONST-VALUE>
            <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
               Sunroof</SW-SYSTEMCONST-REF>
            <VALUE>0</VALUE>
          </SW-SYSTEMCONST-VALUE>
        </SW-SYSTEMCONSTANT-VALUES>
      </SW-SYSTEMCONSTANT-VALUE-SET>
      <SW-SYSTEMCONSTANT-VALUE-SET>
        <SHORT-NAME>V2</SHORT-NAME>
        <SW-SYSTEMCONSTANT-VALUES>
          <SW-SYSTEMCONST-VALUE>
            <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
               Automatictransmission</SW-SYSTEMCONST-REF>
            <VALUE>0</VALUE>
          </SW-SYSTEMCONST-VALUE>
          <SW-SYSTEMCONST-VALUE>
            <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
               Headlight</SW-SYSTEMCONST-REF>
            <VALUE>0</VALUE>
          </SW-SYSTEMCONST-VALUE>
        </SW-SYSTEMCONSTANT-VALUES>
      </SW-SYSTEMCONSTANT-VALUE-SET>
      <SW-SYSTEMCONSTANT-VALUE-SET>
        <SHORT-NAME>V3</SHORT-NAME>
        <SW-SYSTEMCONSTANT-VALUES>
          <SW-SYSTEMCONST-VALUE>
            <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
               Automatictransmission</SW-SYSTEMCONST-REF>
```

```
        <VALUE>1</VALUE>
      </SW-SYSTEMCONST-VALUE>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Headlight</SW-SYSTEMCONST-REF>
        <VALUE>1</VALUE>
      </SW-SYSTEMCONST-VALUE>
    </SW-SYSTEMCONSTANT-VALUES>
  </SW-SYSTEMCONSTANT-VALUE-SET>
  <!-- note that this set is used in all variants above -->
  <SW-SYSTEMCONSTANT-VALUE-SET>
    <SHORT-NAME>V4</SHORT-NAME>
    <SW-SYSTEMCONSTANT-VALUES>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Turbocharge</SW-SYSTEMCONST-REF>
        <VALUE>1</VALUE>
      </SW-SYSTEMCONST-VALUE>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Automatictransmission</SW-SYSTEMCONST-REF>
        <VALUE>0</VALUE>
      </SW-SYSTEMCONST-VALUE>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Headlight</SW-SYSTEMCONST-REF>
        <VALUE>2</VALUE>
      </SW-SYSTEMCONST-VALUE>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Sunroof</SW-SYSTEMCONST-REF>
        <VALUE>0</VALUE>
      </SW-SYSTEMCONST-VALUE>
    </SW-SYSTEMCONSTANT-VALUES>
  </SW-SYSTEMCONSTANT-VALUE-SET>
  <SW-SYSTEMCONSTANT-VALUE-SET>
    <SHORT-NAME>V5</SHORT-NAME>
    <SW-SYSTEMCONSTANT-VALUES>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Turbocharge</SW-SYSTEMCONST-REF>
        <VALUE>1</VALUE>
      </SW-SYSTEMCONST-VALUE>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Automatictransmission</SW-SYSTEMCONST-REF>
        <VALUE>1</VALUE>
      </SW-SYSTEMCONST-VALUE>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Headlight</SW-SYSTEMCONST-REF>
        <VALUE>3</VALUE>
      </SW-SYSTEMCONST-VALUE>
      <SW-SYSTEMCONST-VALUE>
        <SW-SYSTEMCONST-REF DEST="SW-SYSTEMCONST">/SwSystemconsts/
            Sunroof</SW-SYSTEMCONST-REF>
```

```
              <VALUE>1</VALUE>
            </SW-SYSTEMCONST-VALUE>
          </SW-SYSTEMCONSTANT-VALUES>
        </SW-SYSTEMCONSTANT-VALUE-SET>
      </ELEMENTS>
    </AR-PACKAGE>

    <!--  here we have the evaluated variants -->
    <AR-PACKAGE>
      <SHORT-NAME>EvaluatedVariants</SHORT-NAME>
      <ELEMENTS>
        <EVALUATED-VARIANT-SET>
          <SHORT-NAME>foobar</SHORT-NAME>
          <EVALUATED-ELEMENT-REFS>
            <EVALUATED-ELEMENT-REF DEST="APPLICATION-SW-COMPONENT-TYPE">/
               Components/foo</EVALUATED-ELEMENT-REF>
            <EVALUATED-ELEMENT-REF DEST="APPLICATION-SW-COMPONENT-TYPE">/
               Components/bar</EVALUATED-ELEMENT-REF>
          </EVALUATED-ELEMENT-REFS>
          <EVALUATED-VARIANT-REFS>
            <EVALUATED-VARIANT-REF DEST="PREDEFINED-VARIANT">/Variants/
               Economy</EVALUATED-VARIANT-REF>
            <EVALUATED-VARIANT-REF DEST="PREDEFINED-VARIANT">/Variants/
               Senior</EVALUATED-VARIANT-REF>
          </EVALUATED-VARIANT-REFS>
        </EVALUATED-VARIANT-SET>
      </ELEMENTS>
    </AR-PACKAGE>


    <!-- here we have the components -->
    <AR-PACKAGE>
      <SHORT-NAME>Components</SHORT-NAME>
      <ELEMENTS>
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>foo</SHORT-NAME>
        </APPLICATION-SW-COMPONENT-TYPE>
        <APPLICATION-SW-COMPONENT-TYPE>
          <SHORT-NAME>bar</SHORT-NAME>
        </APPLICATION-SW-COMPONENT-TYPE>
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

Note: system constants are not only identified by their name (as implied in Table 7.22), but they are in fact identified by the full reference. This avoids name clashes in hierarchies, e.g. if two (sub)components come from different vendors that for some reason have used the same names.

7.7.6 Classtables

Class	**EvaluatedVariantSet**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta class represents the ability to express if a set of ARElements is able to support one or more particular variants. In other words, for a given set of evaluatedElements this meta class represents a table of evaluated variants, where each PredefinedVariant represents one column. In this column each descendant swSystemconstantValue resp. postbuildVariantCriterionValue represents one entry. In a graphical representation each swSystemconstantValueSet / postBuildVariantCriterionValueSet could be used as an intermediate headline in the table column. If the approvalStatus is "APPROVED" it expresses that the collection of CollectableElements is known be valid for the given evaluatedVariants. Note that the EvaluatedVariantSet is a CollectableElement. This allows to establish a hierarchy of EvaluatedVariantSets. **Tags:** atp.recommendedPackage=EvaluatedVariantSets			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
approvalStatus	NameToken	1	attr	Defines the approval status of a predefined variant. Two values are predefined: "APPROVED" and "REJECTED": • Approved variants are known to work. • Rejected variants are known NOT to work. Further values can be approved on a per-company basis; within AUTOSAR only "APPROVED" and "REJECTED" should be recognized.
evaluatedElement	CollectableElement	*	ref	This represents a particular element which is evaluated in context of the EvaluatedVariants. The approvalStatus applies to this element (and all of its descendants). In other words, the referenced elements are those that were considered when the predefined variant was evaluated.
evaluatedVariant	PredefinedVariant	*	ref	This metaclass represents one particular variant which was evaluated. LowerMultiplicity is set to 0 to support a stepwise approach.

Table 7.24: EvaluatedVariantSet

Class	PredefinedVariant			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This specifies one predefined variant. It is characterized by the union of all system constant values and post-build variant criterion values aggregated within all referenced system constant value sets and post build variant criterion value sets plus the value sets of the included variants. **Tags:** atp.recommendedPackage=PredefinedVariants			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mul.	Kind	Note
includedVariant	PredefinedVariant	*	ref	The associated variants are considered part of this PredefinedVariant. This means the settings of the included variants are included in the settings of the referencing PredefinedVariant. Nevertheless the included variants might be included in several predefined variants.
postBuildVariantCriterionValueSet	PostBuildVariantCriterionValueSet	*	ref	This is the postBuildVariantCriterionValueSet contributing to the predefinded variant.
swSystemconstantValueSet	SwSystemconstantValueSet	*	ref	This ist the set of Systemconstant Values contributing to the predefined variant.

Table 7.25: PredefinedVariant

Class	SwSystemconstantValueSet			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class represents the ability to specify a set of system constant values. **Tags:** atp.recommendedPackage=SwSystemconstantValueSets			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mul.	Kind	Note
swSystemconstantValue	SwSystemconstValue	*	aggr	This is one particular value of a system constant.

Table 7.26: SwSystemconstantValueSet

Class	SwSystemconstValue			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class assigns a particular value to a system constant.			
Base	ARObject			
Attribute	Type	Mul.	Kind	Note
annotation	Annotation	*	aggr	This provides the ability to add information why the value is set like it is. **Tags:** xml.sequenceOffset=30

swSystemconst	SwSystemconst	1	ref	This is the system constant to which the value applies. **Tags:** xml.sequenceOffset=10
value	Numerical	1	attr	This is the particular value of a system constant. It is specified as Numerical. Further restrictions may apply by the definition of the system constant. The value attribute defines the internal value of the SwSystemconst as it is processed in the Formula Language. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime xml.sequenceOffset=20

Table 7.27: SwSystemconstValue

Class	**SwSystemconst**			
Package	M2::MSR::DataDictionary::SystemConstant			
Note	This element defines a system constant which serves an input to select a particular variation point. In particular a system constant serves as an operand of the binding function (swSyscond) in a Variation point. Note that the binding process can only happen if a value was assigned to to the referenced system constants. **Tags:** atp.recommendedPackage=SwSystemconsts			
Base	ARElement, ARObject, AtpDefinition, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
swDataDefProps	SwDataDefProps	0..1	aggr	This denotes the data defintion properties of the system constant. In particular it is the limits and - in case the system constant is an enumeration - the compu method. **Tags:** xml.sequenceOffset=40

Table 7.28: SwSystemconst

Class	**PostBuildVariantCriterionValueSet**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class represents the ability to denote one set of postBuildVariantCriterionValues. **Tags:** atp.recommendedPackage=PostBuildVariantCriterionValueSets			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

postBuildVariantCriterionValue	PostBuildVariantCriterionValue	*	aggr	This is is one particular postbuild variant criterion/value pair being part of the PostBuildVariantSet.

Table 7.29: PostBuildVariantCriterionValueSet

Class	**PostBuildVariantCriterionValue**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class specifies a the value which must be assigned to a particular variant criterion in order to bind the variation point. If multiple criterion/value pairs are specified, they all must must match to bind the variation point.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
annotation	Annotation	*	aggr	This provides the ability to add information why the value is set like it is. **Tags:** xml.sequenceOffset=30
value	Integer	1	attr	This is the particular value of the post-build variant criterion. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime xml.sequenceOffset=20
variantCriterion	PostBuildVariantCriterion	1	ref	This association selects the variant criterion whose value is specified. **Tags:** xml.sequenceOffset=10

Table 7.30: PostBuildVariantCriterionValue

Class	**PostBuildVariantCriterion**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class specifies one particular PostBuildVariantSelector. **Tags:** atp.recommendedPackage=PostBuildVariantCriterions			
Base	ARElement, ARObject, AtpDefinition, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
compuMethod	CompuMethod	1	ref	The compuMethod specifies the possible values for the variant criterion serving as an enumerator.

Table 7.31: PostBuildVariantCriterion

7.8 Choosing Variants

In this section, we describe how to represent a particular variant of an AUTOSAR system.

7.8.1 What is a Variant?

[TPS_GST_00289] Definition of a Variant ⌈ A variant is a collection of bound variation points. In other words, it is represented by a complete assignment of values to system constants respectively post build variant criteria.⌋*()*

More formally, a *variant* is characterized by the following:

1. **Binding Time:** Variants are tied to a particular binding time. This binding time is given in the following model elements:

   - `ConditionByFormula`, which is aggregated by `VariationPoint` in the *aggregation pattern* (Figure 7.2), the *association pattern* (Figure 7.3), and the *property set pattern* (Figures 7.8, 7.7).
   - `AttributeValueVariationPoint` in the *attribute value pattern* (Figure 7.4).

   [constr_2518] Binding time is constrained ⌈ Note that this binding time is again constrained by the value of the tag `vh.latestBindingTime`. ⌋*()*

   See Section 7.1.6 for details.

2. **Variation Points:** The set of variation points that need to bound at the binding time of the variant. In the model, this affects the following elements:

   - `VariationPoint` is used in the *aggregation pattern*, (Figure 7.2), the *association pattern* (Figure 7.3) and the *property set pattern* (Figures 7.8, 7.7).
   - `AttributeValueVariationPoint` in the *attribute value pattern* (Figure 7.4).

3. **System Constants:** The set of system constants that are referenced from within variation points. System constants are referenced from `SwSystemconstDependentFormula` and its subclasses (Section 7.6.8).

4. **Value assignments:** The system constants determined in the previous step need to be assigned values.

7.8.2 Valid Variants

[TPS_GST_00290] Defintion of Valid Variants ⌈ A *valid variant* is defined as follows:

1. A valid variant $\mathcal{V}$ for a binding time $\mathcal{T}$ is an assignment of values to all system constants that are referenced by all variation points which have the binding time $\mathcal{T}$.

2. There exists no `PredefinedVariant` that covers the systems in $\mathcal{V}$, and its status is `REJECTED`.

⌋*()*

7.9 Examples

In this section, we provide four examples for variant handling, each focusing on a single template. We also provide possible implementations to illustrate how these use cases might be translated into practice. It should however be noted that these are just sample implementations, and are not necessarily the only possible way to realize a particular use case.

7.9.1 Example for *Aggregation Pattern*

Description Software component type with variant ports.

Use Case A body control application uses one of two light controllers: low end systems uses the *low-end-light control*, while a high end systems uses *adaptive-curve light-control*.

Implementation The body control application has a port which is used to communicate with the light controller. There are two variants for the connector of this port: a low end and an adaptive curve variant. These two variants are exclusive.

A system constant `CarType` is used to switch between the two variants; a value of 1 means “low end” while a value of 2 means “adaptive curve”.

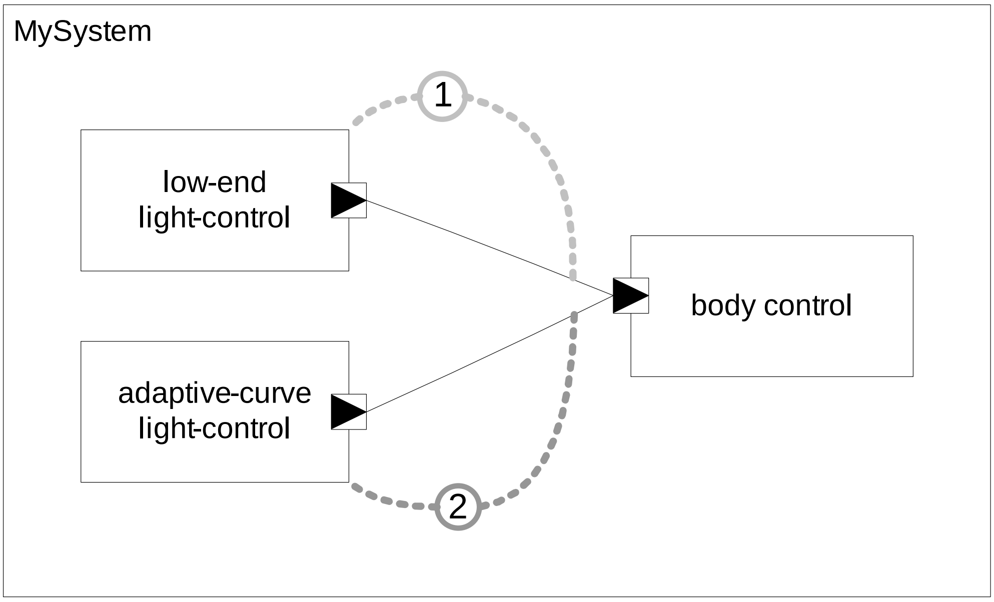


Figure 7.15: Example for *Aggregation Pattern*

Listing 7.2: Example for aggregation pattern in ARXML

```
<AR-PACKAGE>
  <SHORT-NAME>AggregationPattern</SHORT-NAME>
  <INTRODUCTION>
    <P>
      <L-1
        L="EN">Note that the example slightly varies from
```

```
      the example in the document: Body control has one port
      which is used for both variants. </L-1>
    </P>
  </INTRODUCTION>
  <REFERENCE-BASES>
    <REFERENCE-BASE>
      <SHORT-LABEL>default</SHORT-LABEL>
      <IS-DEFAULT>true</IS-DEFAULT>
      <IS-GLOBAL>false</IS-GLOBAL>
      <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
      <PACKAGE-REF
        DEST="AR-PACKAGE">/AggregationPattern</PACKAGE-REF>
    </REFERENCE-BASE>
  </REFERENCE-BASES>
  <ELEMENTS>
    <SW-SYSTEMCONST>
      <SHORT-NAME>CarType</SHORT-NAME>
    </SW-SYSTEMCONST>
    <COMPOSITION-SW-COMPONENT-TYPE>
      <SHORT-NAME>MySystem</SHORT-NAME>
      <COMPONENTS>
        <SW-COMPONENT-PROTOTYPE>
          <SHORT-NAME>LowEndLightControl</SHORT-NAME>
          <TYPE-TREF
            DEST="APPLICATION-SW-COMPONENT-TYPE">LowEndLightControl</
                TYPE-TREF>
          <VARIATION-POINT>
            <SHORT-LABEL>LowEnd</SHORT-LABEL>
            <SW-SYSCOND
              BINDING-TIME="SYSTEM-DESIGN-TIME">
              <SYSC-REF
              DEST="SW-SYSTEMCONST">CarType</SYSC-REF>
              == 1
            </SW-SYSCOND>
          </VARIATION-POINT>
        </SW-COMPONENT-PROTOTYPE>
        <SW-COMPONENT-PROTOTYPE>
          <SHORT-NAME>AdaptiveCurveLightControl</SHORT-NAME>
          <TYPE-TREF
            DEST="APPLICATION-SW-COMPONENT-TYPE">
                AdaptiveCurveLightControl</TYPE-TREF>
          <VARIATION-POINT>
            <SHORT-LABEL>HighEnd</SHORT-LABEL>
            <SW-SYSCOND
              BINDING-TIME="SYSTEM-DESIGN-TIME">
              <SYSC-REF
              DEST="SW-SYSTEMCONST">CarType</SYSC-REF>
              == 2
            </SW-SYSCOND>
          </VARIATION-POINT>
        </SW-COMPONENT-PROTOTYPE>
        <SW-COMPONENT-PROTOTYPE>
          <SHORT-NAME>BodyControl</SHORT-NAME>
          <TYPE-TREF
            DEST="APPLICATION-SW-COMPONENT-TYPE">BodyControl</TYPE-TREF
                >
```

```
        </SW-COMPONENT-PROTOTYPE>
      </COMPONENTS>
      <CONNECTORS>
        <ASSEMBLY-SW-CONNECTOR>
          <SHORT-NAME>LightControl</SHORT-NAME>
          <INTRODUCTION>
            <P>
              <L-1
                L="EN">Note that the shortname in both variants is
                the same.</L-1>
            </P>
          </INTRODUCTION>
          <VARIATION-POINT>
            <SHORT-LABEL>LowEnd</SHORT-LABEL>
            <SW-SYSCOND
              BINDING-TIME="SYSTEM-DESIGN-TIME">
              <SYSC-REF
              DEST="SW-SYSTEMCONST">CarType</SYSC-REF>
              == 1
            </SW-SYSCOND>
          </VARIATION-POINT>
          <PROVIDER-IREF>
            <CONTEXT-COMPONENT-REF
              DEST="SW-COMPONENT-PROTOTYPE">LowEndLightControl</CONTEXT
                  -COMPONENT-REF>
            <TARGET-P-PORT-REF
              DEST="P-PORT-PROTOTYPE">/AggregationPattern/
                  LowEndLightControl/ToLight</TARGET-P-PORT-REF>
          </PROVIDER-IREF>
          <REQUESTER-IREF>
            <CONTEXT-COMPONENT-REF
              DEST="SW-COMPONENT-PROTOTYPE">BodyControl</CONTEXT-
                  COMPONENT-REF>
            <TARGET-R-PORT-REF
              DEST="R-PORT-PROTOTYPE">/AggregationPattern/BodyControl/
                  LightControlInput</TARGET-R-PORT-REF>
          </REQUESTER-IREF>
        </ASSEMBLY-SW-CONNECTOR>
        <ASSEMBLY-SW-CONNECTOR>
          <SHORT-NAME>LightControl</SHORT-NAME>
          <VARIATION-POINT>
            <SHORT-LABEL>HighEnd</SHORT-LABEL>
            <SW-SYSCOND
              BINDING-TIME="SYSTEM-DESIGN-TIME">
              <SYSC-REF
              DEST="SW-SYSTEMCONST">CarType</SYSC-REF>
              == 2
            </SW-SYSCOND>
          </VARIATION-POINT>
          <PROVIDER-IREF>
            <CONTEXT-COMPONENT-REF
              DEST="SW-COMPONENT-PROTOTYPE">AdaptiveCurveLightControl</
                  CONTEXT-COMPONENT-REF>
            <TARGET-P-PORT-REF
              DEST="P-PORT-PROTOTYPE">/AggregationPattern/
                  AdaptiveCurveLightControl/ToLight</TARGET-P-PORT-REF>
```

```
            </PROVIDER-IREF>
            <REQUESTER-IREF>
              <CONTEXT-COMPONENT-REF
                DEST="SW-COMPONENT-PROTOTYPE">BodyControl</CONTEXT-
                    COMPONENT-REF>
              <TARGET-R-PORT-REF
                DEST="R-PORT-PROTOTYPE">/AggregationPattern/BodyControl/
                    LightControlInput</TARGET-R-PORT-REF>
            </REQUESTER-IREF>
          </ASSEMBLY-SW-CONNECTOR>
        </CONNECTORS>
      </COMPOSITION-SW-COMPONENT-TYPE>
      <APPLICATION-SW-COMPONENT-TYPE>
        <SHORT-NAME>LowEndLightControl</SHORT-NAME>
        <PORTS>
          <P-PORT-PROTOTYPE>
            <SHORT-NAME>ToLight</SHORT-NAME>
          </P-PORT-PROTOTYPE>
        </PORTS>
      </APPLICATION-SW-COMPONENT-TYPE>
      <APPLICATION-SW-COMPONENT-TYPE>
        <SHORT-NAME>AdaptiveCurveLightControl</SHORT-NAME>
        <PORTS>
          <P-PORT-PROTOTYPE>
            <SHORT-NAME>ToLight</SHORT-NAME>
          </P-PORT-PROTOTYPE>
        </PORTS>
      </APPLICATION-SW-COMPONENT-TYPE>
      <APPLICATION-SW-COMPONENT-TYPE>
        <SHORT-NAME>BodyControl</SHORT-NAME>
        <PORTS>
          <R-PORT-PROTOTYPE>
            <SHORT-NAME>LightControlInput</SHORT-NAME>
          </R-PORT-PROTOTYPE>
        </PORTS>
      </APPLICATION-SW-COMPONENT-TYPE>
    </ELEMENTS>
  </AR-PACKAGE>
```

Listing 7.2 contains two pairs of `VARIATION-POINT` elements: one that switches between the alternative component prototypes, and one that switches between the alternative connectors.

The following excerpt from the above XML shows the code for the three component prototypes *LowEndLightControl* , *AdaptiveCurveLightControl* and *BodyControl*:

Listing 7.3: Variant Component Prototypes

```
<COMPONENTS>
  <SW-COMPONENT-PROTOTYPE>
    <SHORT-NAME>LowEndLightControl</SHORT-NAME>
    <TYPE-TREF
      DEST="APPLICATION-SW-COMPONENT-TYPE">LowEndLightControl</
          TYPE-TREF>
    <VARIATION-POINT>
      <SHORT-LABEL>LowEnd</SHORT-LABEL>
```

```
          <SW-SYSCOND
            BINDING-TIME="SYSTEM-DESIGN-TIME">
            <SYSC-REF
            DEST="SW-SYSTEMCONST">CarType</SYSC-REF>
            == 1
          </SW-SYSCOND>
        </VARIATION-POINT>
      </SW-COMPONENT-PROTOTYPE>
      <SW-COMPONENT-PROTOTYPE>
        <SHORT-NAME>AdaptiveCurveLightControl</SHORT-NAME>
        <TYPE-TREF
          DEST="APPLICATION-SW-COMPONENT-TYPE">
            AdaptiveCurveLightControl</TYPE-TREF>
        <VARIATION-POINT>
          <SHORT-LABEL>HighEnd</SHORT-LABEL>
          <SW-SYSCOND
            BINDING-TIME="SYSTEM-DESIGN-TIME">
            <SYSC-REF
            DEST="SW-SYSTEMCONST">CarType</SYSC-REF>
            == 2
          </SW-SYSCOND>
        </VARIATION-POINT>
      </SW-COMPONENT-PROTOTYPE>
      <SW-COMPONENT-PROTOTYPE>
        <SHORT-NAME>BodyControl</SHORT-NAME>
        <TYPE-TREF
          DEST="APPLICATION-SW-COMPONENT-TYPE">BodyControl</TYPE-TREF
            >
      </SW-COMPONENT-PROTOTYPE>
    </COMPONENTS>
```

Both *LowEndLightControl* and *AdaptiveCurveLightControl* contain a VARIATION-POINT element, which checks the value of the system constant named CarType.

There are similar variation points embedded in the description of the assembly connector prototypes. Note that these variation points have identical SHORT-NAMEs (*LightControl*), but use different SHORT-LABELs (*LowEnd* and *HighEnd*), as described in Section 7.6.2.

7.9.2 Example for *Association Pattern*

Description Software component type with variant diagnostics procedures.

Use Case The light controller from the previous example provides a standard and a high end method for diagnostics.

Implementation There are two diagnostics procedures: standard_light_diagnostics_proc and complex_diagnostics_proc. These procedures realize different algorithms, which require different API function calls. standard_light_diagnostics_proc is always called, complex_diagnostics_proc only in high-end vehicles.

The system constant *CarType* discriminates between the two types of vehicles: a value of 1 means standard car, a value of 2 high end car.

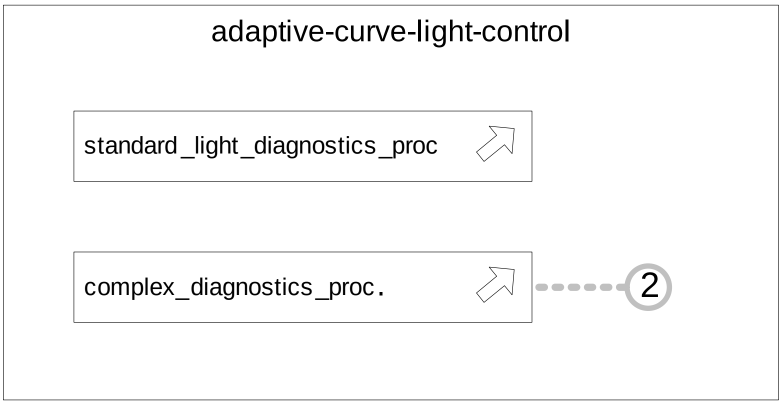


Figure 7.16: Example for *association pattern*

Listing 7.4: Example for association pattern in ARXML

```
<AR-PACKAGE>
  <SHORT-NAME>AssociationPattern</SHORT-NAME>
  <REFERENCE-BASES>
    <REFERENCE-BASE>
      <SHORT-LABEL>default</SHORT-LABEL>
      <IS-DEFAULT>true</IS-DEFAULT>
      <IS-GLOBAL>false</IS-GLOBAL>
      <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
      <PACKAGE-REF
        DEST="AR-PACKAGE">/AssociationPattern</PACKAGE-REF>
    </REFERENCE-BASE>
  </REFERENCE-BASES>
  <ELEMENTS>
    <BSW-MODULE-ENTRY>
      <SHORT-NAME>standard_light_diagnostics_proc</SHORT-NAME>
    </BSW-MODULE-ENTRY>
    <BSW-MODULE-ENTRY>
      <SHORT-NAME>complex_diagnostics_proc</SHORT-NAME>
    </BSW-MODULE-ENTRY>
    <BSW-MODULE-DESCRIPTION>
      <SHORT-NAME>MyDiagnosticManager</SHORT-NAME>
      <INTERNAL-BEHAVIORS>
        <BSW-INTERNAL-BEHAVIOR>
          <SHORT-NAME>Behavior</SHORT-NAME>
          <ENTITYS>
            <BSW-SCHEDULABLE-ENTITY>
              <SHORT-NAME>TheMainFunc</SHORT-NAME>
              <INTRODUCTION>
                <P>
                  <L-1
                    L="EN">complex_diagnostics_proc is called
                    in case of Highend. standard_light_diagnostics_proc
                    is always called.</L-1>
                </P>
              </INTRODUCTION>
              <CALLED-ENTRYS>
```

```
              <BSW-MODULE-ENTRY-REF-CONDITIONAL>
                <BSW-MODULE-ENTRY-REF
                  DEST="BSW-MODULE-ENTRY">complex_diagnostics_proc</
                      BSW-MODULE-ENTRY-REF>
                <VARIATION-POINT>
                  <SW-SYSCOND
                    BINDING-TIME="CODE-GENERATION-TIME">
                    <SYSC-REF
                    DEST="SW-SYSTEMCONST">/AggregationPattern/CarType
                        </SYSC-REF>
                    == 2
                  </SW-SYSCOND>
                </VARIATION-POINT>
              </BSW-MODULE-ENTRY-REF-CONDITIONAL>
              <BSW-MODULE-ENTRY-REF-CONDITIONAL>
                <BSW-MODULE-ENTRY-REF
                  DEST="BSW-MODULE-ENTRY">
                      standard_light_diagnostics_proc</BSW-MODULE-
                      ENTRY-REF>
              </BSW-MODULE-ENTRY-REF-CONDITIONAL>
            </CALLED-ENTRYS>
          </BSW-SCHEDULABLE-ENTITY>
        </ENTITYS>
      </BSW-INTERNAL-BEHAVIOR>
    </INTERNAL-BEHAVIORS>
  </BSW-MODULE-DESCRIPTION>
</ELEMENTS>
</AR-PACKAGE>
```

The variation in Listing 7.4 is contained in the part where the BswModuleEntity calls the BswModuleEntry:

Listing 7.5: Example for association pattern in ARXML

```
<CALLED-ENTRYS>
  <BSW-MODULE-ENTRY-REF-CONDITIONAL>
    <BSW-MODULE-ENTRY-REF
      DEST="BSW-MODULE-ENTRY">complex_diagnostics_proc</
          BSW-MODULE-ENTRY-REF>
    <VARIATION-POINT>
      <SW-SYSCOND
        BINDING-TIME="CODE-GENERATION-TIME">
        <SYSC-REF
        DEST="SW-SYSTEMCONST">/AggregationPattern/CarType
            </SYSC-REF>
        == 2
      </SW-SYSCOND>
    </VARIATION-POINT>
  </BSW-MODULE-ENTRY-REF-CONDITIONAL>
  <BSW-MODULE-ENTRY-REF-CONDITIONAL>
    <BSW-MODULE-ENTRY-REF
      DEST="BSW-MODULE-ENTRY">
          standard_light_diagnostics_proc</BSW-MODULE-
          ENTRY-REF>
  </BSW-MODULE-ENTRY-REF-CONDITIONAL>
</CALLED-ENTRYS>
```

BswModuleEntity has a variant reference to BswModuleEntry (under the role name calledEntry). Hence, <BSW-MODULE-ENTITY> contains *two* elements named <BSW-MODULE-ENTRY-REF-CONDITIONAL>, each of which contains a reference to the called entry. The first one includes a <VARIATION-POINT>.

If the reference from BswModuleEntity to BswModuleEntry would not be variable, then there could be only a single element named <BSW-MODULE-ENTRY-REF>, and of course there would be no <VARIATION-POINT>. But otherwise, the code would look the same.

7.9.3 Example for *Attribute Value Pattern*

Description Adaptive algorithm for a variant array size

Use Case An engine control system needs to adapt to a wide range of engines. Especially, the number of cylinders may vary from engine to engine. The implementation needs to store data for each cylinder.

Implementation Data for the cylinders is stored in an array, who's size corresponds to the number of cylinders. Since we are in an embedded system, we cannot use dynamic arrays, but must use a static array, e.g. `CylinderData cylinder_measures[2*NO_OF_CYLINDERS]`. In the meta model, the size of the array (`2*NO_OF_CYLINDERS`) is an attribute of a class. This attribute must be variant.

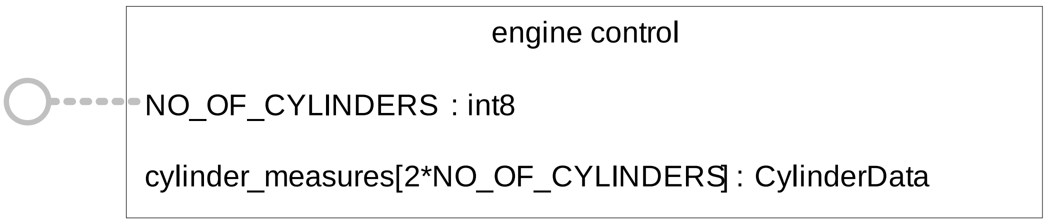


Figure 7.17: Example for *attribute value pattern*

Listing 7.6: Example for attribute value pattern in ARXML

```
<AR-PACKAGE>
  <SHORT-NAME>AttributeValuePattern</SHORT-NAME>
  <REFERENCE-BASES>
    <REFERENCE-BASE>
      <SHORT-LABEL>default</SHORT-LABEL>
      <IS-DEFAULT>true</IS-DEFAULT>
      <IS-GLOBAL>false</IS-GLOBAL>
      <BASE-IS-THIS-PACKAGE>false</BASE-IS-THIS-PACKAGE>
      <PACKAGE-REF
        DEST="AR-PACKAGE">/AttributeValuePattern</PACKAGE-REF>
    </REFERENCE-BASE>
  </REFERENCE-BASES>
  <ELEMENTS>
    <SW-SYSTEMCONST>
      <SHORT-NAME>NO_OF_CYLINDERS</SHORT-NAME>
```

```
        </SW-SYSTEMCONST>
        <APPLICATION-RECORD-DATA-TYPE>
          <SHORT-NAME>CylinderMeasure</SHORT-NAME>
        </APPLICATION-RECORD-DATA-TYPE>
        <APPLICATION-ARRAY-DATA-TYPE>
          <SHORT-NAME>Cylinder_measures</SHORT-NAME>
          <ELEMENT>
            <SHORT-NAME>Cylinder_Measure</SHORT-NAME>
            <CATEGORY>VALUE</CATEGORY>
            <TYPE-TREF
              DEST="APPLICATION-DATA-TYPE">CylinderMeasure</TYPE-TREF>
            <MAX-NUMBER-OF-ELEMENTS
              BINDING-TIME="CODE-GENERATION-TIME">
              2 * <SYSC-REF
              DEST="SW-SYSTEMCONST">NO_OF_CYLINDERS</SYSC-REF>
            </MAX-NUMBER-OF-ELEMENTS>
          </ELEMENT>
        </APPLICATION-ARRAY-DATA-TYPE>
      </ELEMENTS>
    </AR-PACKAGE>
```

In this example, the variation lies in the size of the array `cylinder_measures`. Normally, this size would be a value; in this example, it is a reference to a system constant:

```
<MAX-NUMBER-OF-ELEMENTS BINDING-TIME="CODE-GENERATION-TIME">
 2 * <SYSC-REF DEST="SW-SYSTEMCONST">NO_OF_CYLINDERS</SYSC-REF>
</MAX-NUMBER-OF-ELEMENTS>
```

As one can see, there is no tag `VARIATION-POINT`. The variation point can be recognized by the attribute `BINDING-TIME`[16].

7.9.4 Example for *Property Set Pattern*

Description Varying properties of a `FlexrayCommunicationController`.

Use Case An ECU is connected to a FlexRay bus in two different configurations (car types), requiring different `FlexrayCommunicationController` settings.

Implementation Several property values of a `FlexrayCommunicationController` need to be consistently set or modified in one configuration step.

In our example, we have two variants for the attributes `microPerCycle`, `microtickDuration`, and `samplesPerMicrotick` of the `FlexrayCommunicationController`. Since these three attributes are mutually dependent in both configurations, and their values need to be set together.

The system constant `CarType` is used to discriminate between the two variants, `CarType1` and `CarType2`, illustrated in Table 7.32.

[16] Consequently, a formula without a `BINDING-TIME` attribute on the enclosing XML element is an error.

All other attributes are non-variant in our example. We show only the (alphabetically) first and last attributes of `FlexrayCommunicationController`, namely `acceptedStartupRange` and `wakeUpPattern` in the XML file, omitting the others for brevity.

	CarType 1	CarType 2
`microPerCycle`	320000	80000
`microtickDuration`	$50E-9$	$12.5E-9$
`samplesPerMicrotick`	4	1

Table 7.32: Property Set Pattern: CarType

This example is illustrated in Figure 7.18.

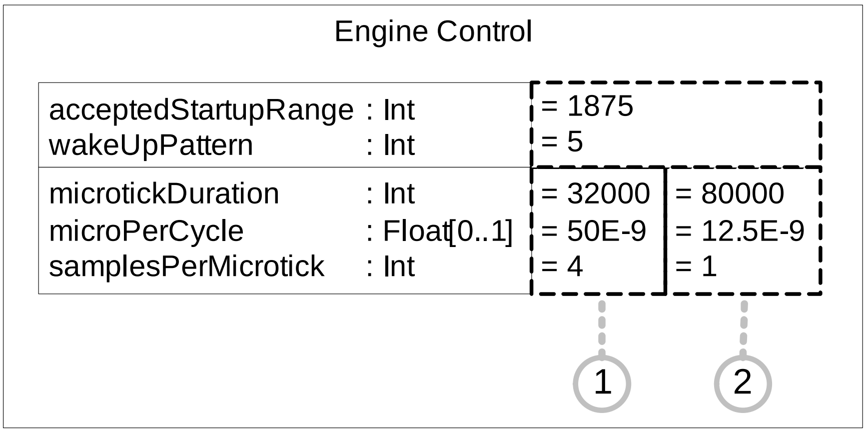


Figure 7.18: Example for *property set pattern*

Listing 7.7 shows the XML code for our example.

Listing 7.7: Example for property set pattern

```
<AR-PACKAGE>
  <SHORT-NAME>PropertySetPattern</SHORT-NAME>
  <ELEMENTS>
    <ECU-INSTANCE>
      <SHORT-NAME>iPhone</SHORT-NAME>
      <COMM-CONTROLLERS>
        <FLEXRAY-COMMUNICATION-CONTROLLER>
          <SHORT-NAME>iFlex</SHORT-NAME>
          <FLEXRAY-COMMUNICATION-CONTROLLER-VARIANTS>
            <FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
              <ACCEPTED-STARTUP-RANGE>1875</ACCEPTED-STARTUP-RANGE>
              <WAKE-UP-PATTERN>5</WAKE-UP-PATTERN>
            </FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
            <FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
              <MICRO-PER-CYCLE>320000</MICRO-PER-CYCLE>
              <MICROTICK-DURATION>50E-9</MICROTICK-DURATION>
              <SAMPLES-PER-MICROTICK>4</SAMPLES-PER-MICROTICK>
              <VARIATION-POINT>
                <SW-SYSCOND
                  BINDING-TIME="CODE-GENERATION-TIME">
                        <SYSC-REF
```

```
                  DEST="SW-SYSTEMCONST">/AggregationPattern/CarType</
                      SYSC-REF>
                         == 1
                       </SW-SYSCOND>
              </VARIATION-POINT>
            </FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
            <FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
              <MICRO-PER-CYCLE>80000</MICRO-PER-CYCLE>
              <MICROTICK-DURATION>12.5E-9</MICROTICK-DURATION>
              <SAMPLES-PER-MICROTICK>1</SAMPLES-PER-MICROTICK>
              <VARIATION-POINT>
                <SW-SYSCOND
                  BINDING-TIME="CODE-GENERATION-TIME">
                        <SYSC-REF
                  DEST="SW-SYSTEMCONST">/AggregationPattern/CarType</
                      SYSC-REF>
                         == 2
                       </SW-SYSCOND>
              </VARIATION-POINT>
            </FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
          </FLEXRAY-COMMUNICATION-CONTROLLER-VARIANTS>
        </FLEXRAY-COMMUNICATION-CONTROLLER>
      </COMM-CONTROLLERS>
    </ECU-INSTANCE>
  </ELEMENTS>
</AR-PACKAGE>
```

At the heart of example 7.7 is the following construct, which defines three sets of variant attributes for the FlexrayCommunicationController.

```
<FLEXRAY-COMMUNICATION-CONTROLLER>
  <SHORT-NAME>iFlex</SHORT-NAME>
  <FLEXRAY-COMMUNICATION-CONTROLLER-VARIANTS>
    <FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
      ...
    </FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
    <FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
      ...
      <VARIATION-POINT>
        <SW-SYSCOND BINDING-TIME="CODE-GENERATION-TIME">
          <SYSC-REF DEST="SW-SYSTEMCONST">/AggregationPattern/CarType</SYSC
             -REF>
           == 1
        </SW-SYSCOND>
      </VARIATION-POINT>
    </FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
    <FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
      ...
      <VARIATION-POINT>
        <SW-SYSCOND BINDING-TIME="CODE-GENERATION-TIME">
          <SYSC-REF DEST="SW-SYSTEMCONST">/AggregationPattern/CarType</SYSC
             -REF>
           == 2
        </SW-SYSCOND>
      </VARIATION-POINT>
    </FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL>
```

```
  </FLEXRAY-COMMUNICATION-CONTROLLER-VARIANTS>
</FLEXRAY-COMMUNICATION-CONTROLLER>
```

As one can see, FLEXRAY-COMMUNICATION-CONTROLLER contains a wrapper element FLEXRAY-COMMUNICATION-CONTROLLER-VARIANTS, and a FLEXRAY-COMMUNICATION-CONTROLLER-CONDITIONAL for each variation:

- The first CONDITIONAL holds the non-variant attributes (acceptedStartupRange to wakeUpPattern). Note that this CONDITIONAL does not contain a variation point.
- The second CONDITIONAL holds the first set of variant attributes, namely those for *CarType* 1.
- The third CONDITIONAL holds the first set of variant attributes, namely those for *CarType* 2.

8 Documentation Support

8.1 Introduction

The AUTOSAR meta-model and XML schema are based upon ASAM FSX[20]. They provide support for well-structured, content-focused and integrated documentation.

The documentation supported by AUTOSAR is "well structured" in the sense that the building blocks used to build the documentation delimit the beginning and the end of each construct, the constructs are context-neutral and can be cut and pasted wherever the construct is legal[1].

The author of an AUTOSAR documentation does not need to focus on formatting of the text. Instead, he/she can focus on the content, structuring this content in a hierarchy of chapters. He can use figures, lists, tables, and formula to express his though clearly, even making notes[2] to stress some points. However, he does not specify the appearance of these elements. He lets a tool format all of them according to a consistent style (e.g. corporate identity).

One advantages of such a well-structured and content-focused documentation is that it can be processed and transformed easily, thus supporting operation like merging different sources to produce a comprehensive documentation from multiple components' documentation. Different parts of the content can be annotated with their intended audience, so that it is possible to generate audience-specific documents from the same composite source.

The documentation can be integrated within an M1-level artifact (e.g., a SWC-T instance) in the following levels:

- **[TPS_GST_00305] Single Paragraph** ⌈ A single paragraph in the role `desc` provides a short description of an identifiable object to help a human being identify the object. It can be inserted in any `Identifiable` element for description of identifiable).⌋ *()* See Chapter 8.2.1 and Section 4.3 for more details.
- **[TPS_GST_00306] Documentation Block** ⌈A documentation block is available in any `Identifiable` element as `introduction`. This type of documentation is typically used to capture a short introduction about the role of an element or respectively how it is built.⌋ *()* See Chapter 8.2 and Section 4.3 for more details.
- **[TPS_GST_00307] Standalone Documentation** ⌈ A standalone documentation structured into multiple chapters is also offered in AUTOSAR. It supports references to particular model elements. This type of documentation is suited to describe the interactions among multiple elements and to provide a complete overview.⌋ *()* See Section 8.3 for details.

[1]The construct chapter, for example, can be nested into any other chapter becoming a sub-chapter or a sub-sub-chapter. The advantage becomes clear when one tries to restructure a LaTeX report moving chapters, sections, and subsections at different level in the document hierarchy.

[2]Examples of notes include caution, hints, exercises.

Figure 8.1 illustrates[3] the macroscopic text model of AUTOSAR, in particular the available entry points on which documentation is integrated in particular AUTOSAR metamodel elements. DocumentationContainer is not a real metamodel element. It is used in this diagram to illustrate any AUTOSAR metamodel element which may contain documentation.

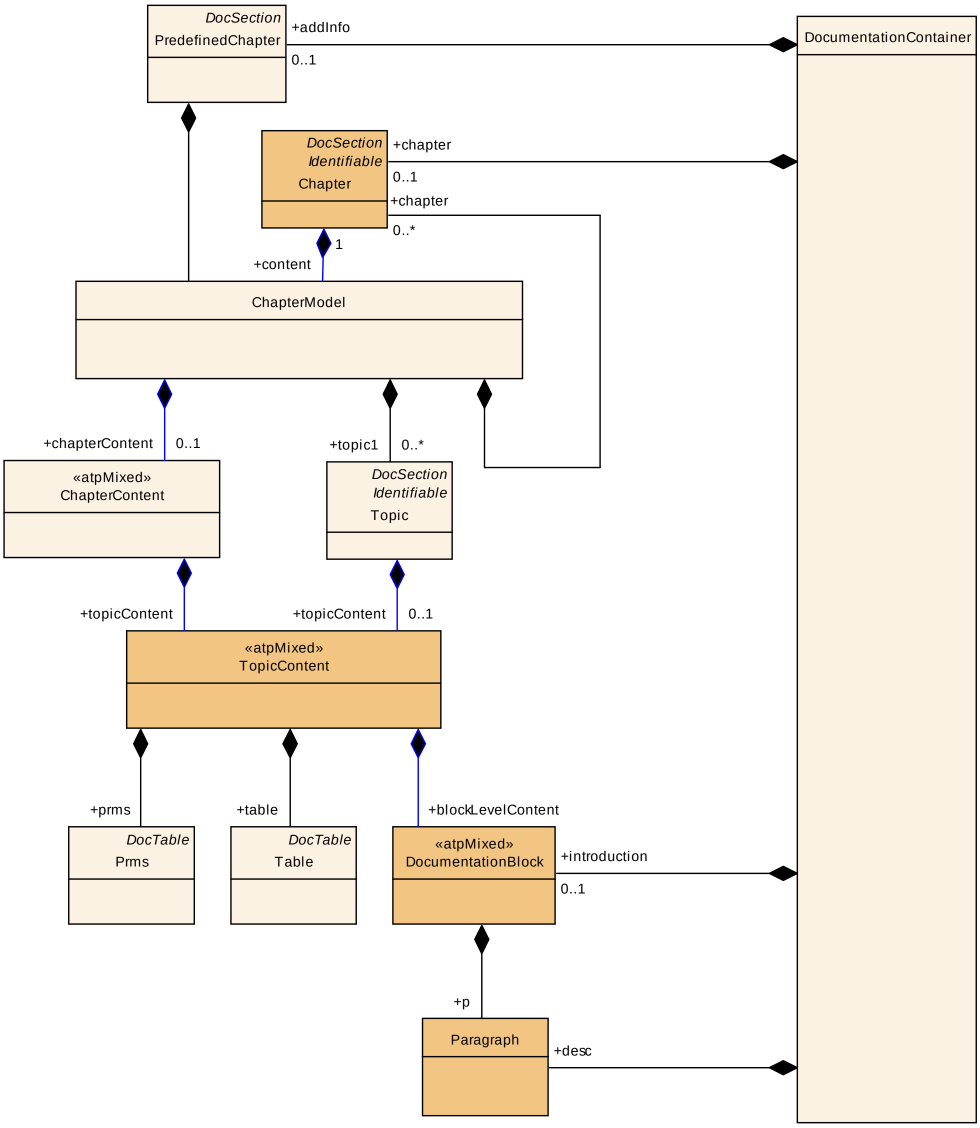


Figure 8.1: Macroscopic text model (simplified)

In figure 8.1, each of the three levels extends the mechanisms offered by the previous one. The documentation block used in the `introduction` contains paragraphs used in `desc`. The standalone documentation are build around chapters containing documentation block as well as generic tables `table` and parameter tables `prms`. There are two types of chapters: the `Chapter`, which have a title and the predefined chapter `PredefinedChapter`, which name is given by their context[4].

[3]note that this is a simplified illustration of the real model

[4]In the software component template, for example, a component has an optional set of predefined documentation aspects (e.g., swFeatureDesc, swTestDesc, swCalibrationNotes)

[TPS_GST_00308] Purpose of Chapter ⌈ A chapter addresses one or more topics. It may be organized into tables and documentation blocks followed by sub chapters or topics.⌋ *()*

[TPS_GST_00309] Purpose of Topic1 ⌈ A Topic is a logical unit, which is given explicit boundaries and a label concisely capturing its content. Usually a topic does not get a number nor an entry in table of contents of e.g. printed document.⌋ *()*

[TPS_GST_00310] Synopsis of Chapters and Topics ⌈Chapters and topics have basically the same content. However, a chapter is typically formatted differently, may offer additional representation means and will probably be extended independently of the topic in the future. Therefore, ChapterContent contains the TopicContent.⌋ *()*

Please note that the various names (e.g., prms, desc, introduction) are used to remain consistent with [20].

The remaining sections of this chapter describe the following aspects of AUTOSAR documentation:

- Section 8.2.1 describes the mechanisms used within a single paragraph.
- Section 8.2 describes the documentation features supported by the introduction and the classes used to implement them.
- Section 8.3 describes the exhaustive documentation features used to produce a standalone documentation.
- Section 8.6 describes the multi-language support offered by AUTOSAR documentation.

8.2 Documentation Block

[TPS_GST_00311] DocumentationBlock fits in a table cell ⌈ The DocumentationBlock is limited such that it can be represented in a table cell and therefore can not contain tabular elements. It contains the following basic documentation elements:

- **paragraph**: The construct p identifies the text organized as a paragraph.
- **List**: A list is a sequence of items. In AUTOSAR, the concept of list implemented using different keywords.
- **Figure**: The figure is the construct used to insert a diagram in a document. It is composed of a FigureCaption and the diagram itself. Depending on the tool used, different diagram format are supported (example of graphical format include svg (scalable vector graphic), jpeg, and gif).
- **Formula**: The construct formula is used to represent a mathematical expression. Different kinds of specification of the formula are possible (for example the TEXmath format).

- **Verbatim**: `verbatim` represents a block in which whitespace (in particular blanks and line feeds) are kept "as they are". This enables basic formatting to be carried out, which can even be displayed on simple devices. Verbatim is often used to represent source code or xml in books.
- **note**: The construct `note` is used to express an annotation. Examples of annotation types include hint, caution, tip, instruction, and exercise.
- **trace**: The construct `trace` is used to manage tracing between items in documents. See [2] for more details.
- **structuredReq**: The construct `structuredReq` this is used for requirements documents. See [2] for more details.

⌋*()* See figure 8.2 for more details.

Class	≪**atpMixed**≫ **DocumentationBlock**			
Package	M2::MSR::Documentation::BlockElements			
Note	This class represents a documentation block. It is made of basic text structure elements which can be displayed in a table cell.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
defList	DefList	0..1	aggr	This represents a definition list in the documentation block. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=40
figure	MlFigure	0..1	aggr	This represents a figure in the documentation block. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=70
formula	MlFormula	0..1	aggr	This is a formula in the definition block. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=60
labeledList	LabeledList	0..1	aggr	This represents a labeled list. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=50
list	List	0..1	aggr	This represents numbered or unnumbered list. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=30
msrQuery P2	MsrQueryP2	0..1	aggr	

note	Note	0..1	aggr	This represents a note in the text flow. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=80
p	MultiLanguageParagraph	0..1	aggr	This is one particular paragraph. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=10
structuredReq	StructuredReq	0..1	aggr	This aggregation supports structured requirements embedded in a documentation block. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=100
trace	TraceableText	0..1	aggr	This represents traceable text in the documentation block. This allows to specify requirements/constraints in any documentation block. The kind of the trace is specified in the category. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=90
verbatim	MultiLanguageVerbatim	0..1	aggr	This represents one particular verbatim text. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=20

Table 8.1: DocumentationBlock

Figure 8.2 illustrates the constructs contained in a documentation block and the constructs that contains a documentation block.

[TPS_GST_00312] Variation in Documentation ⌈ The elements in `DocumentationBlock` are aggregated as ≪`atpVariation`≫ with a latest binding time set to `PostBuild`. This indicates that also post build variation can be documented properly.⌋ *()* See Chapter 7.6.4 for details.

A documentation part with binding time `PostBuild` can not be bound at startup of an ECU. This part describes functionality which depends on `PostBuild` variability.

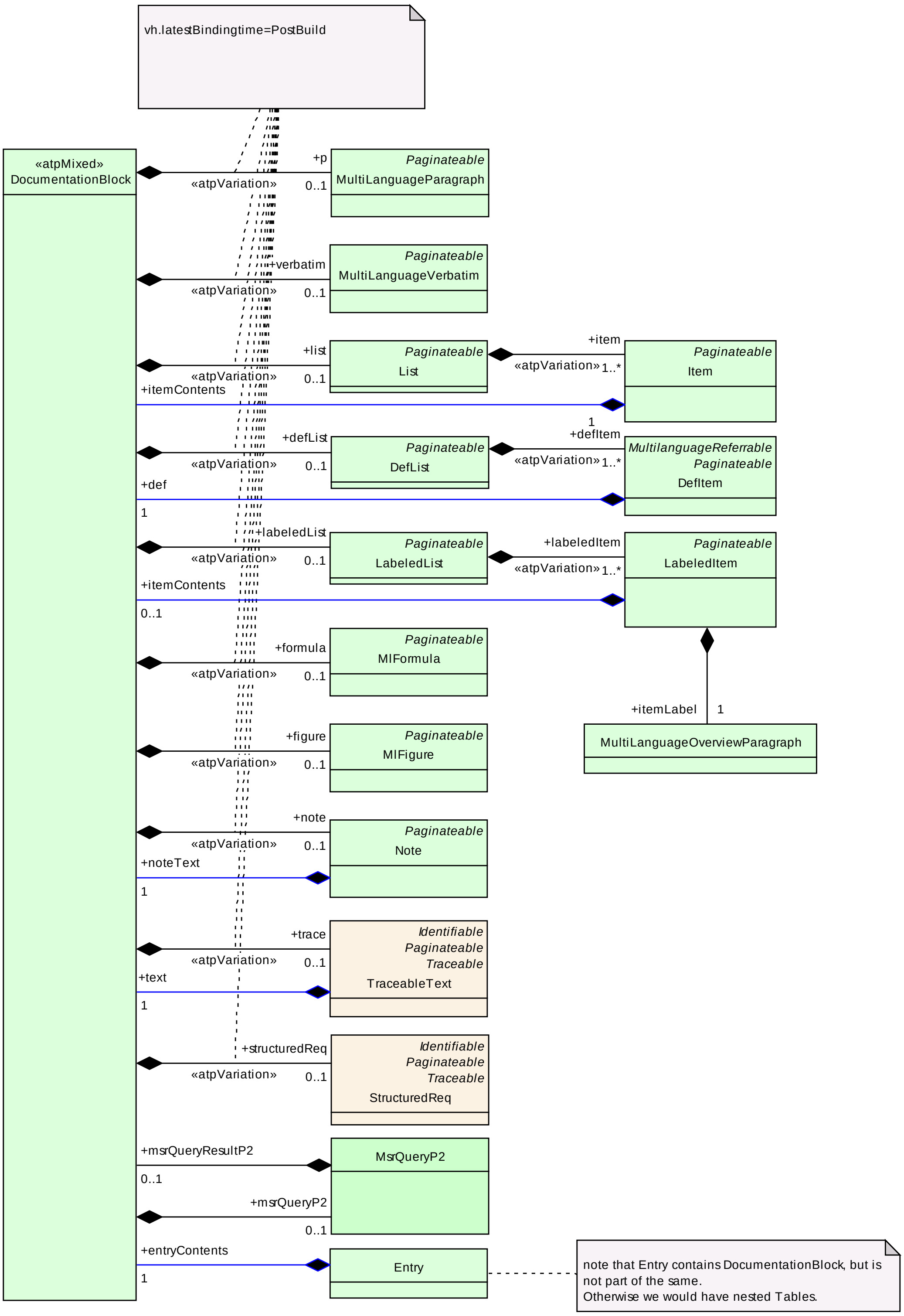


Figure 8.2: documentation block overview

8.2.1 Paragraph

[TPS_GST_00313] Types of Paragraph ⌈ There are two different types of paragraphs in AUTOSAR. They differ only in the elements, which they may contain:

- the overview paragraph (`LOverviewParagraph`) is used as a compact descriptive paragraph `desc`. It therefore cannot embed Identifiables which might be rendered as structure (such as `Xdoc` etc.).
- the regular paragraph (`LParagraph`) (used as p) additionally provides elements which might be rendered as structures such as meta data of external files, document and standards.

⌋ *()*

[constr_2595] Footnotes should not be nested ⌈ Note that even if supported by the meta model, footnotes shall not be nested. Nested footnotes might lead to problems with the processing of the footnote link. In other words `LParagraph` shall not be aggregated with role `ft` within a `LParagraph` which already has the role `ft`. ⌋ *()*[5]

Note: The value of attribute L within ft should be consistent to the attribute L of the container of ft.

Class	≪**atpMixedString**≫ **MixedContentForParagraph (abstract)**			
Package	M2::MSR::Documentation::TextModel::InlineTextModel			
Note	This mainly represents the text model of a full blown paragraph within a documentation.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
br	Br	1	aggr	This element is the same as function here as in a HTML document i.e. it forces a line break. **Tags:** xml.sequenceOffset=40
e	EmphasisText	1	aggr	This is emphasized text. **Tags:** xml.sequenceOffset=70
ft	SlParagraph	1	aggr	This is a foot note within a paragraph.
ie	IndexEntry	1	aggr	This is an index entry. **Tags:** xml.sequenceOffset=110
std	Std	1	aggr	This is a refeernce to a standard. **Tags:** xml.sequenceOffset=120
sub	Superscript	1	attr	This is subscript text. **Tags:** xml.sequenceOffset=100

[5]The L attribute of the ft class was introduced in R4.2.2. This unintentionally led to backwards incompatibility. To correct this the classes SlParagraph and SlOverviewParagraph are introduced as vehicle to overcome the incompatibility. Both classes own a L attribute. This attribute restores the backwards compatibility to R4.1 (where the attribute was not available) while maintaining backwards compatibility to 4.2.2 (where the attribute was required). The value of this attribute shall be ignored in any case.

sup	Superscript	1	attr	This is superscript text. **Tags:** xml.sequenceOffset=90
trace	Traceable	1	ref	This allows to place an arbitrary reference to a traceable object in documentation.
tt	Tt	1	aggr	This is a technical term. **Tags:** xml.sequenceOffset=30
xdoc	Xdoc	1	aggr	This is a reference to a printable external document. **Tags:** xml.sequenceOffset=130
xfile	Xfile	1	aggr	This represents a reference to an external file which usually cannot be printed. **Tags:** xml.sequenceOffset=140
xref	Xref	1	aggr	This is a cross reference. **Tags:** xml.sequenceOffset=50
xrefTarget	XrefTarget	1	aggr	This element specifies a reference target which can be scattered throughout the text. **Tags:** xml.sequenceOffset=60

Table 8.2: MixedContentForParagraph

Class	≪`atpMixedString`≫ **MixedContentForOverviewParagraph (abstract)**			
Package	M2::MSR::Documentation::TextModel::InlineTextModel			
Note	This is the text model of a restricted paragraph item within a documentation. Such restricted paragraphs are used mainly for overview items, e.g. desc.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
br	Br	1	aggr	This element is the same as function here as in a HTML document i.e. it forces a line break.
e	EmphasisText	1	aggr	This is emphasis text. **Tags:** xml.sequenceOffset=60
ft	SlOverviewParagraph	1	aggr	This is a foot note within a paragraph.
ie	IndexEntry	1	aggr	This is an index entry. **Tags:** xml.sequenceOffset=100
sub	Superscript	1	attr	This is superscript text. **Tags:** xml.sequenceOffset=90
sup	Superscript	1	attr	This is subscript text. **Tags:** xml.sequenceOffset=80
trace	Traceable	1	ref	This allows to place an arbitrary reference to a traceable object in documentation.

tt	Tt	1	aggr	This is a technical term. **Tags:** xml.sequenceOffset=30
xref	Xref	1	aggr	This is a cross reference. **Tags:** xml.sequenceOffset=40
xrefTarget	XrefTarget	1	aggr	This element specifies a reference target which can be scattered throughout the text. **Tags:** xml.sequenceOffset=50

Table 8.3: MixedContentForOverviewParagraph

Class	**MultiLanguageParagraph**			
Package	M2::MSR::Documentation::TextModel::MultilanguageData			
Note	This is the content model of a multilingual paragraph in a documentation.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true
l1	LParagraph	1..*	aggr	This is the paragraph content in one partiucular language. **Tags:** xml.roleElement=true; xml.roleWrapper Element=false; xml.sequenceOffset=20; xml.type Element=false; xml.typeWrapperElement=false

Table 8.4: MultiLanguageParagraph

Class	≪`atpMixedString`≫ **MixedContentForParagraph (abstract)**			
Package	M2::MSR::Documentation::TextModel::InlineTextModel			
Note	This mainly represents the text model of a full blown paragraph within a documentation.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
br	Br	1	aggr	This element is the same as function here as in a HTML document i.e. it forces a line break. **Tags:** xml.sequenceOffset=40
e	EmphasisText	1	aggr	This is emphasized text. **Tags:** xml.sequenceOffset=70
ft	SlParagraph	1	aggr	This is a foot note within a paragraph.
ie	IndexEntry	1	aggr	This is an index entry. **Tags:** xml.sequenceOffset=110

std	Std	1	aggr	This is a refeernce to a standard. **Tags:** xml.sequenceOffset=120
sub	Superscript	1	attr	This is subscript text. **Tags:** xml.sequenceOffset=100
sup	Superscript	1	attr	This is superscript text. **Tags:** xml.sequenceOffset=90
trace	Traceable	1	ref	This allows to place an arbitrary reference to a traceable object in documentation.
tt	Tt	1	aggr	This is a technical term. **Tags:** xml.sequenceOffset=30
xdoc	Xdoc	1	aggr	This is a reference to a printable external document. **Tags:** xml.sequenceOffset=130
xfile	Xfile	1	aggr	This represents a reference to an external file which usually cannot be printed. **Tags:** xml.sequenceOffset=140
xref	Xref	1	aggr	This is a cross reference. **Tags:** xml.sequenceOffset=50
xrefTarget	XrefTarget	1	aggr	This element specifies a reference target which can be scattered throughout the text. **Tags:** xml.sequenceOffset=60

Table 8.5: MixedContentForParagraph

8.2.2 Verbatim

[TPS_GST_00314] Purpoes of Verbatim ⌈ Verbatim (represented by `MultiLanguageVerbatim` respectively `MixedContentForVerbatim`) marks the text as "preformatted" – all the spaces and carriage returns are rendered exactly as they are typed be the user respectively appear in the model. Such content should also be rendered using a mono spaced font. ⌋ *()*

[TPS_GST_00315] Rendering of inline elements of Verbatim ⌈ Even if the content needs to be rendered verbatim, the model still allows inline elements. It is expected the number of characters are not changed when those elements are rendered. ⌋ *()*

Class	**MultiLanguageVerbatim**			
Package	M2::MSR::Documentation::TextModel::MultilanguageData			
Note	This class represents multilingual Verbatim. Verbatim means, that white-space is maintained. When Verbatim is rendered in PDF or Online media, white-space is obeyed. Blanks are rendered as well as newline characters.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
allowBreak	NameToken	0..1	attr	This indicates if the verbatim text might be split on multiple pages. Default is "1". **Tags:** xml.attribute=true
float	FloatEnum	0..1	attr	Indicate whether it is allowed to break the element. The following values are allowed: **Tags:** xml.attribute=true
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true
l5	LVerbatim	1..*	aggr	This the text in one particular language. **Tags:** xml.roleElement=true; xml.roleWrapper Element=false; xml.sequenceOffset=20; xml.type Element=false; xml.typeWrapperElement=false
pgwide	PgwideEnum	0..1	attr	Used to indicate wether the figure should take the complete page width (value = "pgwide") or not (value = "noPgwide"). **Tags:** xml.attribute=true

Table 8.6: MultiLanguageVerbatim

Class	≪atpMixedString≫ **MixedContentForVerbatim (abstract)**			
Package	M2::MSR::Documentation::TextModel::InlineTextModel			
Note	This is the text model for preformatted (verbatim) text. It mainly consists of attributes which do not change the length on rendering. This class represents multilingual verbatim. Verbatim, sometimes called preformatted text, means that white-space is maintained. When verbatim is rendered in PDF or Online media, it is rendered using a monospaced font while white-space is obeyed. Blanks are rendered as well as newline characters. Even if there are inline elements, the length of the data must not be influenced by formatting.			
Base	ARObject, WhitespaceControlled			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
br	Br	1	aggr	This element is the same as function here as in a HTML document i.e. it forces a line break. **Tags:** xml.sequenceOffset=50

e	EmphasisText	1	aggr	This is emphsized text. Note that in verbatim, the attribute font should not be considered since verbatim is always rendered as monospace font. **Tags:** xml.sequenceOffset=30
tt	Tt	1	aggr	This represents a technical term in verbatim. Note that it's the responibility of the user not to take a tt that would add additional character to the text (such as SgmlElement).
xref	Xref	1	aggr	This is a crossreference within a verbatim text. The attributes may disturb the arrangement of the text. It is subject to the author to keep this under control. **Tags:** xml.sequenceOffset=40

Table 8.7: MixedContentForVerbatim

Class	**WhitespaceControlled (abstract)**			
Package	M2::MSR::Documentation::TextModel::LanguageDataModel			
Note	This meta-class represents the ability to control the white-space handling e.g. in xml serialization. This is implemented by adding the attribute "space".			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
xmlSpace	XmlSpaceEnum	1	attr	This attribute is used to signal an intention that in that element, white space should be preserved by applications. It is defined according to xml:space as declared by W3C. **Tags:** xml.attribute=true; xml.attributeRef=true; xml.enforceMinMultiplicity=true; xml.name=space; xml.nsPrefix=xml

Table 8.8: WhitespaceControlled

8.2.3 Lists in Documentation

In documentation it is often appropriate to present facts in form of lists. AUTOSAR supports the following kinds of lists:

- **[TPS_GST_00316] Plain List** ⌈ The **plain list** (`List`) is composed of one or more list items (`item`). There are two types of lists, numbered and unnumbered[6] This is controlled by `type` in `List`.

  An `Item` contains a `DocumentationBlock`. In most cases, it is a simple paragraph, but it often one or more paragraphs followed by a sub-list. ⌋*()*

[6]An unnumbered list is also called bullet list.

- **[TPS_GST_00317] Labeled List** ⌈ The **labeled list** (LabeledList) is a list, where every item has a label (LabeledItem) and a content, which is a DocumentationBlock.

  The policy how to render the labeled list is denoted in itemLabelPos in IndentSample. ⌋*()*

- **[TPS_GST_00318] Definition List** ⌈ The **definition list** (DefList) is used to introduce terms and their definition. The term is captured in a DefItem and the definition expressed in a DocumentationBlock.

  Note that the DefList maintains the specific semantics of defintions, even if it might be rendered in the same way as LabeledList. For example the defItems in a DefList are Referrable. ⌋*()*

[constr_2520] Nesting of lists shall be limited ⌈ The nesting of lists shall be limited to a reasonable depth such that it can safely be rendered on A4 pages. A reasonable approach is not to nest more than three levels. ⌋*()*

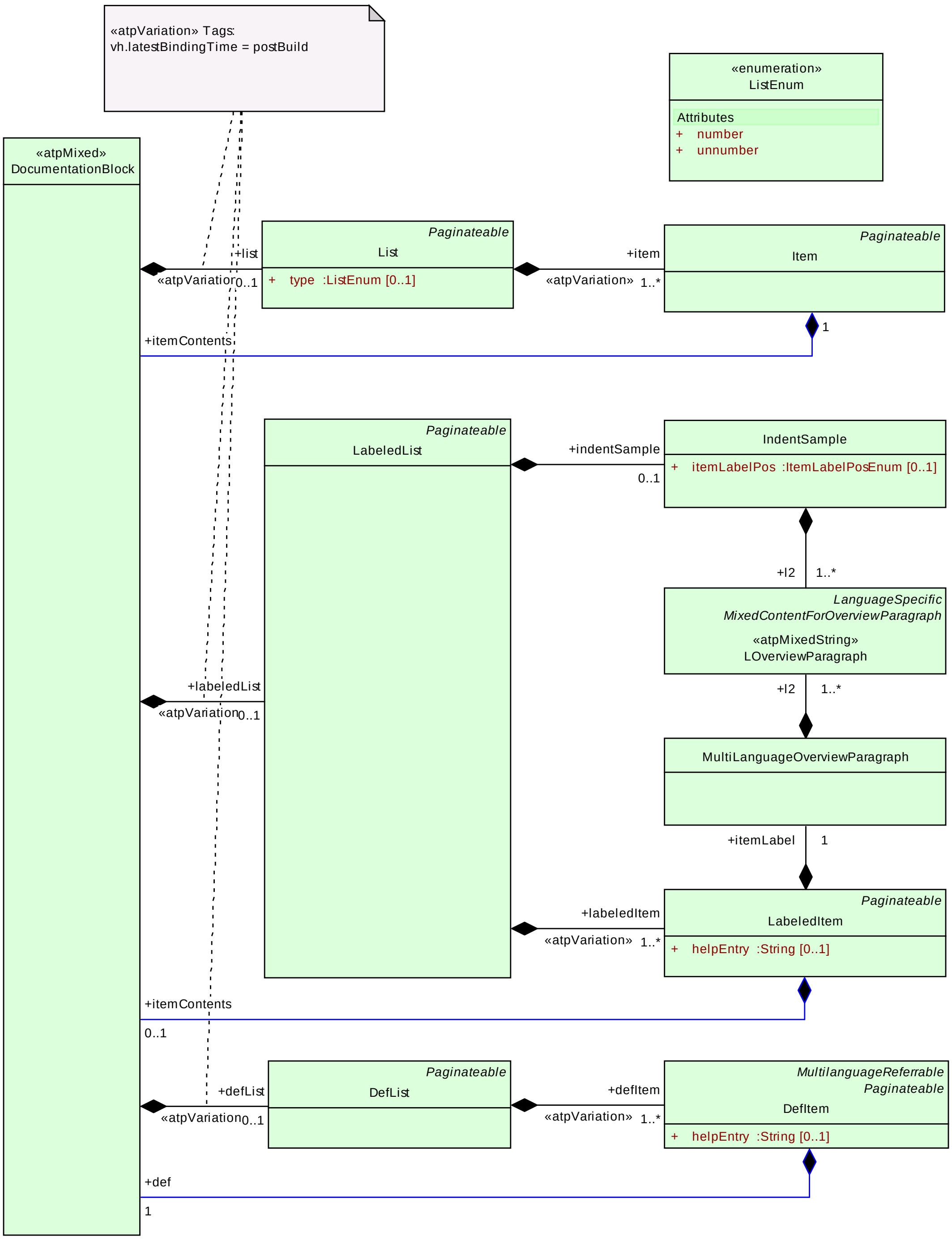


Figure 8.3: List Element Overview

8.2.3.1 Class tables for `List`

Class	**List**			
Package	M2::MSR::Documentation::BlockElements::ListElements			
Note	This meta-class represents the ability to express a list. The kind of list is specified in the attribute.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
item	Item	1..*	aggr	this represents a particular list item. Note that this is again a documentation block.Therefore lists can be arbitrarily nested. It is discouraged to have a very deep nesting. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.roleElement=true; xml.roleWrapper Element=false; xml.sequenceOffset=20; xml.type Element=false; xml.typeWrapperElement=false
type	ListEnum	0..1	attr	The type of the list. Default is "UNNUMBER" **Tags:** xml.attribute=true

Table 8.9: List

Class	**Item**			
Package	M2::MSR::Documentation::BlockElements::ListElements			
Note	This meta-class represents one particular item in a list.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
itemConte nts	Documentation Block	1	aggr	this represents the actual content of the item. It is composed of a DocumentationBlock. This way it is possible to use simple paragraphs to nested lists, formula, figures or notes. **Tags:** xml.roleElement=false; xml.roleWrapper Element=false; xml.typeElement=false; xml.type WrapperElement=false

Table 8.10: Item

Enumeration	**ListEnum**
Package	M2::MSR::Documentation::BlockElements::ListElements
Note	This meta-class represents the notation of the various types of lists.
Literal	***Description***
number	This indicates that the list is an numerated list. **Tags:** atp.EnumerationValue=0
unnumber	This indicates that it is an enumeration (bulleted list) **Tags:** atp.EnumerationValue=1

Table 8.11: ListEnum

8.2.3.2 Class tables for LabeledList

Class	LabeledList			
Package	M2::MSR::Documentation::BlockElements::ListElements			
Note	This meta-class represents a labeled list, in which items have a label and a content. The policy how to render such items is specified in the labeled list.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
indentSample	IndentSample	0..1	aggr	This is a sample item. This sample is used by a rendering system to measure out the width of indentation. Since this depends on the particular fontsize etc. the indentation cannot be specified e.g. in mm. **Tags:** xml.sequenceOffset=20
labeledItem	LabeledItem	1..*	aggr	This represents one particular item in the labeled list. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=30; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.12: LabeledList

Class	LabeledItem			
Package	M2::MSR::Documentation::BlockElements::ListElements			
Note	this represents an item of a labeled list.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true
itemContents	DocumentationBlock	0..1	aggr	This represents the actual content of the item. It is composed of a DocumentationBlock. This way it is possible to use simple paragraphs to nested lists, formula, figures or notes. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.sequenceOffset=30; xml.typeElement=false; xml.typeWrapperElement=false
itemLabel	MultiLanguageOverviewParagraph	1	aggr	This is the label of the item. **Tags:** xml.sequenceOffset=20

Table 8.13: LabeledItem

Class	**IndentSample**			
Package	M2::MSR::Documentation::BlockElements::ListElements			
Note	This represents the ability to specify indentation of a labeled list by providing a sample content. This content can be measured by the rendering system in order to determine the width of indentation.			
Base	ARObject			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
itemLabelPos	ItemLabelPosEnum	0..1	attr	The position of the label in case the label is too long. The default is "NO-NEWLINE" **Tags:** xml.attribute=true
l2	LOverviewParagraph	1..*	aggr	This represents the indent sample in one particular language. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.14: IndentSample

Enumeration	**ItemLabelPosEnum**
Package	M2::MSR::Documentation::BlockElements::ListElements
Note	This enumerator specifies, how the label of a labeled list shall be rendered.
Literal	*Description*
newline	The label is renders in a new line. **Tags:** atp.EnumerationValue=0
newlineIfNecessary	The label is rendered in a new line if it is longer than the indentation. **Tags:** atp.EnumerationValue=1
noNewline	The label is rendered in one line with the item even if it is longer than the indentation. **Tags:** atp.EnumerationValue=2

Table 8.15: ItemLabelPosEnum

8.2.3.3 Class tables for `DefList`

Class	**DefList**			
Package	M2::MSR::Documentation::BlockElements::ListElements			
Note	This meta-class represents the ability to express a list of definitions. Note that a definition list might be rendered similar to a labeled list but has a particular semantics to denote definitions.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*

defItem	DefItem	1..*	aggr	This is one entry in the definition list. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.roleElement=true; xml.roleWrapper Element=false; xml.sequenceOffset=20; xml.type Element=false; xml.typeWrapperElement=false

Table 8.16: DefList

Class	**DefItem**			
Package	M2::MSR::Documentation::BlockElements::ListElements			
Note	This represents an entry in a definition list. The defined item is specified using shortName and longName.			
Base	ARObject, DocumentViewSelectable, MultilanguageReferrable, Paginateable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
def	Documentation Block	1	aggr	This represents the definition part of the DefItem. **Tags:** xml.sequenceOffset=20
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true

Table 8.17: DefItem

8.2.4 Figures in Documentation

[TPS_GST_00319] Figures in Documentation ⌈ AUTOSAR supports to include figures in documentation by `MlFigure`. This is composed of a caption (`figureCaption`) and a graphic `lGraphic` with language attribute. The caption gives a title to the figure and also makes the figure referrable. ⌋*()*

[TPS_GST_00320] Details of Figures in Documentation ⌈ `figureCaption` refers to the actual diagram in a standardized diagram format as specified in `GraphicNotationEnum`.

The figure contains also a `map` specifying regions of an image or object and assigning a specific action to each region (e.g., retrieve a document, run a program, etc.) When the region is activated by the user, the action is executed. ⌋*()*

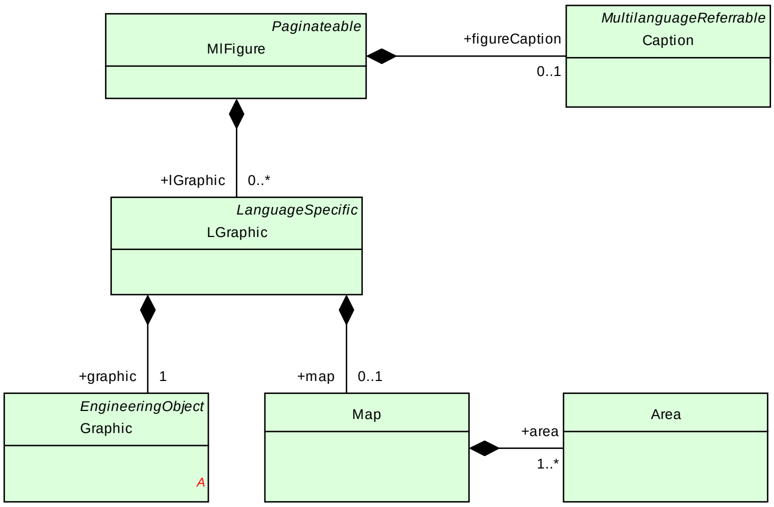


Figure 8.4: Figure Overview

Class	**Area**			
Package	M2::MSR::Documentation::BlockElements::Figure			
Note	This element specifies a region in an image map. Image maps enable authors to specify regions in an object (e.g. a graphic) and to assign a specific activity to each region (e.g. load a document, launch a program etc.). For more details refer to the specification of HTML.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
accesskey	String	0..1	attr	This attribute assigns an access key to an element. An access key is an individual character (e.g. "B") within the document character range. If an access key with an element assigned to it is pressed, the element comes into focus. The activity performed when an element comes into focus, is dependent on the element itself **Tags:** xml.attribute=true
alt	String	0..1	attr	This attribute specifies the text to be inserted as an alternative to illustrations, shapes or applets, where these cannot be displayed by user agents. **Tags:** xml.attribute=true
class	String	0..1	attr	Blank separated list of classes **Tags:** xml.attribute=true
coords	String	0..1	attr	This attribute specifies the position and shape on the screen. The number of values and their order depend on the geometrical figure defined. **Tags:** xml.attribute=true

href	String	0..1	attr	This attribute specifies the memory location of a web resource. It is therefore able to specify a link between the current element and the target element. **Tags:** xml.attribute=true
nohref	AreaEnumNohref	0..1	attr	If this attribute is set, the Area has no associated link. **Tags:** xml.attribute=true
onblur	String	0..1	attr	The ONBLUR-Event occurs, when focus is switched away from an element. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onclick	String	0..1	attr	The ONCLICK-Event occurs, if the current element is clicked-on. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
ondblclick	String	0..1	attr	The ONCLICK-Event occurs, if the current element is "double" clicked-on. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onfocus	String	0..1	attr	The ONFOCUS-Event occurs, if an element comes into focus (e.g., through navigation using the tab button). A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onkeydown	String	0..1	attr	The ONKEYDOWN-Event occurs, if a button on the current element is pressed down. A script can be stored in this attribute to be performed in the event. **Tags:** xml.attribute=true

onkeypres s	String	0..1	attr	The ONKEYPRESS-Event occurs, if a button on the current element is pressed down and released. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onkeyup	String	0..1	attr	The ONKEYUP-Event occurs, if a button on the current element is released. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onmoused own	String	0..1	attr	The ONMOUSEDOWN-Event occurs, if the mouse button used for clicking is held down on the current element. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onmousem ove	String	0..1	attr	The ONMOUSEMOVE-Event occurs, if the mouse pointer is moved on the current element (i.e. it is located on the current element). A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onmouseo ut	String	0..1	attr	The ONMOUSEOUT-Event occurs, if the mouse pointer is moved from the current element. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onmouseo ver	String	0..1	attr	The ONMOUSEOVER-Event occurs, if the mouse pointer is moved to the current element from another location outside it. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true

onmouseup	String	0..1	attr	The ONMOUSEUP-Event occurs if the mouse button used for clicking is released on the current element. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
shape	AreaEnumShape	0..1	attr	The shape of the area. Note that in HTML this is defaulted to RECT. **Tags:** xml.attribute=true
style	String	0..1	attr	Information on the associated style **Tags:** xml.attribute=true
tabindex	String	0..1	attr	This attribute specifies the position of the current element in tabbing-order for the corresponding document. The value must lie between 0 and 32767. The Tabbing Order defines the sequence in which elements are focused on, when the user navigates using the keyboard. **Tags:** xml.attribute=true
title	String	0..1	attr	Title information of the Area element **Tags:** xml.attribute=true

Table 8.18: Area

Enumeration	**AreaEnumNohref**
Package	M2::MSR::Documentation::BlockElements::Figure
Note	This enumerator specifies the fact that the area has no reference.
Literal	***Description***
nohref	This indicates that the area has no active link. **Tags:** atp.EnumerationValue=0

Table 8.19: AreaEnumNohref

Enumeration	**AreaEnumShape**
Package	M2::MSR::Documentation::BlockElements::Figure
Note	This enumerator specifies the shape of the area.
Literal	***Description***
circle	The shape is a circle. **Tags:** atp.EnumerationValue=0

default	This specifies the fact that the area covers the rest of the figure. **Tags:** atp.EnumerationValue=1
poly	The area is specified as polygon. **Tags:** atp.EnumerationValue=2
rect	The shape is specified as rectangle. **Tags:** atp.EnumerationValue=3

Table 8.20: AreaEnumShape

Class	**Graphic**			
Package	M2::MSR::Documentation::BlockElements::Figure			
Note	This class represents an artifact containing the image to be inserted in the document			
Base	ARObject, EngineeringObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
editHeight	String	0..1	attr	Specifies the height of the graphic when it is displayed in an editor. The unit can be added to the number in the string. Possible units are: cm, mm, px, pt. The default unit is px. **Tags:** xml.attribute=true
editWidth	String	0..1	attr	Specifies the width of the graphic when it is displayed in an editor. The unit can be added to the number in the string. Possible units are: cm, mm, px, pt. The default unit is px. **Tags:** xml.attribute=true
editfit	GraphicFitEnum	0..1	attr	Specifies how the graphic shall be displayed in an editor. If the attribute is missing, **Tags:** xml.attribute=true
editscale	String	0..1	attr	Set the proportional scale when displayed in an editor. **Tags:** xml.attribute=true
filename	String	0..1	attr	Name of the file that should be displayed. This attribute is supported in ASAM FSX and kept in AUTOSAR in order to support cut and paste. **Tags:** xml.attribute=true
fit	GraphicFitEnum	0..1	attr	It determines the way in which the graphic should be inserted. Enter the attribute value "AS-IS" , to insert a graphic in its original dimensions. The graphic is adapted, if it is too big for the space for which it was intended. Default is "AS-IS" **Tags:** xml.attribute=true

generator	NameToken	0..1	attr	This attribute specifies the generator which is used to generate the image. Use case is that when editing a documentation, a figure (to be delivered by the modeling tool) is inserted by the authoring tool as reference (this is the role of graphic). But the real figure maybe injected during document processing. To be able to recognize this situation, this attribute can be applied. **Tags:** xml.attribute=true
height	String	0..1	attr	Define the displayed height of the figure. The unit can be added to the number in the string. Possible units are: cm, mm, px, pt. The default unit is px. **Tags:** xml.attribute=true
htmlFit	GraphicFitEnum	0..1	attr	How to fit the graphic in an online media. Default is AS-IS. **Tags:** xml.attribute=true
htmlHeight	String	0..1	attr	Specifies the height of the graphic when it is displayed online. The unit can be added to the number in the string. Possible units are: cm, mm, px, pt. The default unit is px. **Tags:** xml.attribute=true
htmlScale	String	0..1	attr	Set the proportional scale when displayed online. **Tags:** xml.attribute=true
htmlWidth	String	0..1	attr	Specifies the width of the graphic when it is displayed online. The unit can be added to the number in the string. Possible units are: cm, mm, px, pt. The default unit is px. **Tags:** xml.attribute=true
notation	GraphicNotationEnum	0..1	attr	This attribute captures the format used to represent the graphic. **Tags:** xml.attribute=true; xml.id=GRAPHIC_TYPE__GRAPHIC_TYPE__NOTATION
scale	String	0..1	attr	In this element the dimensions of the graphic can be altered proportionally. **Tags:** xml.attribute=true
width	String	0..1	attr	Define the displayed width of the figure. The unit can be added to the number in the string. Possible units are: cm, mm, px, pt. The default unit is px. **Tags:** xml.attribute=true

Table 8.21: Graphic

Enumeration	**GraphicFitEnum**
Package	M2::MSR::Documentation::BlockElements::Figure
Note	This enumerator specifies the policy how to place and scale the figure on the page.
Literal	***Description***
AsIs	This indicates that the image shall be incorporated as is without scaling, rotation etc. **Tags:** atp.EnumerationValue=0
FitToPage	Fit to the page **Tags:** atp.EnumerationValue=1
FitToText	fit to the text containing the graphic. **Tags:** atp.EnumerationValue=2
LimitToPage	This indicates that the width of the graphic shall be limited to the **page width**. The image shall not be scaled down but cropped. **Tags:** atp.EnumerationValue=3
LimitToText	This indicates that the width of the graphic shall be limited to the width of the current **text flow**. The image shall not be scaled down but cropped. **Tags:** atp.EnumerationValue=4
Rotate180	Rotate 180 degree **Tags:** atp.EnumerationValue=5
Rotate180 LimitToText	Rotate 180 degree **Tags:** atp.EnumerationValue=6
Rotate90Ccw FitToText	Rotate by 90 degree counter clock wise and then fit to text **Tags:** atp.EnumerationValue=8
Rotate90Ccw LimitToText	Rotate by 90 degree counter clock wise and then fit to text **Tags:** atp.EnumerationValue=9
Rotate90Cw	Rotate 90 degree clockwise **Tags:** atp.EnumerationValue=10
Rotate90Cw FitToText	Rotate by 90 degree and then fit to text **Tags:** atp.EnumerationValue=11
Rotate90Cw LimitToText	Rotate by 90 degree and then fit to text **Tags:** atp.EnumerationValue=12
Rotate90ccw	Rotate 90 degree counter clockwise **Tags:** atp.EnumerationValue=7

Table 8.22: GraphicFitEnum

Enumeration	**GraphicNotationEnum**

Package	M2::MSR::Documentation::BlockElements::Figure
Note	This enumerator specifies the various notations (finally file types) used to represent the figure.
Literal	***Description***
bmp	bitmap image **Tags:** atp.EnumerationValue=0
eps	Encapsulated Postscript **Tags:** atp.EnumerationValue=1
gif	Graphics Interchange Format **Tags:** atp.EnumerationValue=2
jpg	"Joint Photographic Experts Group" format **Tags:** atp.EnumerationValue=3
pdf	Portable Document Format **Tags:** atp.EnumerationValue=4
png	Portable Network Graphics **Tags:** atp.EnumerationValue=5
svg	scalable vector graphic **Tags:** atp.EnumerationValue=6
tiff	Tagged Image File Format **Tags:** atp.EnumerationValue=7

Table 8.23: GraphicNotationEnum

Class	**Map**			
Package	M2::MSR::Documentation::BlockElements::Figure			
Note	Image maps enable authors to specify regions of an image or object and assign a specific action to each region (e.g., retrieve a document, run a program, etc.) When the region is activated by the user, the action is executed. The class follows the html approach and is intended to support interactive documents.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
area	Area	1..*	aggr	This element specifies a region in an image map. Image maps enable authors to specify regions in an object (e.g. a graphic) and to assign a specific activity to each region (e.g. load a document, launch a program etc.). **Tags:** xml.roleElement=true; xml.roleWrapper Element=false; xml.sequenceOffset=20; xml.type Element=false; xml.typeWrapperElement=false

class	String	0..1	attr	This attribute assigns a class name or set of class names to an element. Any number of elements may be assigned the same class name or set of class names. Multiple class names must be separated by white space characters. Class names are typically used to apply CSS formatting rules to an element. **Tags:** xml.attribute=true
name	NameToken	0..1	attr	This attribute assigns a name to the image map in the MAP element. This name can be used to be referenced in an HTML image through the attribute USEMAP. Although this is not actually necessary in the MSR model, it was inserted in order to support the MAPs which were created for HTML. **Tags:** xml.attribute=true
onclick	String	0..1	attr	The ONCLICK-Event occurs, if the current element is clicked on. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
ondblclick	String	0..1	attr	The ONDBLCLICK-Event occurs, if the current Event is "double" clicked-on. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onkeydown	String	0..1	attr	The ONKEYDOWN-Event occurs, if a button on the current element is pressed down. A script can be stored in this attribute to be performed in the event. **Tags:** xml.attribute=true
onkeypress	String	0..1	attr	The ONKEYPRESS-Event occurs, if a button on the current element is pressed down and released. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onkeyup	String	0..1	attr	The ONKEYUP-Event occurs, if a button on the current element is released. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true

onmousedown	String	0..1	attr	The ONMOUSEDOWN-Event occurs, if the mouse button used for clicking is held down on the current element. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onmousemove	String	0..1	attr	The ONMOUSEMOVE-Event occurs, if the mouse pointer is moved on the current element (i.e. it is located on the current element). A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onmouseout	String	0..1	attr	The ONMOUSEOUT-Event occurs, if the mouse pointer is moved from the current element. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onmouseover	String	0..1	attr	The ONMOUSEOVER-Event occurs, if the mouse pointer is moved to the current element from another location outside it. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
onmouseup	String	0..1	attr	The ONMOUSEUP-Event occurs if the mouse button used for clicking is released on the current element. A script can be stored in this attribute to be performed in the Event. **Tags:** xml.attribute=true
title	String	0..1	attr	This attribute offers advisory information. Some Web browsers will display this information as tooltips. Authoring tools may make this information available to users as additional information about the element. **Tags:** xml.attribute=true

Table 8.24: Map

Class	**MlFigure**			
Package	M2::MSR::Documentation::BlockElements::Figure			
Note	This metaclass represents the ability to embed a figure.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
figureCaption	Caption	0..1	aggr	This element specifies the title of an illustration.
frame	FrameEnum	0..1	attr	Used to defined the frame line around a figure. It can assume the following values: • TOP - Border at the top of the figure • BOTTOM - Border at the bottom of the figure • TOPBOT - Borders at the top and bottom of the figure • ALL - Borders all around the figure • SIDES - Borders at the sides of the figure • NONE - No borders around the figure **Tags:** xml.attribute=true
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true
lGraphic	LGraphic	*	aggr	Container of the graphic (or diagram) and optional map of the figure in a given language. **Tags:** xml.roleWrapperElement=false; xml.sequenceOffset=30
pgwide	PgwideEnum	0..1	attr	Used to indicate wether the figure should take the complete page width (value = "pgwide") or not (value = "noPgwide"). **Tags:** xml.attribute=true
verbatim	MultiLanguageVerbatim	0..1	aggr	<verbatim> is a paragraph in which white-space (in particular blanks and line feeds) is obeyed. This enables basic preformatting to be carried out, which can even be displayed on simple devices. Behavior is the same as PRE in HTML . **Tags:** xml.sequenceOffset=50

Table 8.25: MlFigure

Class	**LGraphic**			
Package	M2::MSR::Documentation::BlockElements::Figure			
Note	This meta-class represents the figure in one particular language.			
Base	ARObject, LanguageSpecific			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
graphic	Graphic	1	aggr	Reference to the actual graphic represented in the figure. **Tags:** xml.sequenceOffset=20
map	Map	0..1	aggr	Image maps enable authors to specify regions of an image or object and assign a specific action to each region. **Tags:** xml.sequenceOffset=30

Table 8.26: LGraphic

8.2.5 Formula in Documentation

[TPS_GST_00321] Mathematical Subjects in Documentation ⌈AUTOSAR supports to use formula to document mathematical subjects. `MlFormula` supports an optional caption (`formulaCaption`) to give a title to the formula and also makes the formula referable.⌋*()*

[TPS_GST_00322] Various Formula Representation ⌈The formula itself takes at least one of the following forms:

- a graphic (`LGraphic`), which contains the formula represented as a graphic.
- a math captured in TEXmath mode (`texMath`)
- a generic math (`genericMath`)
- a verbatim (`verbatim`) when the formula is written as simple text, where the spaces are preserved

These forms may exist simultaneously. When a documentation is rendered, the rendering engine should use the representation with best fit to the rendition format. ⌋*()*

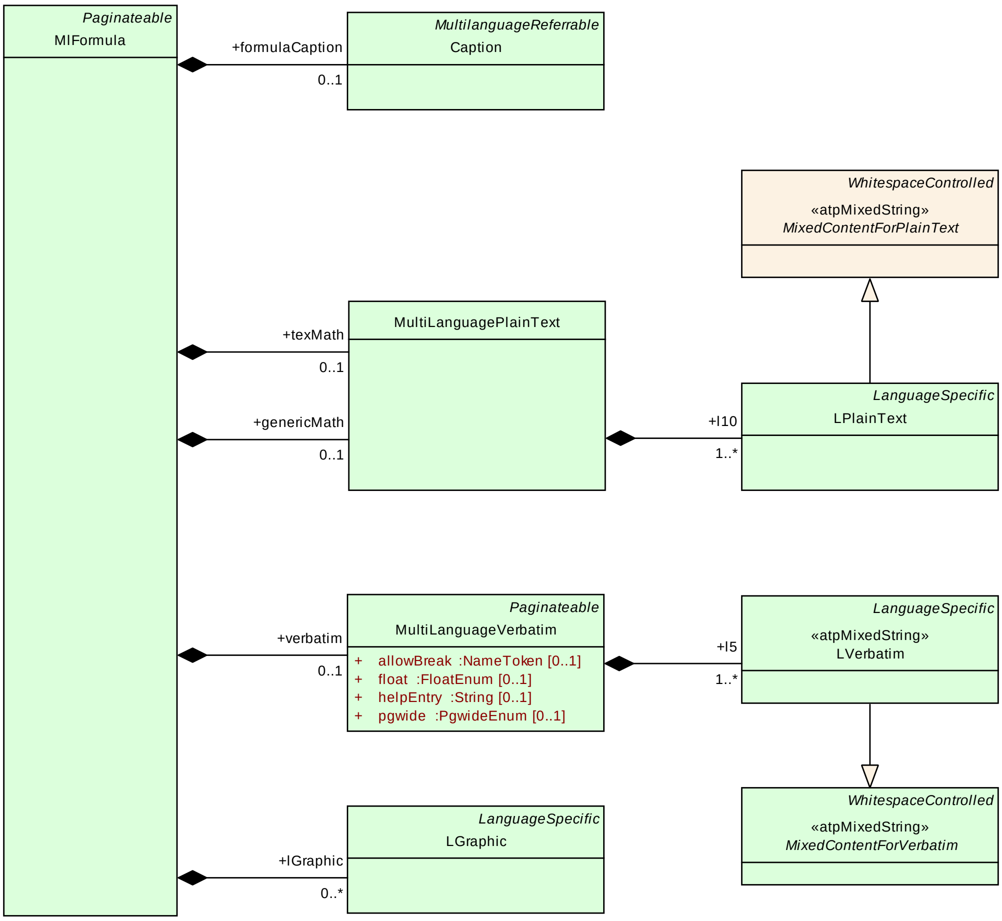


Figure 8.5: Formula Overview

Class	**MlFormula**			
Package	M2::MSR::Documentation::BlockElements::Formula			
Note	This meta-class represents the ability to express a formula in a documentation. The formula can be expressed by various means. If more than one representation is available, they need to be consistent. The rendering system can use the representation which is most appropriate.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
formulaCaption	Caption	0..1	aggr	This element specifies the identification or heading of a formula. **Tags:** xml.sequenceOffset=20
genericMath	MultiLanguagePlainText	0..1	aggr	this rpresents the semantic and mathematical descriptions which are processed by a math-processor. **Tags:** xml.sequenceOffset=80
lGraphic	LGraphic	*	aggr	This represents a formula as an embedded figure. **Tags:** xml.roleWrapperElement=false; xml.sequenceOffset=30

texMath	MultiLanguagePlainText	0..1	aggr	this is the TeX representation of TeX formula. A TeX formula can be processed by a TeX or a LaTeX processor. **Tags:** xml.sequenceOffset=60
verbatim	MultiLanguageVerbatim	0..1	aggr	this represents a formula using only text and white-space. It can be used to denote the formula in a kind of pseudo code or whatever appears approprate. **Tags:** xml.sequenceOffset=50

Table 8.27: MlFormula

8.2.6 Notes in Documentation

[TPS_GST_00323] Purpose of Note ⌈ The meta-class Note can be used to place notes with side heads and icons in a document. It is used for example to highlight instructions, exercises, cautions etc. The note itself contains a documentation block. It is composed of an optional label and one or more paragraphs. ⌋ *()*

[constr_2522] Notes should not be nested ⌈ Note even if it is possible to nest notes it is not recommended to do so, since it might lead to problems with the rendering of the note icon. ⌋ *()*

Class	**Note**			
Package	M2::MSR::Documentation::BlockElements::Note			
Note	This represents a note in a documentation, which may be used to highlight specific issues such as hints or caution notes. N.B., Documentation notes can be nested recursively, even if this is not really intended. In case of nested notes e.g. the note icon of inner notes might be omitted while rendering the note.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
label	MultilanguageLongName	0..1	aggr	This label can be used to superseed the default label specified by the noteType attribute. It is in particular useful for noteType="other". **Tags:** xml.sequenceOffset=20
noteText	DocumentationBlock	1	aggr	This is the text content of the note. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.sequenceOffset=30; xml.typeElement=false; xml.typeWrapperElement=false
noteType	NoteTypeEnum	0..1	attr	Type of the Note. Default is "HINT" **Tags:** xml.attribute=true

Table 8.28: Note

Enumeration	**NoteTypeEnum**
Package	M2::MSR::Documentation::BlockElements::Note
Note	This enumerator specifies the type of the note. It can be used to render a note label or even a note icon.
Literal	***Description***
caution	This indicates that the note is an alert which shall be considered carefully. **Tags:** atp.EnumerationValue=0
example	This indicates that the note represents an example, e.g. a code example etc. **Tags:** atp.EnumerationValue=1
exercise	This indicates that the note represents an exercise for the reader. **Tags:** atp.EnumerationValue=2
hint	This indicates that the note represents a hint which helps the user for better understanding. **Tags:** atp.EnumerationValue=3
instruction	This indicates that the note represents an instruction, e.g. a step by step procedure. **Tags:** atp.EnumerationValue=4
other	This indicates that the note is something else. The particular type of the note shall then be specified in the label of the note. **Tags:** atp.EnumerationValue=5
tip	This indicates that the note represents which is good to know. It is similar to a hint, but focuses more to good practice than to better understanding. **Tags:** atp.EnumerationValue=6

Table 8.29: NoteTypeEnum

8.2.7 Support for Traceability in Documentation

AUTOSAR documentation support includes the ability to perform tracing between text elements. This tracing is primarily intended to be applied as bottom up tracing such as tracing from a specification statement to particular requirements which are fulfilled by the specified item. See [2] for more details.

[TPS_GST_00243] Informal references to traceable text ⌈ It is also possible to provide informal references to `Traceable` within a paragraph by `trace`.

This association specifies a kind of citation of the trace. In contrast to `Traceable.trace` it is an arbitrary dependency which is for reference purpose. This association is not intended to be counted in requirements tracing analysis.

Note that when generating hyperlinked documents, this association can be represented as [TPS_STDT_0042] without hyperlink if the associated trace is not part of the document.

⌋()

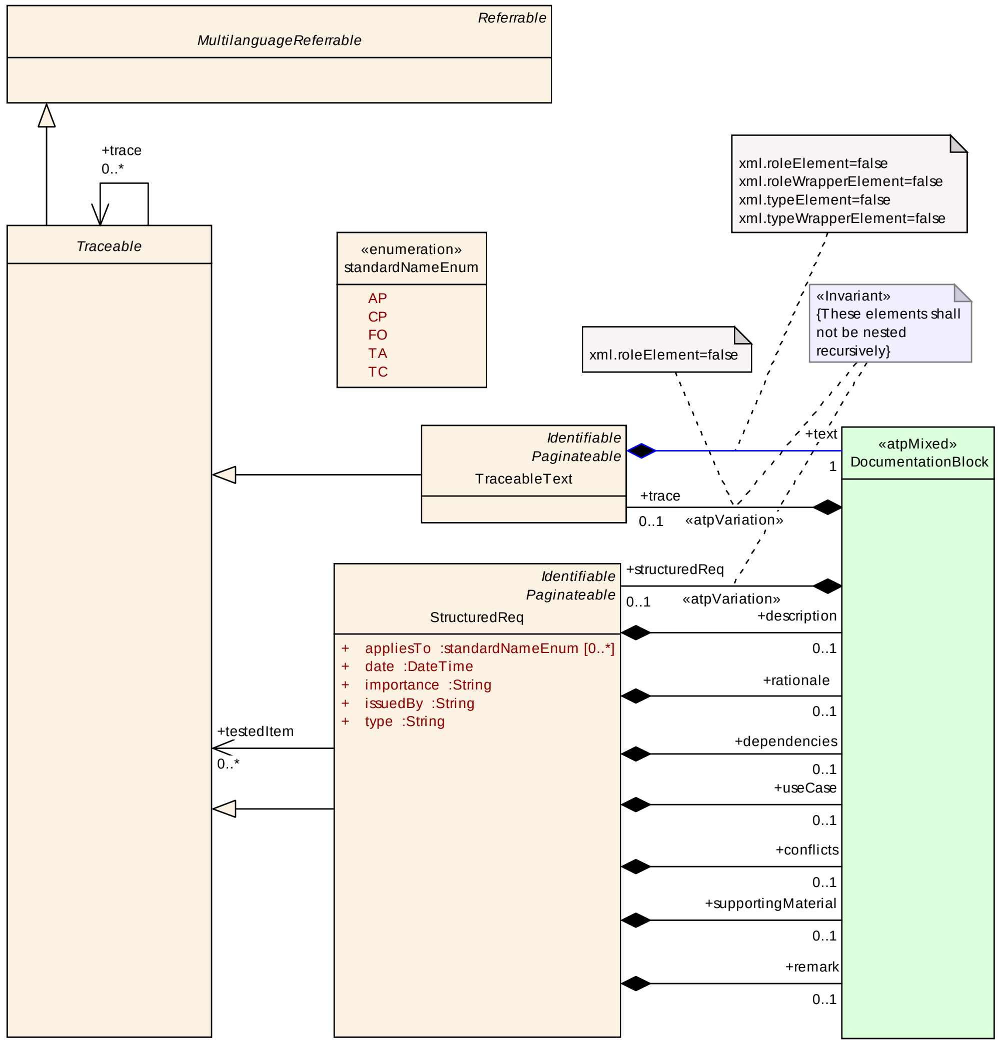


Figure 8.6: Support for Traceability

Class	**Traceable (abstract)**			
Package	M2::MSR::Documentation::BlockElements::RequirementsTracing			
Note	This meta class represents the ability to be subject to tracing within an AUTOSAR model. Note that it is expected that its subclasses inherit either from MultilanguageReferrable or from Identifiable. Nevertheless it also inherits from MultilanguageReferrable in order to provide a common reference target for all Traceables.			
Base	ARObject, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

trace	Traceable	*	ref	This assocation represents the ability to trace to upstream requirements / constraints. This supports for example the bottom up tracing ProjectObjectives <- MainRequirements <- Features <- RequirementSpecs <- BSW/AI **Tags:** xml.sequenceOffset=20

Table 8.30: Traceable

Class	**TraceableText**			
Package	M2::MSR::Documentation::BlockElements::RequirementsTracing			
Note	This meta-class represents the ability to denote a traceable text item such as requirements etc. The following approach appliles: • **shortName** represents the tag for tracing • **longName** represents the head line • **category** represents the kind of the tagged text			
Base	ARObject, DocumentViewSelectable, Identifiable, MultilanguageReferrable, Paginateable, Referrable, Traceable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
text	Documentation Block	1	aggr	This represents the text to which the tag applies. **Tags:** xml.roleElement=false; xml.roleWrapper Element=false; xml.sequenceOffset=30; xml.type Element=false; xml.typeWrapperElement=false

Table 8.31: TraceableText

Class	**StructuredReq**			
Package	M2::MSR::Documentation::BlockElements::RequirementsTracing			
Note	This represents a structured requirement. This is intended for a case where specific requirements for features are collected. Note that this can be rendered as a labeled list.			
Base	ARObject, DocumentViewSelectable, Identifiable, MultilanguageReferrable, Paginateable, Referrable, Traceable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
appliesTo	standardNameE num	*	attr	This attribute represents the platform the requirement is assigned to. **Tags:** xml.namePlural=APPLIES-TO-DEPENDEN CIES; xml.sequenceOffset=25

conflicts	Documentation Block	0..1	aggr	This represents an informal specification of conflicts. **Tags:** xml.sequenceOffset=40
date	DateTime	1	attr	This represents the date when the requirement was initiated. **Tags:** xml.sequenceOffset=5
dependencies	Documentation Block	0..1	aggr	This represents an informal specification of dependencies. Note that upstream tracing should be formalized in the property trace provided by the superclass Traceable. **Tags:** xml.sequenceOffset=30
description	Documentation Block	0..1	aggr	Ths represents the general description of the requirement. **Tags:** xml.sequenceOffset=10
importance	String	1	attr	This allows to represent the importance of the requirement. **Tags:** xml.sequenceOffset=8
issuedBy	String	1	attr	This represents the person, organization or authority which issued the requirement. **Tags:** xml.sequenceOffset=6
rationale	Documentation Block	0..1	aggr	This represents the rationale of the requirement. **Tags:** xml.sequenceOffset=20
remark	Documentation Block	0..1	aggr	This represents an informal remark. Note that this is not modeled as annotation, since these remark is still essential part of the requirement. **Tags:** xml.sequenceOffset=60
supportingMaterial	Documentation Block	0..1	aggr	This represents an informal specifiaction of the supporting material. **Tags:** xml.sequenceOffset=50
testedItem	Traceable	*	ref	This assocation represents the ability to trace on the same specification level. This supports for example the of acceptance tests. **Tags:** xml.sequenceOffset=70
type	String	1	attr	This attribute allows to denote the type of requirement to denote for example is it an "enhancement", "new feature" etc. **Tags:** xml.sequenceOffset=7

useCase	Documentation Block	0..1	aggr	This describes the relevant use cases. Note that formal references to use cases should be done in the trace relation. **Tags:** xml.sequenceOffset=35

Table 8.32: StructuredReq

8.2.8 Mixed Content and Inline Text Model Element

[TPS_GST_00324] Inline Elements in Documentation ⌈ Depending on the context, AUTOSAR supports various inline elements. Inline elements represents specific markup of text within e.g. a paragraph. Example for this is subscript/superscript etc. ⌋ *()*

In listing 8.1 the `desc` uses the inline elements:

- `Tt` to express specific technical terms by the tpye "PARAMETER",
- `EmphasisText` to emphasized text by the font type "ITALIC" and
- `Br` to force a line break.

Listing 8.1: Inline Elements in Documentation

```
<BSW-MODULE-ENTRY>
  <SHORT-NAME>Dcm_ReadMemory</SHORT-NAME>
  <LONG-NAME>
    <L-4 L="EN">Dcm_ReadMemory</L-4>
  </LONG-NAME>
  <DESC>
    <L-2 L="EN">The Dcm_ReadMemory callout is used to request memory data
        identified by the parameter <TT TYPE="PARAMETER">memoryAddress</TT
        > and <TT type="PARAMETER">memorySize</TT> from the UDS request
        message.
        This service is needed for the implementation of <E TYPE="ITALIC">
          UDS services</E>:<BR/>
        - ReadMemoryByAddress<BR/>
        - RequestUpload<BR/>
        - ReadDataByIdentifier (in case of Dynamical DID defined by memory
          address)</L-2>
  </DESC>
</BSW-MODULE-ENTRY>
```

Table 8.33 indicates the availability of inline elements in the various content models.

	Br	EmphasisText	IndexEntry	Std	Superscript	Tt	Traceable	Xdoc	Xfile	Xref	XrefTarget	MixedContentForOverviewParagraph	MixedContentForParagraph
MixedContentForLongName		e	ie		sub / sup		trace						
MixedContentForOverviewParagraph	br	e	ie		sub / sup	tt	trace			xref	xrefTarget	ft	
MixedContentForParagraph	br	e	ie	std	sub / sup	tt	trace	xdoc	xfile	xref	xrefTarget		ft
MixedContentForPlainText													
MixedContentForUnitNames					sub / sup								
MixedContentForVerbatim	br	e				tt				xref			
EmphasisText					sub / sup	tt							

Table 8.33: Inline Text Model

[constr_2596] Used colors of attributes color and bgcolor ⌈ The used colors of the attributes color and bgcolor shall base on the 6 digits RGB hex-code following

```
|#([a-fA-F0-9]{6})|
```

. ⌋()

Class	**Br**			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This element is the same as function here as in a HTML document i.e. it forces a line break.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 8.34: Br

Class	≪**atpMixedString**≫ **EmphasisText**			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This is an emphasized text. As a compromise it contains some rendering oriented attributes such as color and font.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
color	String	0..1	attr	This allows to recommend a color of the emphasis. It is specified bases on 6 digits RGB hex-code. **Tags:** xml.attribute=true

font	EEnumFont	0..1	attr	This specifies the font style in which the emphasized text shall be rendered. **Tags:** xml.attribute=true
sub	Superscript	1	attr	this is subscript text
sup	Superscript	1	attr	This is superscript text
tt	Tt	0..1	aggr	This is a technical term. **Tags:** xml.sequenceOffset=30
type	EEnum	0..1	attr	Indicates how the text may be emphasized. Note that this is only a proposal which can be overridden or ignored by particular formatting engines. Default is BOLD. **Tags:** xml.attribute=true

Table 8.35: EmphasisText

Primitive	**ExtIdClassEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This is in fact an enumerator. The possible values are all legal XML names of identifiable objects even those of other XML files. If the schemas of all questionable files are generated from a common meta-model, this is something like an IdentifiableSubtypesEnum. Maybe a future version of the Schema generator can generate such an enum. As of now it is specified as string. **Tags:** xml.xsd.customType=EXT-ID-CLASS-ENUM; xml.xsd.type=string

Table 8.36: ExtIdClassEnum

Class	≪**atpMixedString**≫ **IndexEntry**			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This class represents an index entry.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
sub	Superscript	1	attr	This is subscript text. **Tags:** xml.sequenceOffset=40
sup	Superscript	1	attr	This is superscript text. **Tags:** xml.sequenceOffset=30

Table 8.37: IndexEntry

Class	**Std**			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This represents a reference to external standards.			
Base	ARObject, Referrable, SingleLanguageReferrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
date	DateTime	0..1	attr	This element specifies the release date of the external standard if applicable. **Tags:** xml.sequenceOffset=50
position	String	0..1	attr	This represents the reference to the relevant positions of a standard. Kept as a string. **Tags:** xml.sequenceOffset=70
state	String	0..1	attr	This represents version and state of a standard. Kept as a string. **Tags:** xml.sequenceOffset=40
subtitle	String	0..1	attr	This represents the subtitle of the standard. **Tags:** xml.sequenceOffset=30
url	Url	0..1	aggr	This represents the URL of the standard. **Tags:** xml.sequenceOffset=60

Table 8.38: Std

Primitive	**Superscript**
Package	M2::MSR::Documentation::TextModel::InlineTextElements
Note	This is text which is rendered superscript or subscript depending on the role. **Tags:** xml.xsd.customType=SUPSCRIPT; xml.xsd.type=string

Table 8.39: Superscript

Class	**Tt**			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This meta-class represents the ability to express specific technical terms. The kind of term is denoted in the attribute "type".			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
term	String	1	attr	This is the term itself. **Tags:** xml.roleElement=false; xml.roleWrapper Element=false; xml.typeElement=false; xml.type WrapperElement=false

texRender	String	0..1	attr	This attribute holds information how the content (represented by attribute "term") of the particular technical term is rendered using LaTeX. This allows to inject specific LaTeX commands such as \sep{}. An example is to render "MyClass" as "My\sep{}Class". Default is the value of the attribute "term". **Tags:** xml.attribute=true
type	NameToken	1	attr	This attribute specifies the type of the technical term. Values are such as "VARIABLE" "CALPRM". It is no longer an enum in order to support process specific extensions. **Tags:** xml.attribute=true

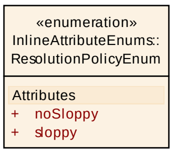
Table 8.40: Tt

Class	**Xdoc**			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This meta-class represents the ability to refer to an external document which can be rendered as printed matter.			
Base	ARObject, Referrable, SingleLanguageReferrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
date	DateTime	0..1	attr	This element specifies the release date of the external document if applicable. **Tags:** xml.sequenceOffset=50
number	String	0..1	attr	This represents document number of an external document that is referenced. Kept as a string. **Tags:** xml.sequenceOffset=30
position	String	0..1	attr	This represents the reference to the relevant positions of a standard. Kept as a string. **Tags:** xml.sequenceOffset=80
publisher	String	0..1	attr	This represents the publisher of an external document that is being referenced. Kept as a string. **Tags:** xml.sequenceOffset=60
state	String	0..1	attr	This represents version and state of the external document. Kept as a string. **Tags:** xml.sequenceOffset=40
url	Url	0..1	aggr	This specifies the URL of the external document. **Tags:** xml.sequenceOffset=70

Table 8.41: Xdoc

Class	Xfile			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This represents to reference an external file within a documentation.			
Base	ARObject, Referrable, SingleLanguageReferrable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
tool	String	0..1	attr	This element describes the tool which was used to generate the corresponding Xfile . Kept as a string since no specific syntax can be provided to denote a tool. **Tags:** xml.sequenceOffset=50
toolVersion	String	0..1	attr	This element describes the tool version which was used to generate the corresponding xfile. Kept as a string, since no specific syntax can be specified. **Tags:** xml.sequenceOffset=60
url	Url	0..1	aggr	This represents the URL of the external file. **Tags:** xml.sequenceOffset=30

Table 8.42: Xfile



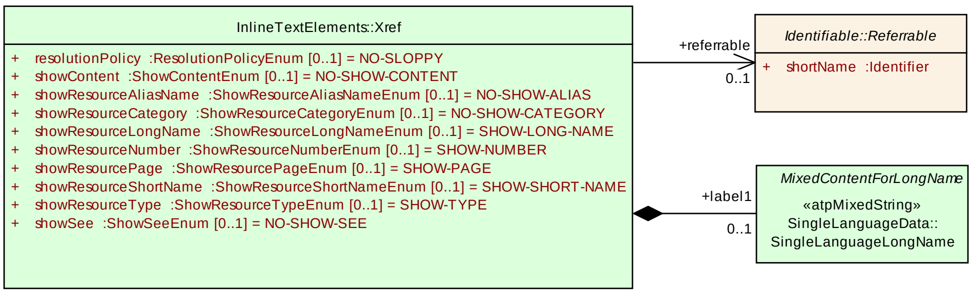


Figure 8.7: Xref overview

Class	Xref			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This represents a cross-reference within documentation.			
Base	ARObject			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
label1	SingleLanguage LongName	0..1	aggr	This allows to specify a replacement text which shall be rendered if showContent is selected.
referrable	Referrable	0..1	ref	This establishes the reference in Autosar style

resolutionPolicy	ResolutionPolicyEnum	0..1	attr	Indicates if the content of the xref element follow a dedicated resolution policy. The default is "NO-SLOPPY". **Tags:** xml.attribute=true
showContent	ShowContentEnum	0..1	attr	Indicates if the content of the xref element shall be rendered. The default is "NO-SHOW-CONTENT". **Tags:** xml.attribute=true
showResourceAliasName	ShowResourceAliasNameEnum	0..1	attr	This indicates if the alias names of the referenced objects shall be rendered. This means this is some kind of backward searching: look whether there is an alias for the referenced object, if yes, print it. If there is more than one AliasNameSet, Xref might render all of those. If no alilas is found and showResourceShortName is set to NoShowShortName, then the shortName of the reference target shall be displayed. By this showResourceAliasName is similar to showResourceShortName but shows the aliasName instead of the shortName. Default is NO-SHOW-ALIAS-NAME. **Tags:** xml.attribute=true
showResourceCategory	ShowResourceCategoryEnum	0..1	attr	Indicates if the category of the referenced resource shall be rendered. Default is "NO-SHOW-CATEGORY". **Tags:** xml.attribute=true
showResourceLongName	ShowResourceLongNameEnum	0..1	attr	Indicates if the longName of the referenced resource shall be rendered. Default is "SHOW-LONG-NAME". **Tags:** xml.attribute=true
showResourceNumber	ShowResourceNumberEnum	0..1	attr	Indicates if the Number of the referenced resource shall be shown. Default is "SHOW–NUMBER" **Tags:** xml.attribute=true
showResourcePage	ShowResourcePageEnum	0..1	attr	Indicates if the page number of the referenced resource shall be shown. Default is "SHOW-PAGE" **Tags:** xml.attribute=true
showResourceShortName	ShowResourceShortNameEnum	0..1	attr	Indicates if the shortJName of the referenced resource shall be shown. Default is "SHOW-SHORT-NAME" **Tags:** xml.attribute=true

showResourceType	ShowResourceTypeEnum	0..1	attr	Indicates if the type of the referenced Resource shall be shown. Default is "SHOW-TYPE" **Tags:** xml.attribute=true
showSee	ShowSeeEnum	0..1	attr	Indicates if the word "see " shall be shown before the reference. Default is "NO-SHOW-SEE". Note that this is there for compatibility reasons only. **Tags:** xml.attribute=true

Table 8.43: Xref

Class	**XrefTarget**			
Package	M2::MSR::Documentation::TextModel::InlineTextElements			
Note	This element specifies a reference target which can be scattered throughout the text.			
Base	ARObject, Referrable, SingleLanguageReferrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 8.44: XrefTarget

Enumeration	**EEnumFont**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This specifies the possible kind of fonts to be used for emphasis.
Literal	***Description***
default	The emphasis uses the default font. **Tags:** atp.EnumerationValue=0
mono	The emphasis uses a monospaced font. **Tags:** atp.EnumerationValue=1

Table 8.45: EEnumFont

Enumeration	**EEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This specifies the possible kinds of emphasis as proposal how to render it on paper or screen. Note that it would have been better to use plain, weak (italic), strong (bold), veryStrong (bolditalic) ... But users complained about this.
Literal	***Description***
bold	The emphasis is preferably represented in boldface font. **Tags:** atp.EnumerationValue=0
bolditalic	The emphasis is preferably represented in boldface plus italic font. **Tags:** atp.EnumerationValue=1

italic	The emphasis is preferably represented in italic font. **Tags:** atp.EnumerationValue=2
plain	The emphasis has no specific rendering. It is used if e.g. semantic information is applied to the emphasis text. **Tags:** atp.EnumerationValue=3

Table 8.46: EEnum

Enumeration	**ResolutionPolicyEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This specifies if the content of the xref element follow a dedicated resolution policy.
Literal	***Description***
noSloppy	The content of the xref element is **not** linked by a sloppy reference. **Tags:** atp.EnumerationValue=0
sloppy	The content of the xref element is linked by a sloppy reference. **Tags:** atp.EnumerationValue=1

Table 8.47: ResolutionPolicyEnum

Enumeration	**ShowContentEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This specifies if the content of the xref element shall be rendered.
Literal	***Description***
noShow Content	The content of the Xref.label is **not** rendered at the place of the reference. **Tags:** atp.EnumerationValue=0
showContent	The content of the element is rendered at the place of the reference. **Tags:** atp.EnumerationValue=1

Table 8.48: ShowContentEnum

Enumeration	**ShowResourceAliasNameEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This enumerator specifies if the alias names of the reference target shall be rendered with the xref.
Literal	***Description***
noShowAlias Name	This indicates that alias names of the referenced object shall **not** be rendered at the place of the reference. **Tags:** atp.EnumerationValue=0

showAlias Name	This indicates that the alias names of the referenced object shall be rendered at the place of the reference. **Tags:** atp.EnumerationValue=1

Table 8.49: ShowResourceAliasNameEnum

Enumeration	**ShowResourceCategoryEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This enumerator specifies if the category of the reference target shall be rendered with the xref.
Literal	***Description***
noShow Category	The category of the target is **not** rendered at the place of the reference. **Tags:** atp.EnumerationValue=0
showCate-gory	The category of the target is rendered at the place of the reference. **Tags:** atp.EnumerationValue=1

Table 8.50: ShowResourceCategoryEnum

Enumeration	**ShowResourceLongNameEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This enumerator specifies if the long name of the reference target shall be rendered with the xref.
Literal	***Description***
noShowLong Name	The long name of the target is **not** rendered at the place of the reference. **Tags:** atp.EnumerationValue=0
showLong Name	The long name of the target is rendered at the place of the reference. **Tags:** atp.EnumerationValue=1

Table 8.51: ShowResourceLongNameEnum

Enumeration	**ShowResourceNumberEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This enumerator specifies if the number (e.g. chapter number) of the reference target shall be rendered with the xref.
Literal	***Description***
noShow Number	The number of the target is **not** rendered at the place of the reference. **Tags:** atp.EnumerationValue=0
showNumber	The number of the target is rendered at the place of the reference. **Tags:** atp.EnumerationValue=1

Table 8.52: ShowResourceNumberEnum

Enumeration	**ShowResourcePageEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This enumerator specifies if the page numer of the reference target shall be rendered with the xref.
Literal	***Description***
noShowPage	The page number of the target is **not** rendered at the place of the reference. **Tags:** atp.EnumerationValue=0
showPage	The page number of the target is rendered at the place of the reference. **Tags:** atp.EnumerationValue=1

Table 8.53: ShowResourcePageEnum

Enumeration	**ShowResourceShortNameEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This enumerator specifies if the short name of the reference target shall be rendered with the xref.
Literal	***Description***
noShowShort Name	The short name of the target is **not** rendered at the place of the reference. **Tags:** atp.EnumerationValue=0
showShort Name	The short name of the target is rendered at the place of the reference. **Tags:** atp.EnumerationValue=1

Table 8.54: ShowResourceShortNameEnum

Enumeration	**ShowResourceTypeEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This enumerator specifies if the type (e.g. derived from the class) of the reference target shall be rendered with the xref.
Literal	***Description***
noShowType	The type of the target is **not** rendered at the place of the reference. **Tags:** atp.EnumerationValue=0
showType	The type of the target is rendered at the place of the reference. **Tags:** atp.EnumerationValue=1

Table 8.55: ShowResourceTypeEnum

Enumeration	**ShowSeeEnum**
Package	M2::MSR::Documentation::TextModel::InlineAttributeEnums
Note	This enumerator specifies if the word "see" shall be rendered before the xref.
Literal	***Description***

noShowSee	The word "see" is **not** rendered before the reference. **Tags:** atp.EnumerationValue=0
showSee	The word "see"is rendered before the reference. **Tags:** atp.EnumerationValue=1

Table 8.56: ShowSeeEnum

8.3 Standalone Documentation

[TPS_GST_00325] Standalone Documentation ⌈ The standalone documentation provides means to capture documentation independently of the structure of an AUTOSAR system. In order to achieve this, it extends the introduction by adding chapters, topics, visual tables, and generic parameter sets (`prms`). One could say, it wraps the `DocumentationBlock` in chapters, topics, tables.

In addition to this, it allows to refer to AUTOSAR-Objects, which are the context of the documentation.

It is also provided as `Documentation` which is an `ARElement` of its own rights allowing for a reference to the document's context. ⌋*()*

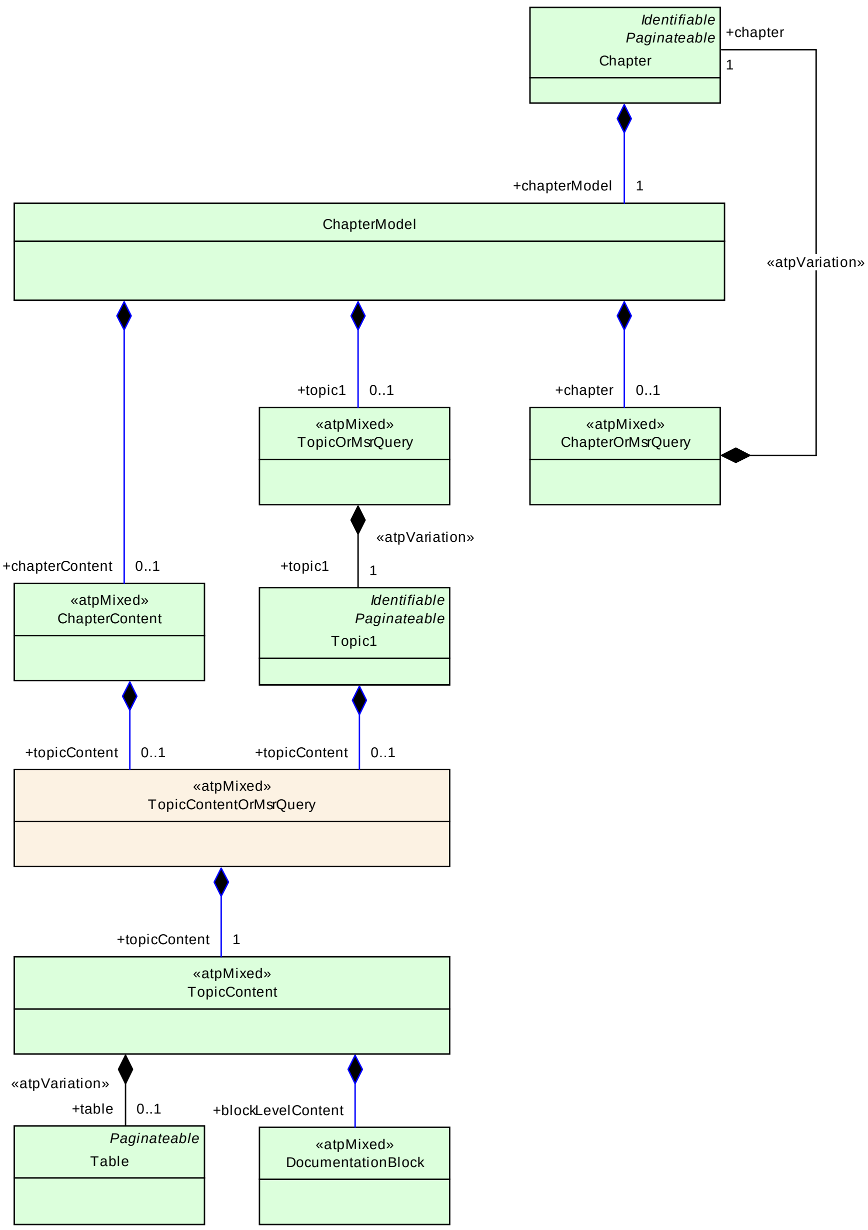


Figure 8.8: Standalone Documentation Overview

8.3.1 Documentation's Context

[TPS_GST_00326] Context of Standalone Documentation ⌈ Standalone Documentation can specify a context to which it relates to. This context serves two purposes:

- reference targets to make the documentation self contained,
- support assembly of the complete documentation, e.g. within a project.

⌋ *()*

Figure 8.9 depicts how the documentation context is captured. AUTOSAR provides Documentation, which is a packageable element and can be used to depict documentation in the context of any identifiable element or even M1 instance.

[constr_2533] Documentation context is either a feature or an identifiable ⌈ One particular DocumentationContext shall be either a feature or an identifiable but not both at the same time. If this is desired, one should create multiple DocumentationContext. ⌋*()*

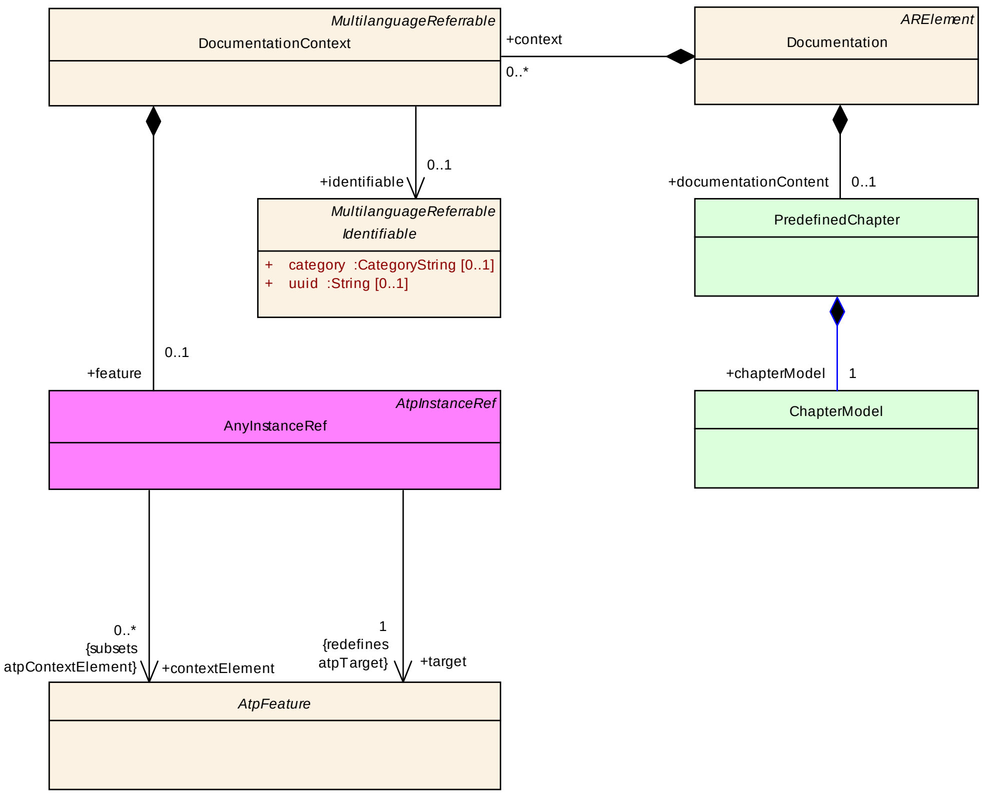


Figure 8.9: Standalone documentation as ArElement

Class	**DocumentationContext**			
Package	M2::AUTOSARTemplates::GenericStructure::DocumentationOnM1			
Note	This class represents the ability to denote a context of a so called standalone documentation. Note that this is an «atpMixed». The contents needs to be considered as ordered.			
Base	ARObject, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
feature	AtpFeature	0..1	iref	This refers to a particular feature (instance in the M0 model) to which is the context of the documentation.
identifiable	Identifiable	0..1	ref	This is an identifiable object which is part of the context of the documentation.

Table 8.57: DocumentationContext

Class	**AnyInstanceRef**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::AnyInstanceRef			
Note	Describes a reference to any instance in an AUTOSAR model. This is the most generic form of an instance ref. Refer to the superclass notes for more details.			
Base	ARObject,AtpInstanceRef			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
base	AtpClassifier	1	ref	This is the base from which navigation path begins. **Stereotypes:** atpDerived
contextElement	AtpFeature	*	ref	This is one step in the navigation path specified by the instance ref.
target	AtpFeature	1	ref	This is the target of the instance ref.

Table 8.58: AnyInstanceRef

8.3.2 Chapter

[TPS_GST_00327] Chapter ⌈ The chapter element is composed of its caption provided by `Identifiable`, its immediate content `chapterContent` and more logical blocks grouped as topics `topic1` and sub chapters `chapter`. The chapter's content is composed of parameters, tables and documentation blocks. ⌋ *()*

[TPS_GST_00328] Predefined Chapter ⌈ The `PredefinedChapter` is a chapter which cannot be nested because it depicts a particular semantics. Anyhow it can have nested chapters inside. ⌋ *()*

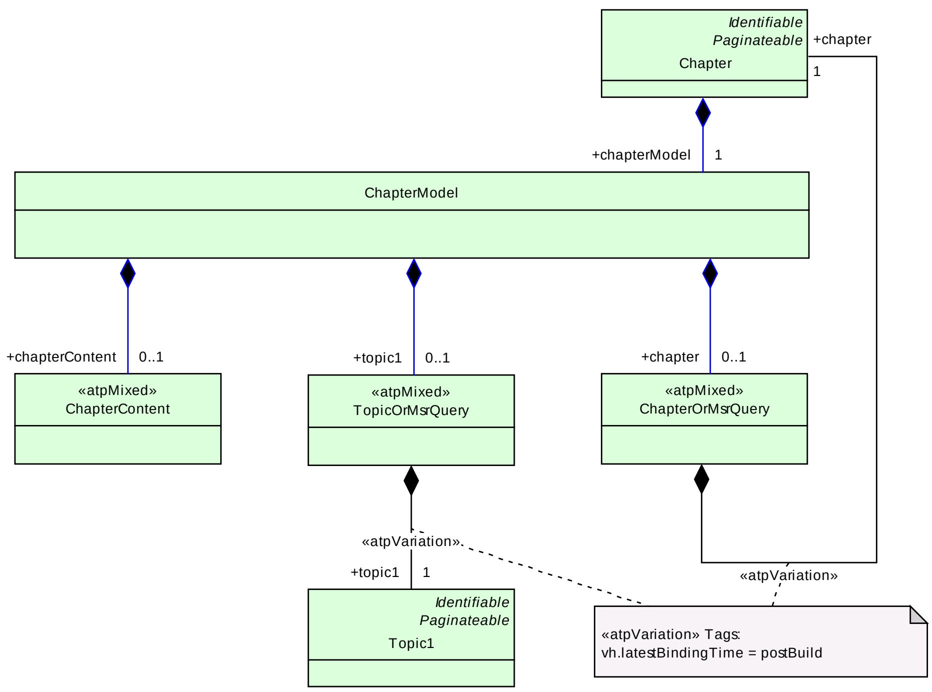


Figure 8.10: Chapter Overview

Class	**Chapter**			
Package	M2::MSR::Documentation::Chapters			
Note	This meta-class represents a chapter of a document. Chapters are the primary structuring element in documentation.			
Base	ARObject, DocumentViewSelectable, Identifiable, MultilanguageReferrable, Paginateable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
chapterModel	ChapterModel	1	aggr	This represents the overall contents of the chapter. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.typeElement=false; xml.typeWrapperElement=false
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax shall be defined by the applied help system respectively help system generator. Maybe it is a concatenated Identifier, but as of now we leave it as an arbitrary string. **Tags:** xml.attribute=true

Table 8.59: Chapter

Class	**ChapterModel**			
Package	M2::MSR::Documentation::Chapters			
Note	This is the basic content model of a chapter except the Chapter title. This can be utilized in general chapters as well as in predefined chapters. A chapter has content on three levels: 1. chapter content 2. topics 3. subchapters			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
chapter	ChapterOrMsrQuery	0..1	aggr	This is a particular subchapter. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.sequenceOffset=200; xml.typeElement=false; xml.typeWrapperElement=false
chapterContent	ChapterContent	0..1	aggr	This is the chapter content which is not a topic or a subchapter. It is the content which is directly in the chapter. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.sequenceOffset=30; xml.typeElement=false; xml.typeWrapperElement=false

topic1	TopicOrMsrQuery	0..1	aggr	This is a topic within the chapter. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.sequenceOffset=170; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.60: ChapterModel

Class	≪**atpMixed**≫ **ChapterContent**			
Package	M2::MSR::Documentation::Chapters			
Note	This class represents the content which is directly in a chapter. It is basically the same as the one in a Topic but might have additional complex structures (e.g. Synopsis)			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
prms	Prms	1	aggr	This is a parameter table within a chapter. **Tags:** xml.sequenceOffset=150
topicContent	TopicContentOrMsrQuery	0..1	aggr	This is that part of a chapter content which may appear in a chapter as well as in a topic. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.sequenceOffset=40; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.61: ChapterContent

Enumeration	**ChapterEnumBreak**
Package	M2::MSR::Documentation::BlockElements::PaginationAndView
Note	This allows to specify the page break policy of a paginatable element.
Literal	***Description***
break	This indicates the a page break shall be applied before the current block. **Tags:** atp.EnumerationValue=0
noBreak	This indicates that there is no need to force a page break before this block. **Tags:** atp.EnumerationValue=1

Table 8.62: ChapterEnumBreak

Class	**PredefinedChapter**			
Package	M2::MSR::Documentation::Chapters			
Note	This represents a predefined chapter.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

chapterModel	ChapterModel	1	aggr	This is the content of the predefined chapter. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.63: PredefinedChapter

8.3.3 Tables in Documentation

[TPS_GST_00329] Tables in Documentation ⌈ AUTOSAR supports to use tables in documentation by the meta-class `Table` which is an implementation of the Oasis exchange table model ([21]). ⌋*()* The model is depicted in Figure 8.11.

[TPS_GST_00330] Partitions of a Table ⌈ A table (`Table`) contains one or more partitions (`Tgroup`). The first partition has column specification (`Colspec`), which specifies the attributes of column within the partition.

Subsequent partitions can define their own column specification or inherit from the last partition that had a specification. A partition is composed of exactly one body (`tbody`) one optional header (`thead`) and one optional footer (`tfoot`). ⌋*()*

[TPS_GST_00331] Table Row ⌈ The table partition (body, header and footer) are composed of one or more rows (`Row`). On the level of table rows is possible to control the page breaks and view. Each Row is composed of one or more entries (`Entry`), which contains a documentation block. ⌋*()*

A table can also have a caption.

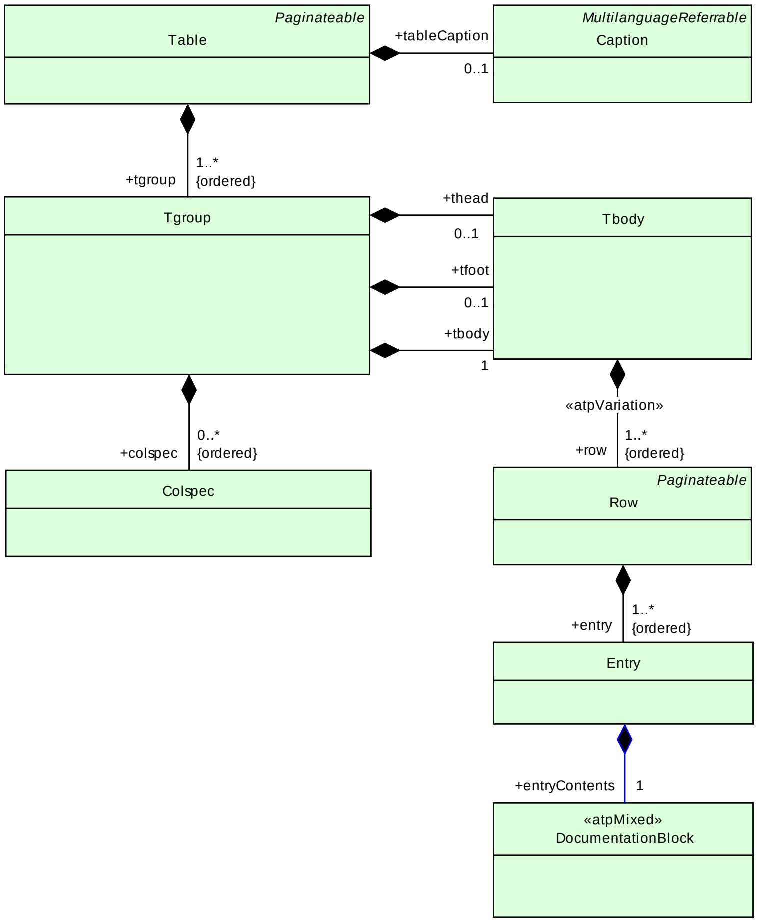


Figure 8.11: Table Model Overview

Class	**Table**			
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable			
Note	This class implements an exchange table according to OASIS Technical Resolution TR 9503:1995. [http://www.oasis-open.org/specs/a503.htm]			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
colsep	TableSeparatorString	0..1	attr	Indicates if by default a line should be drawn between the columns of this table. **Tags:** xml.attribute=true
float	FloatEnum	1	attr	Indicate whether it is allowed to break the element. **Tags:** xml.attribute=true
frame	FrameEnum	0..1	attr	Used to defined the frame line around a table. **Tags:** xml.attribute=true

helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true
orient	OrientEnum	0..1	attr	Indicate whether a table should be represented as landscape or portrait. • land : landscape • port : portrait **Tags:** xml.attribute=true
pgwide	NameToken	0..1	attr	Used to indicate wether the figure should take the complete page width (value = "pgwide") or not (value = "noPgwide"). **Tags:** xml.attribute=true
rowsep	TableSeparatorString	0..1	attr	Indicates if by default a line should be drawn at the bottom of table rows. **Tags:** xml.attribute=true
tableCaption	Caption	0..1	aggr	This element specifies the table heading. **Tags:** xml.sequenceOffset=20
tabstyle	NameToken	0..1	attr	Indicates an external table style. **Tags:** xml.attribute=true
tgroup (ordered)	Tgroup	1..*	aggr	A table can be built of individual segments. Such a segment is called tgroup. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=30; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.64: Table

Enumeration	**FloatEnum**
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable
Note	This enumerator specifies the policy how an objects floats on a page.
Literal	***Description***
float	This indicates that a page formatter is allowed to float the table to optimize the pagination. This is for example supported by TeX. **Tags:** atp.EnumerationValue=0
noFloat	This indicates that a page formatter is not allowed to float the object to optimize the pagination. **Tags:** atp.EnumerationValue=1

Table 8.65: FloatEnum

Enumeration	**FrameEnum**
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable
Note	This enumerator specifies the policy, where to place a frame border around the table.
Literal	***Description***
all	Borders all around the table **Tags:** atp.EnumerationValue=0
bottom	Border at the bottom of the table **Tags:** atp.EnumerationValue=1
none	No borders around the table **Tags:** atp.EnumerationValue=2
sides	Borders at the sides of the table **Tags:** atp.EnumerationValue=3
top	Border at the top of the table **Tags:** atp.EnumerationValue=4
topbot	Borders at the top and bottom of the table **Tags:** atp.EnumerationValue=5

Table 8.66: FrameEnum

Class	**Tgroup**			
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable			
Note	This meta-class represents the ability to denote a table section.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
align	AlignEnum	0..1	attr	Specifies how the cell entries shall be horizontally aligned within the specified TGROUP. Default is "LEFT" **Tags:** xml.attribute=true
cols	Integer	1	attr	This attribute represents the number of columns in the table. **Tags:** xml.attribute=true
colsep	TableSeparatorString	0..1	attr	Indicates if by default a line shall be drawn between the columns of this table group. **Tags:** xml.attribute=true
colspec (ordered)	Colspec	*	aggr	This specifies one particular column specification in the table. There must be one entry for each column. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

rowsep	TableSeparatorString	0..1	attr	Indicates if by default a line shall be drawn at the bottom of the rows in this table group. **Tags:** xml.attribute=true
tbody	Tbody	1	aggr	This is the main part of the table segment, called the table body. **Tags:** xml.sequenceOffset=60
tfoot	Tbody	0..1	aggr	This represents the footer of the table segement. This segment is printed at the end of the table or before a page break. **Tags:** xml.sequenceOffset=50
thead	Tbody	0..1	aggr	This represents the heading of the table section. The heading is usually repeated at the beginning of each new page. **Tags:** xml.sequenceOffset=40

Table 8.67: Tgroup

Enumeration	**AlignEnum**
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable
Note	This enumerator specifies horizontal alignment.
Literal	***Description***
center	The content of the table is horizontally centered. **Tags:** atp.EnumerationValue=0
justify	This indicates that the content of table cell shall be justified (rendered as a block where white-space is expanded such that all lines are filled up). **Tags:** atp.EnumerationValue=1
left	This indicates that the content of a table cell is left justified. **Tags:** atp.EnumerationValue=2
right	This indicates that the content of a table cell is left justified. **Tags:** atp.EnumerationValue=3

Table 8.68: AlignEnum

Class	**Tbody**			
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable			
Note	This meta-class represents a part within a table group. Such a part can be the table head, the table body or the table foot.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

row (ordered)	Row	1..*	aggr	This is a particular row in a table. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false
valign	ValignEnum	0..1	attr	Indicates how the cells in the rows shall be aligned. Default is inherited from tbody, otherwise it is "TOP" **Tags:** xml.attribute=true

Table 8.69: Tbody

Enumeration	**ValignEnum**
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable
Note	This enumerator specifies vertical alignment.
Literal	***Description***
bottom	The contents of the table cell is bottom aligned. **Tags:** atp.EnumerationValue=0
middle	The contents of the table is vertically centered. **Tags:** atp.EnumerationValue=1
top	The contents of the table cell is top aligned. **Tags:** atp.EnumerationValue=2

Table 8.70: ValignEnum

Class	**Row**			
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable			
Note	This meta-class represents the ability to express one row in a table.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
entry (ordered)	Entry	1..*	aggr	This represents one particular table cell. It is an entry in the table. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false
rowsep	TableSeparatorString	0..1	attr	Indicates if by default a line should be displayed below the row. **Tags:** xml.attribute=true

valign	ValignEnum	0..1	attr	Indicates how the cells in the rows shall be aligned. Default is inherited from tbody, otherwise it is "TOP" **Tags:** xml.attribute=true

Table 8.71: Row

Class	**Entry**			
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable			
Note	This represents one particular table cell.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
align	AlignEnum	0..1	attr	Specifies how the cell ENTRY shall be horizontally aligned. Default is "LEFT" **Tags:** xml.attribute=true
bgcolor	String	1	attr	This allows to recommend a background color of the entry. It is specified bases on 6 digits RGB hex-code. **Tags:** xml.attribute=true
colname	String	0..1	attr	Indicate the name of the column, where the entry should appear. **Tags:** xml.attribute=true
colsep	TableSeparatorString	0..1	attr	Indicates whether a line should be displayed end of this entry. **Tags:** xml.attribute=true
entryContents	DocumentationBlock	1	aggr	This is the content of the TableEntry **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.typeElement=false; xml.typeWrapperElement=false
morerows	String	0..1	attr	Number of additional rows. Default is "0" **Tags:** xml.attribute=true
nameend	String	0..1	attr	When an entry spans multiple column this is the name of the last column. **Tags:** xml.attribute=true
namest	String	0..1	attr	When an entry spans multiple column this is the name of the first column. **Tags:** xml.attribute=true

rotate	String	0..1	attr	Indicates if the cellcontent shall be rotated. Default is 0; 1 would rotate the contents 90 degree counterclockwise. This attribute is defined by OASIS. **Tags:** xml.attribute=true
rowsep	TableSeparator String	0..1	attr	Indicates whether a line should be displayed at the bottom end of the cell. **Tags:** xml.attribute=true
spanname	String	0..1	attr	Capture the name of entry merging multiple columns. **Tags:** xml.attribute=true
valign	ValignEnum	0..1	attr	Indicates how the content of the cell shall be aligned. Default is inherited from row or tbody, otherwise "TOP" **Tags:** xml.attribute=true

Table 8.72: Entry

Primitive	**TableSeparatorString**
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable
Note	This represents the ability to denote a separator string within an OASIS exchange table. • **0**: no line is displayed • **1**: line is displayed **Tags:** xml.xsd.customType=TABLE-SEPARATOR-STRING; xml.xsd.pattern=[0-1]; xml.xsd.type=string

Table 8.73: TableSeparatorString

8.3.4 Topics in Documentation

[TPS_GST_00332] Topics in Documentation ⌈ A topic (`Topic1`)[7] is a logical unit, which subdivides a content of a chapter mainly by providing intermediate head lines. Note that these head lines are not part of generated table of contents. ⌋*()*

[7]The name topic1 is given to remain compatible with [20]

Class	Topic1			
Package	M2::MSR::Documentation::Chapters			
Note	This meta-class represents a topic of a documentation. Topics are similar to chapters but they cannot be nested. They also do not appear in the table of content. Topics can be used to produce intermediate headlines thus structuring a chapter internally.			
Base	ARObject, DocumentViewSelectable, Identifiable, MultilanguageReferrable, Paginateable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true
topicContent	TopicContentOrMsrQuery	0..1	aggr	This is the content of the topic. **Tags:** xml.roleElement=false; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.74: Topic1

8.3.5 Parameter tables

[TPS_GST_00333] Parameter Tables ⌈ Parameter tables can be used to collect numerical or textual parameters in a documentation. Such parameters should not to be confused with parameters in the software of an ECU. Parameter tables are intended to create a kind of data sheets. ⌋*()*

Class	Prms			
Package	M2::MSR::Documentation::BlockElements::GerneralParameters			
Note	This metaclass represents the ability to specify a parameter table. It can be used e.g. to specify parameter tables in a data sheet.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
label	MultilanguageLongName	0..1	aggr	This represents the caption of the parameter table. **Tags:** xml.sequenceOffset=20
prm	GeneralParameter	1..*	aggr	This represents one particular parameter in the the table. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=30; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.75: Prms

8.4 Document production

Production of e.g. printed documents is done using document processors. These processors determine the document content and layout. Nevertheless it is necessary to support this document production process by some policies in order to tweak the final output.

[TPS_GST_00334] Support of Pagination of Documents ⌈ AUTOSAR provides basic support for a pagination policy (`Paginateable`) which allows to tweak the page breaks of generated documents. ⌋ *()*

Class	**Paginateable (abstract)**			
Package	M2::MSR::Documentation::BlockElements::PaginationAndView			
Note	This meta-class represents the ability to control the pagination policy when creating documents.			
Base	ARObject, DocumentViewSelectable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
break	ChapterEnumBreak	0..1	attr	This attributes allows to specify a forced page break. **Tags:** xml.attribute=true
keepWithPrevious	KeepWithPreviousEnum	0..1	attr	This attribute denotes the pagination policy. In particular it defines if the containing text block shall be kept together with the previous block. **Tags:** xml.attribute=true

Table 8.76: Paginateable

Enumeration	**ChapterEnumBreak**
Package	M2::MSR::Documentation::BlockElements::PaginationAndView
Note	This allows to specify the page break policy of a paginatable element.
Literal	***Description***
break	This indicates the a page break shall be applied before the current block. **Tags:** atp.EnumerationValue=0
noBreak	This indicates that there is no need to force a page break before this block. **Tags:** atp.EnumerationValue=1

Table 8.77: ChapterEnumBreak

Enumeration	**KeepWithPreviousEnum**
Package	M2::MSR::Documentation::BlockElements::PaginationAndView
Note	This enumerator specifies a page break policy by controlling blocks which shall be kept together.
Literal	***Description***

keep	This indicates that the block shall be kept together with the previous block. **Tags:** atp.EnumerationValue=0
noKeep	This indicates that there is no need to keep the block with the previous one. This is the same as if the attribute itself is missing. **Tags:** atp.EnumerationValue=1

Table 8.78: KeepWithPreviousEnum

Class	**DocumentViewSelectable (abstract)**			
Package	M2::MSR::Documentation::BlockElements::PaginationAndView			
Note	This meta-class represents the ability to be dedicated to a particular audience or document view.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
si	NameTokens	1	attr	This attribute allows to denote a semantic information which is used to identify documentation objects to be selected in customizable document views. It shall be defined in agreement between the involved parties. **Tags:** xml.attribute=true
view	ViewTokens	0..1	attr	This attribute lists the document views in which the object shall appear. If it is missing, the object appears in all document views. **Tags:** xml.attribute=true

Table 8.79: DocumentViewSelectable

Primitive	**ViewTokens**
Package	M2::MSR::Documentation::BlockElements::PaginationAndView
Note	This primitive specifies the tokens to specify a documentation view. **Tags:** xml.xsd.customType=VIEW-TOKENS; xml.xsd.pattern=(-?[a-zA-Z_]+)(( )+-?[a-zA-Z_]+)*; xml.xsd.type=string

Table 8.80: ViewTokens

8.5 Including generated documentation parts

[TPS_GST_00336] Including generated Documentation Parts ⌈ AUTOSAR supports an approach where parts of the documentation are automatically generated and included at a particular location within the documentation.

This support is provided by the so called MSR query mechanism (`MsrQueryP1`, `MsrQueryP2`, `MsrQueryTopic1` and `MsrQueryChapter`). These classes allow to represent the properties of the inclusion as well as the result of the inclusion. Thereby the intermediate results can be visualized and exchanged after the generated parts were included. Hence it is not necessary that all parties involved in the project are able to perform the inclusion process.

Details are subject to mutual agreement. ⌋*()*

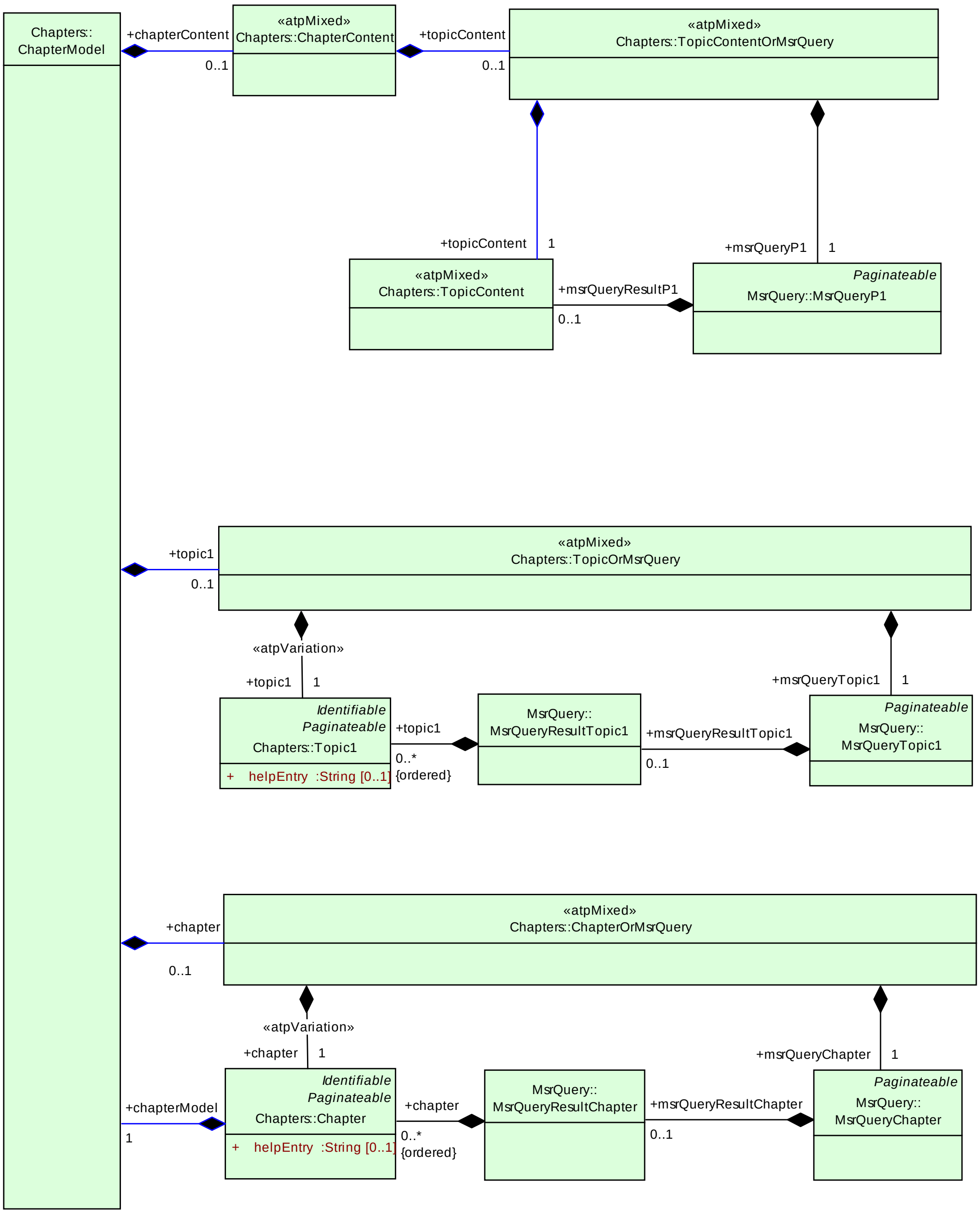


Figure 8.12: Including generated documentation parts by MsrQuery

The following meta-classes represent the alternative of manually edited documentation and included generated parts.

Class	≪atpMixed≫ **TopicContentOrMsrQuery**			
Package	M2::MSR::Documentation::Chapters			
Note	This meta-class represents a topic or a topic content which is generated using queries.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
msrQueryP1	MsrQueryP1	1	aggr	This represents automatically contributed contents provided by an msrquery.
topicContent	TopicContent	1	aggr	This is the content of a topic. **Tags:** xml.roleElement=false

Table 8.81: TopicContentOrMsrQuery

Class	≪atpMixed≫ **TopicOrMsrQuery**			
Package	M2::MSR::Documentation::Chapters			
Note	This class provides the alternative of a Topic with an MsrQuery which delivers a topic.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
msrQueryTopic1	MsrQueryTopic1	1	aggr	This represents automatically contributed topics provided by an msrquery. **Tags:** xml.sequenceOffset=190
topic1	Topic1	1	aggr	This is used to create particcular topics within a chapter. A topic is similar to a subchapter, but cannot be nesxted and will not appear in the table of contents of the document. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=180

Table 8.82: TopicOrMsrQuery

Class	≪atpMixed≫ **ChapterOrMsrQuery**			
Package	M2::MSR::Documentation::Chapters			
Note	This meta-class represents the ability to denote a particular chapter or a query returning a chapter.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
chapter	Chapter	1	aggr	This establishes a subschapter. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild xml.sequenceOffset=210
msrQueryChapter	MsrQueryChapter	1	aggr	This represents automatically contributed chapters provided by an msrquery. **Tags:** xml.sequenceOffset=220

Table 8.83: ChapterOrMsrQuery

The following meta-classes represent the included generated parts.

Class	**MsrQueryP1**			
Package	M2::MSR::Documentation::MsrQuery			
Note	This meta-class represents the ability to express a query which yields the content of a topic as a result.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
msrQueryProps	MsrQueryProps	1	aggr	This is argument and properties of the paragraph query. **Tags:** xml.sequenceOffset=20
msrQueryResultP1	TopicContent	0..1	aggr	This represents the result of the query. **Tags:** xml.sequenceOffset=30

Table 8.84: MsrQueryP1

Class	**MsrQueryTopic1**			
Package	M2::MSR::Documentation::MsrQuery			
Note	This meta-class represents the ability to specify a query which yields a set of topics as a result.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
msrQueryProps	MsrQueryProps	1	aggr	This is argument and properties of the topic query. **Tags:** xml.sequenceOffset=20
msrQueryResultTopic1	MsrQueryResultTopic1	0..1	aggr	This represents the result of the query. **Tags:** xml.sequenceOffset=30

Table 8.85: MsrQueryTopic1

Class	**MsrQueryChapter**			
Package	M2::MSR::Documentation::MsrQuery			
Note	This meta-class represents the ability to express a query which yields a set of chapters as a result.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
msrQueryProps	MsrQueryProps	1	aggr	This is argument and properties of the chapter query. **Tags:** xml.sequenceOffset=20
msrQueryResultChapter	MsrQueryResultChapter	0..1	aggr	This represents the result of the query. **Tags:** xml.sequenceOffset=30

Table 8.86: MsrQueryChapter

The following meta-classes control the inclusion process.

Class	**MsrQueryProps**			
Package	M2::MSR::Documentation::MsrQuery			
Note	This metaclass represents the ability to specificy a query which yields some documentation text. The qualities of the result are determined by the context in which the query is used.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
comment	String	0..1	attr	This element contains a commentary in text form. **Tags:** xml.sequenceOffset=40
msrQuery Arg	MsrQueryArg	*	aggr	This element specifies an argument within an MsrQuery. **Tags:** xml.roleElement=true; xml.roleWrapper Element=false; xml.sequenceOffset=30; xml.type Element=false; xml.typeWrapperElement=false
msrQuery Name	String	1	attr	This element specifies the name of the MSR-QUERY triggered. **Tags:** xml.sequenceOffset=20

Table 8.87: MsrQueryProps

Class	**MsrQueryArg**			
Package	M2::MSR::Documentation::MsrQuery			
Note	This represents an argument to the query. Note that the arguments are not standardized and therefore subject to mutual agreement.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
arg	String	1	attr	This is the value of the argument. **Tags:** xml.roleElement=false; xml.roleWrapper Element=false; xml.typeElement=false; xml.type WrapperElement=false
si	NameToken	1	attr	This denotes the name of the query argument (semantic information) **Tags:** xml.attribute=true

Table 8.88: MsrQueryArg

The following meta-classes represent the included results.

Class	**MsrQueryResultChapter**			
Package	M2::MSR::Documentation::MsrQuery			
Note	This metaclass represents the result of an msrquery which is a set of chapters.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**

chapter (ordered)	Chapter	*	aggr	This is one particular chapter in the query result. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.89: MsrQueryResultChapter

Class	**MsrQueryResultTopic1**			
Package	M2::MSR::Documentation::MsrQuery			
Note	This metaclass represents the ability to express the result of a query which is a set of topics.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
topic1 (ordered)	Topic1	*	aggr	This represents one particular topic in the query result. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.90: MsrQueryResultTopic1

8.6 Handling Multiple Languages in an AUTOSAR Artifact

[TPS_GST_00337] Multiple Languages ⌈ AUTOSAR supports a multi-language documentation[8], where each construct of the document can have the optional attribute `l` in `LanguageSpecific` with a value that denotes the language in which it is written. The languages available in a document are defined in `adminData`. ⌋*()*

See Chapter 3 for details.

The following block level elements and their sub-constructs support multilingual text/-graphics:

- paragraph
- formula
- figure
- verbatim

Figure 8.13 illustrates the approach for multilanguage support using LongName as an example. It shows how the single language and the multilanguage version are derived from a common model.

[8] based on [20]

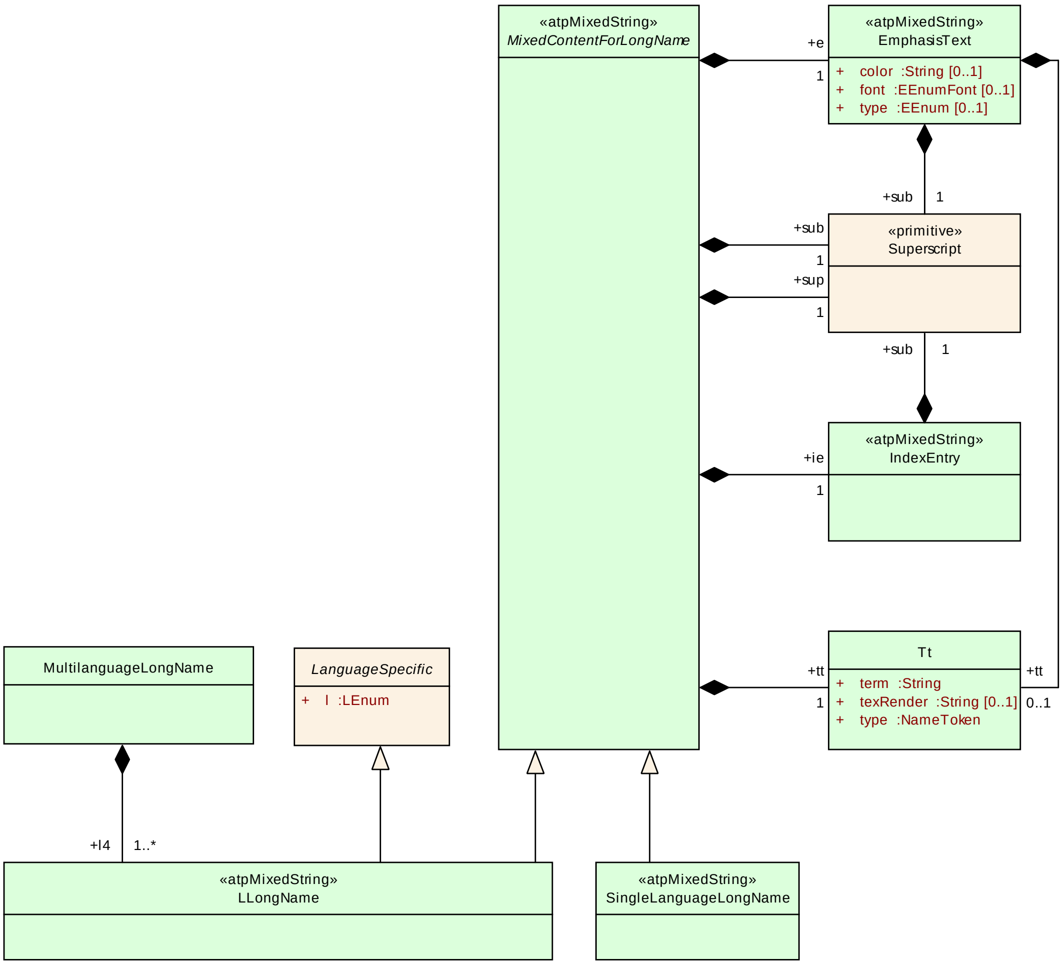


Figure 8.13: The `MultilanguageLongname`

The annotation of each construct with the language it which it is written allows the author of a documentation block to write interlinear in two or more languages weaved together in a single source document, then to generate the documentation block in each of these languages.

[constr_2523] Used languages need to be consistent ⌈ The used languages of an AUTOSAR file are specified in the top level `adminData`. All other elements shall be provided in the languages specified for the document. ⌋*()* See Chapter 3 for more details.

This approach supports a better maintainability. In a documentation block written in English, French and German, for example, it is easier to maintain the three versions consistent when each paragraph is immediately followed by its translation in the other languages as when they are found at completely different locations or worse separated documents.

The following example illustrate this approach:

Listing 8.2: Example of Excerpt from a Multilingual Documentation Block in ARXML

```
<AR-PACKAGE>
  <SHORT-NAME>Documentation</SHORT-NAME>
```

```
    <INTRODUCTION>
      <P>
        <L-1 L="EN">
          In a documentation block written  in English,
          French and German, for example, it is easier
          to maintain the three versions consistent
          when each paragraph is immediately followed
          by its translation in the other languages as
          when they are found at completely different
          locations or worse separated documents.
          </L-1>
        <L-1 L="FR">
          Dans un bloque documentaire écrit en anglais,
          français et allemand, par exemple, il est plus
          facile de maintenir les trois versions
          consistantes entre elles, quand chaque paragraphe
          est suivi immédiatement de sa traduction dans les
          autres langues que si ces dernières ce trouvaient
          dans des endroits différents ou même pire dans des
          documents séparés.
          </L-1>
      </P>
    </INTRODUCTION>
  </AR-PACKAGE>
```

Class	**MultiLanguageVerbatim**			
Package	M2::MSR::Documentation::TextModel::MultilanguageData			
Note	This class represents multilingual Verbatim. Verbatim means, that white-space is maintained. When Verbatim is rendered in PDF or Online media, white-space is obeyed. Blanks are rendered as well as newline characters.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
allowBreak	NameToken	0..1	attr	This indicates if the verbatim text might be split on multiple pages. Default is "1". **Tags:** xml.attribute=true
float	FloatEnum	0..1	attr	Indicate whether it is allowed to break the element. The following values are allowed: **Tags:** xml.attribute=true
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true
l5	LVerbatim	1..*	aggr	This the text in one particular language. **Tags:** xml.roleElement=true; xml.roleWrapper Element=false; xml.sequenceOffset=20; xml.type Element=false; xml.typeWrapperElement=false

pgwide	PgwideEnum	0..1	attr	Used to indicate wether the figure should take the complete page width (value = "pgwide") or not (value = "noPgwide"). **Tags:** xml.attribute=true

Table 8.91: MultiLanguageVerbatim

Class	≪**atpMixedString**≫ **LVerbatim**			
Package	M2::MSR::Documentation::TextModel::LanguageDataModel			
Note	MixedContentForVerbatim in one particular language. The language is denoted in the attribute l.			
Base	ARObject, LanguageSpecific, MixedContentForVerbatim, WhitespaceControlled			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 8.92: LVerbatim

Class	**MultiLanguageOverviewParagraph**			
Package	M2::MSR::Documentation::TextModel::MultilanguageData			
Note	This is the content of a multilingual paragraph in an overview item.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
l2	LOverviewParagraph	1..*	aggr	This represents the text in one particular language. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.93: MultiLanguageOverviewParagraph

Class	≪**atpMixedString**≫ **LOverviewParagraph**			
Package	M2::MSR::Documentation::TextModel::LanguageDataModel			
Note	MixedContentForOverviewParagraph in one particular language. The language is denoted in the attribute l.			
Base	ARObject, LanguageSpecific, MixedContentForOverviewParagraph			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 8.94: LOverviewParagraph

Class	**MultiLanguageParagraph**			
Package	M2::MSR::Documentation::TextModel::MultilanguageData			
Note	This is the content model of a multilingual paragraph in a documentation.			
Base	ARObject, DocumentViewSelectable, Paginateable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
helpEntry	String	0..1	attr	This specifies an entry point in an online help system to be linked with the parent class. The syntax must be defined by the applied help system respectively help system generator. **Tags:** xml.attribute=true
l1	LParagraph	1..*	aggr	This is the paragraph content in one partiucular language. **Tags:** xml.roleElement=true; xml.roleWrapper Element=false; xml.sequenceOffset=20; xml.type Element=false; xml.typeWrapperElement=false

Table 8.95: MultiLanguageParagraph

Class	≪atpMixedString≫ **LParagraph**			
Package	M2::MSR::Documentation::TextModel::LanguageDataModel			
Note	This is the text for a paragraph in one particular language. The language is denoted in the attribute l.			
Base	ARObject, LanguageSpecific, MixedContentForParagraph			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
–	–	–	–	–

Table 8.96: LParagraph

Enumeration	**PgwideEnum**
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable
Note	This enumerator specifies, if the table shall be rendered across the entire page, even if it is placed in side-head layouts.
Literal	*Description*
noPgwide	This indicates that the table shall be fit in the current text flow. **Tags:** atp.EnumerationValue=0
pgwide	This indicates that the table may use the entire page width. This is in particular important in case of so called "side-head layouts" but also if the table is in a list or in a note. **Tags:** atp.EnumerationValue=1

Table 8.97: PgwideEnum

Class	≪atpMixedString≫ **MixedContentForPlainText (abstract)**			
Package	M2::MSR::Documentation::TextModel::InlineTextModel			
Note	This represents a plain text which conceptually is handled as mixed contents. It is modeled as such for symmetry reasons.			
Base	ARObject, WhitespaceControlled			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table 8.98: MixedContentForPlainText

Class	**MultiLanguagePlainText**			
Package	M2::MSR::Documentation::TextModel::MultilanguageData			
Note	This is a multilingual plaint Text.It is intended to be rendered as a paragraph.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
l10	LPlainText	1..*	aggr	This is the plain text in one particular language. **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false

Table 8.99: MultiLanguagePlainText

Class	≪atpMixedString≫ **LPlainText**			
Package	M2::MSR::Documentation::TextModel::LanguageDataModel			
Note	This represents plain string in one particular language. The language is denoted in the attribute l.			
Base	ARObject, LanguageSpecific, MixedContentForPlainText, WhitespaceControlled			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table 8.100: LPlainText

Class	**LanguageSpecific (abstract)**			
Package	M2::MSR::Documentation::TextModel::LanguageDataModel			
Note	This meta-class represents the ability to denote a particular language for which an object is applicable.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**

l	LEnum	1	attr	'This attribute denotes the language in which the language specific document entity is given. Note that "FOR-ALL" means, that the entity is applicable to all languages. It is language neutral. It follows ISO 639-1:2002 and is specified in upper case. **Tags:** xml.attribute=true; xml.enforceMin Multiplicity=true

Table 8.101: LanguageSpecific

Enumeration	**LEnum**
Package	M2::MSR::Documentation::TextModel::LanguageDataModel
Note	This denotes the possible language designators according to the two letter code of ISO 693.
Literal	***Description***
aa	Afar **Tags:** atp.EnumerationValue=0
ab	Abkhazian **Tags:** atp.EnumerationValue=1
af	Afrikaans **Tags:** atp.EnumerationValue=2
am	Amharic **Tags:** atp.EnumerationValue=3
ar	Arabic **Tags:** atp.EnumerationValue=4
as	Assamese **Tags:** atp.EnumerationValue=5
ay	Aymara **Tags:** atp.EnumerationValue=6
az	Azerbaijani **Tags:** atp.EnumerationValue=7
ba	Bashkir **Tags:** atp.EnumerationValue=8
be	Byelorussian **Tags:** atp.EnumerationValue=9
bg	Bulgarian **Tags:** atp.EnumerationValue=10

bh	Bihari **Tags:** atp.EnumerationValue=11
bi	Bislama **Tags:** atp.EnumerationValue=12
bn	Bengali **Tags:** atp.EnumerationValue=13
bo	Tibetian **Tags:** atp.EnumerationValue=14
br	Breton **Tags:** atp.EnumerationValue=15
ca	Catalan **Tags:** atp.EnumerationValue=16
co	Corsican **Tags:** atp.EnumerationValue=17
cs	Czech **Tags:** atp.EnumerationValue=18
cy	Welsh **Tags:** atp.EnumerationValue=19
da	Danish **Tags:** atp.EnumerationValue=20
de	German **Tags:** atp.EnumerationValue=21
dz	Bhutani **Tags:** atp.EnumerationValue=22
el	Greek **Tags:** atp.EnumerationValue=23
en	English **Tags:** atp.EnumerationValue=24
eo	Esperanto **Tags:** atp.EnumerationValue=25
es	Spanish **Tags:** atp.EnumerationValue=26
et	Estonian **Tags:** atp.EnumerationValue=27

eu	Basque **Tags:** atp.EnumerationValue=28
fa	Persian **Tags:** atp.EnumerationValue=29
fi	Finnish **Tags:** atp.EnumerationValue=30
fj	Fiji **Tags:** atp.EnumerationValue=31
fo	Faeroese **Tags:** atp.EnumerationValue=32
forAll	The content applies to all languages **Tags:** atp.EnumerationValue=33
fr	French **Tags:** atp.EnumerationValue=34
fy	Frisian **Tags:** atp.EnumerationValue=35
ga	Irish **Tags:** atp.EnumerationValue=36
gd	Scots Gaelic **Tags:** atp.EnumerationValue=37
gl	Galician **Tags:** atp.EnumerationValue=38
gn	Guarani **Tags:** atp.EnumerationValue=39
gu	Gjarati **Tags:** atp.EnumerationValue=40
ha	Hausa **Tags:** atp.EnumerationValue=41
hi	Hindi **Tags:** atp.EnumerationValue=42
hr	Croatian **Tags:** atp.EnumerationValue=43
hu	Hungarian **Tags:** atp.EnumerationValue=44

hy	Armenian **Tags:** atp.EnumerationValue=45
ia	Interlingua **Tags:** atp.EnumerationValue=46
ie	Interlingue **Tags:** atp.EnumerationValue=47
ik	Inupiak **Tags:** atp.EnumerationValue=48
in	Indonesian **Tags:** atp.EnumerationValue=49
is	Icelandic **Tags:** atp.EnumerationValue=50
it	Italian **Tags:** atp.EnumerationValue=51
iw	Hebrew **Tags:** atp.EnumerationValue=52
ja	Japanese **Tags:** atp.EnumerationValue=53
ji	Yiddish **Tags:** atp.EnumerationValue=54
jw	Javanese **Tags:** atp.EnumerationValue=55
ka	Georgian **Tags:** atp.EnumerationValue=56
kk	Kazakh **Tags:** atp.EnumerationValue=57
kl	Greenlandic **Tags:** atp.EnumerationValue=58
km	Cambodian **Tags:** atp.EnumerationValue=59
kn	Kannada **Tags:** atp.EnumerationValue=60
ko	Korean **Tags:** atp.EnumerationValue=61

ks	Kashmiri **Tags:** atp.EnumerationValue=62
ku	Kurdish **Tags:** atp.EnumerationValue=63
ky	Kirghiz **Tags:** atp.EnumerationValue=64
la	Latin **Tags:** atp.EnumerationValue=65
ln	Lingala **Tags:** atp.EnumerationValue=66
lo	Laothian **Tags:** atp.EnumerationValue=67
lt	Lithuanian **Tags:** atp.EnumerationValue=68
lv	Lavian, Lettish **Tags:** atp.EnumerationValue=69
mg	Malagasy **Tags:** atp.EnumerationValue=70
mi	Maori **Tags:** atp.EnumerationValue=71
mk	Macedonian **Tags:** atp.EnumerationValue=72
ml	Malayalam **Tags:** atp.EnumerationValue=73
mn	Mongolian **Tags:** atp.EnumerationValue=74
mo	Moldavian **Tags:** atp.EnumerationValue=75
mr	Marathi **Tags:** atp.EnumerationValue=76
ms	Malay **Tags:** atp.EnumerationValue=77
mt	Maltese **Tags:** atp.EnumerationValue=78

my	Burmese **Tags:** atp.EnumerationValue=79
na	Nauru **Tags:** atp.EnumerationValue=80
ne	Nepali **Tags:** atp.EnumerationValue=81
nl	Dutch **Tags:** atp.EnumerationValue=82
no	Norwegian **Tags:** atp.EnumerationValue=83
oc	Occitan **Tags:** atp.EnumerationValue=84
om	(Afan) Oromo **Tags:** atp.EnumerationValue=85
or	Oriya **Tags:** atp.EnumerationValue=86
pa	Punjabi **Tags:** atp.EnumerationValue=87
pl	Polish **Tags:** atp.EnumerationValue=88
ps	Pashto, Pushto **Tags:** atp.EnumerationValue=89
pt	Portuguese **Tags:** atp.EnumerationValue=90
qu	Quechua **Tags:** atp.EnumerationValue=91
rm	Rhaeto-Romance **Tags:** atp.EnumerationValue=92
rn	Kirundi **Tags:** atp.EnumerationValue=93
ro	Romanian **Tags:** atp.EnumerationValue=94
ru	Russian **Tags:** atp.EnumerationValue=95

rw	Kinyarwanda **Tags:** atp.EnumerationValue=96
sa	Sanskrit **Tags:** atp.EnumerationValue=97
sd	Sindhi **Tags:** atp.EnumerationValue=98
sg	Sangro **Tags:** atp.EnumerationValue=99
sh	Serbo-Croatian **Tags:** atp.EnumerationValue=100
si	Singhalese **Tags:** atp.EnumerationValue=101
sk	Slovak **Tags:** atp.EnumerationValue=102
sl	Slovenian **Tags:** atp.EnumerationValue=103
sm	Samoan **Tags:** atp.EnumerationValue=104
sn	Shona **Tags:** atp.EnumerationValue=105
so	Somali **Tags:** atp.EnumerationValue=106
sq	Albanian **Tags:** atp.EnumerationValue=107
sr	Serbian **Tags:** atp.EnumerationValue=108
ss	Siswati **Tags:** atp.EnumerationValue=109
st	Sesotho **Tags:** atp.EnumerationValue=110
su	Sundanese **Tags:** atp.EnumerationValue=111
sv	Swedish **Tags:** atp.EnumerationValue=112

sw	Swahili **Tags:** atp.EnumerationValue=113
ta	Tamil **Tags:** atp.EnumerationValue=114
te	Tegulu **Tags:** atp.EnumerationValue=115
tg	Tajik **Tags:** atp.EnumerationValue=116
th	Thai **Tags:** atp.EnumerationValue=117
ti	Tigrinya **Tags:** atp.EnumerationValue=118
tk	Turkmen **Tags:** atp.EnumerationValue=119
tl	Tagalog **Tags:** atp.EnumerationValue=120
tn	Setswana **Tags:** atp.EnumerationValue=121
to	Tonga **Tags:** atp.EnumerationValue=122
tr	Turkish **Tags:** atp.EnumerationValue=123
ts	Tsonga **Tags:** atp.EnumerationValue=124
tt	Tatar **Tags:** atp.EnumerationValue=125
tw	Twi **Tags:** atp.EnumerationValue=126
uk	Ukrainian **Tags:** atp.EnumerationValue=127
ur	Urdu **Tags:** atp.EnumerationValue=128
uz	Uzbek **Tags:** atp.EnumerationValue=129

vi	Vietnamese **Tags:** atp.EnumerationValue=130
vo	Volapuk **Tags:** atp.EnumerationValue=131
wo	Wolof **Tags:** atp.EnumerationValue=132
xh	Xhosa **Tags:** atp.EnumerationValue=133
yo	Yoruba **Tags:** atp.EnumerationValue=134
zh	Chinese **Tags:** atp.EnumerationValue=135
zu	Zulu **Tags:** atp.EnumerationValue=136

Table 8.102: LEnum

8.7 Document Views

[TPS_GST_00335] View Approach ⌈ AUTOSAR provides support of multiple document views. They are supported by `DocumentViewSelectable`. ⌋*()*

In the following the illustrated example uses

- for `LanguageSpecific` the LEnum "en",
- for the stereotype ≪`atpVariation`≫ the `SwSystemconst` "Country" with the `SwSystemconstValue`s "1" and "2" and
- for the `DocumentViewSelectable` the ViewTokens "INTERNAL" and "DETAILED".

Based on these settings the document representation is defined inside the blue marked slice in Figure 8.14.

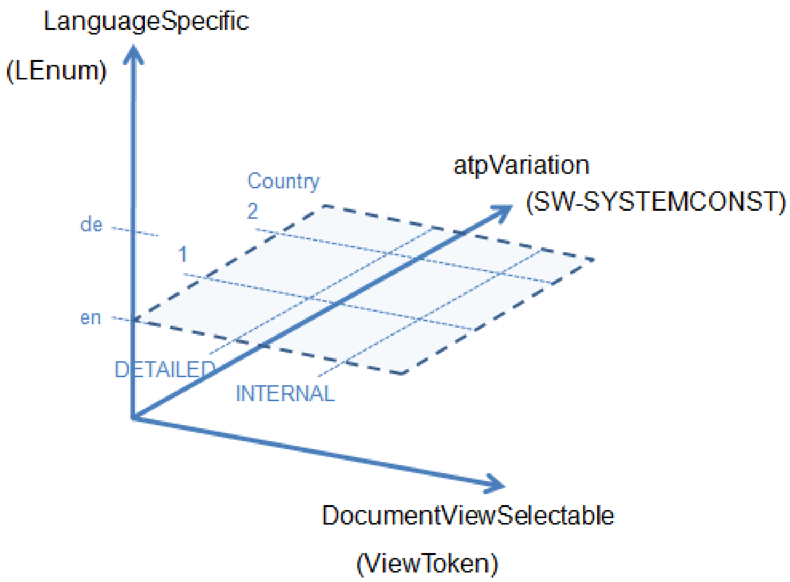


Figure 8.14: View Approach

Beside the LanguageSpecific aspect of a document and the system inherent configuration by the stereotype ≪atpVariation≫ the DocumentViewSelectable opens a third dimension to generate documentation to a particular audience or document view.

In a first step the Documentation content is enhanced with document views in which the object shall appear. At a later development step a dedicated view is selected which ensures that the intended audience is met (see Figure 8.15).

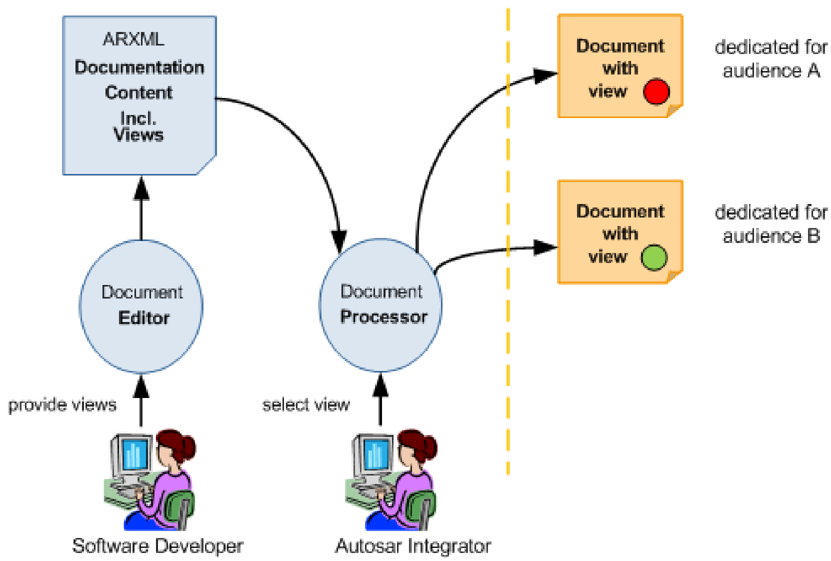


Figure 8.15: Application of document views

Several use cases are possible:

- no view specified [TPS_GST_00366],
- dedicated view specified [TPS_GST_00367],
- multiple views specified [TPS_GST_00368],
- exclude content [TPS_GST_00369],

[TPS_GST_00366] No View Specified ⌈ A document without views specified shall be shown completely to all audiences. ⌋ *()*

LEnum==en		**SW-SYSTEMCONST**	
		Country==1	Country==2
ViewToken	DETAILED	-	-
	INTERNAL	-	-
	-	-	-

Table 8.103: Use Case - No selection

1 Feature Description Passenger Lock

1.1 Function of Passenger Lock

The feature A of the passenger lock is realized by the functions A1 and A2.

The feature B of the passenger lock is realized by the functions B1 and B2.

The function A1 is always useable. The use of function A2 depends on the selected system configuration.

The function A1 compares the parameter P1 and P2 and provides the status.

The function A2 is only active in case the condition is set Country = 1.FuncA2/SwSystemconsts/Country== 1

The use of the function B1 depends on the selected system configuration. The function B2 is a dedicated function for service purpose.

The function B1 is only active in case the condition is set Country = 2.FuncB1/SwSystemconsts/Country== 2

The application of this function shall be started from the given initial values. Afterwards iterative approach to the physical limits.FuncB1/SwSystemconsts/Country== 2

The function B2 shall be executed during standard services. The calculation result of this function must be in the range of +2 to −3. If this range is exceeded follow the service instruction in the manuel.

- Use this application only in engineering mode.
- See service instruction A2.

The upgrade of function B2 will be done by implementation of CRQ0815.

Figure 8.16: Use Case - No selection

The yellow marked text in Figure 8.16 indicates that these paragraphs contain a `VariationPoint` with the `SwSystemconst` "Country".

Listing 8.3: Paragraph contains a `VariationPoint` with the `SwSystemconst` "Country==1"

```
<P>
  <L-1 L="EN">The function A2 is only active in case the condition is
     set Country = 1.</L-1>
```

```
    <L-1 L="DE">Die Funktion A2 wird nur aktiv, wenn die Bedingung
       Country = 1 gesetzt ist.</L-1>
    <VARIATION-POINT>
      <SHORT-LABEL>FuncA2</SHORT-LABEL>
      <SW-SYSCOND BINDING-TIME="SYSTEM-DESIGN-TIME"><SYSC-REF DEST="SW-
         SYSTEMCONST">/SwSystemconsts/Country</SYSC-REF>== 1</SW-
         SYSCOND>
    </VARIATION-POINT>
  </P>
```

[TPS_GST_00367] Dedicated View Specified ⌈ Specifying a view for a dedicated audience at a part of a document means "show it to this audience only" or in other words "do not show parts marked for other audiences". ⌋*()*

Specifying a view in a document is an explicit inclusion of the affected parts of a document. To ensure that an element is shown to all intended audiences, it shall have all accordingly views explicitly set ([TPS_GST_00368]).

$$include = selectedViews \in declaredViews$$

LEnum==en		**SW-SYSTEMCONST**	
		Country==1	Country==2
ViewToken	DETAILED	-	-
	INTERNAL	X	-
	-	-	-

Table 8.104: Use Case - Dedicated View specified and selected (INTERNAL)

The `DocumentViewSelectable` with the ViewToken "INTERNAL" and the `SwSystemconst` "Country" with the `SwSystemconstValue` "1" are selected. Content specified with the ViewTokens "DETAILED" is not selected.

1 Feature Description Passenger Lock

1.1 Function of Passenger Lock

The feature A of the passenger lock is realized by the functions A1 and A2.

The feature B of the passenger lock is realized by the functions B1 and B2.

The function A1 is always useable. The use of function A2 depends on the selected system configuration.

The function A1 compares the parameter P1 and P2 and provides the status.

The function A2 is only active in case the condition is set Country = 1.

The use of the function B1 depends on the selected system configuration. The function B2 is a dedicated function for service purpose.

The function B2 shall be executed during standard services. The calculation result of this function must be in the range of +2 to -3. If this range is exceeded follow the service instruction in the manuel.

- See service instruction A2.

The upgrade of function B2 will be done by implementation of CRQ0815.

Figure 8.17: Use Case - Dedicated View specified and selected (INTERNAL)

This use case brings out two essential items:

- The red marked text in Figure 8.17 indicate that these paragraphs contain DocumentViewSelectable with the ViewToken "INTERNAL".

  Listing 8.4: Paragraphs contain DocumentViewSelectable with the ViewToken "INTERNAL"

```
<P VIEW="INTERNAL">
  <L-1 L="EN">The function B2 shall be executed during standard
      services. The calculation result of this function must be
      in the range of +2 to -3. If this range is exceeded follow
      the service instruction in the manuel.</L-1>
  <L-1 L="DE">Die Funktion B2 wird im Standardservice ausgefÃ¼hrt
      . Die Berechnungsergebnisse dieser Funktion muss in Bereich
       von +2 bis -3 liegen. Wird dieser Bereich Ã¼berschritten,
      ist der Serviceanweiseung im Handbuch zu folgen.</L-1>
</P>
<LIST TYPE="UNNUMBER" VIEW="INTERNAL">
  <ITEM VIEW="DETAILED">
    <P>
      <L-1 L="EN">Use this application only in engineering mode.<
          /L-1>
      <L-1 L="DE">Diese Anwendung ist nur im Engineering Mode zu
          verwenden.</L-1>
    </P>
  </ITEM>
  <ITEM>
    <P>
      <L-1 L="EN">See service instruction A2.</L-1>
      <L-1 L="DE">Siehe Serviceanweisung A2.</L-1>
    </P>
  </ITEM>
</LIST>
```

The first item of the list is assigned to the ViewToken "DETAILED" and therefore it does not appear in the generated document.

- The blue marked text in Figure 8.17 indicates that this paragraph contains `DocumentViewSelectable` with the ViewTokens "INTERNAL" and "DETAILED" (see listing 8.5).

Listing 8.5: Paragraphs contain `DocumentViewSelectable` with the ViewTokens "INTERNAL" and "DETAILED".

```
<P VIEW="INTERNAL DETAILED">
  <L-1 L="EN">The upgrade of function B2 will be done by
      implementation of CRQ0815.</L-1>
  <L-1 L="DE">Die Erweiterung der Funktion B2 wird durch die
      Implementierung von CRQ0815 erfolgen.</L-1>
</P>
```

Selecting the ViewToken "DETAILED" the blue marked text also appears because of its declaration as can be seen in Figure 8.18.

[TPS_GST_00368] Multiple Views Specified ⌈ It is possible to an entity to be visible in a list of views. This shall be interpreted as "show the information if currently selected view is denoted in the list". ⌋ *()*

LEnum==en		**SW-SYSTEMCONST**	
		Country==1	Country==2
ViewToken	DETAILED	X	-
	INTERNAL	-	-
	-	-	-

Table 8.105: Use Case - Dedicated View specified and selected (DETAILED)

The generated output will look like in Figure 8.18.

1 Feature Description Passenger Lock

1.1 Function of Passenger Lock

The feature A of the passenger lock is realized by the functions A1 and A2.

The feature B of the passenger lock is realized by the functions B1 and B2.

The function A1 is always useable. The use of function A2 depends on the selected system configuration.

The function A1 compares the parameter P1 and P2 and provides the status.

The function A2 is only active in case the condition is set Country = 1.

The use of the function B1 depends on the selected system configuration. The function B2 is a dedicated function for service purpose.

The upgrade of function B2 will be done by implementation of CRQ0815.

Figure 8.18: Use Case - Dedicated View specified and selected (DETAILED)

[TPS_GST_00369] Exclude content ⌈ Excluding content means "do not present it for any audience". This can be achieved by specifying an arbitrary named view (e.g. DONOTPRESENT), whcih will never be selected for production. ⌋*()*

In case the ViewToken "DETAILED" is selected (Table 8.105) only text specified with this dedicated view and text without any view specified will appear. The text specified with the ViewToken "INTERNAL" will be excluded form the content (see Figure 8.18).

9 The Build Action Manifest

9.1 Introduction

Any exchange of BSW modules also includes the exchange of ECU configuration code generators (a.k.a. ECUC processors, Module Generators).

- Seamless integration of these Module Generators into SW build frameworks requires precise knowledge on input/output data.
- With this knowledge Integration of foreign stacks is simplified and less error prone
- Without a formal specification of this knowledge, the integration of "foreign" Module Generators is inefficient and error-prone.

With such formal specifications being available, the following benefits exist for the BSW module integrators:

- Significant reduction of integration effort and ambiguity.
- As code generation is not tied to specialized editor applications anymore, a single configuration editor can be used for the entire project.

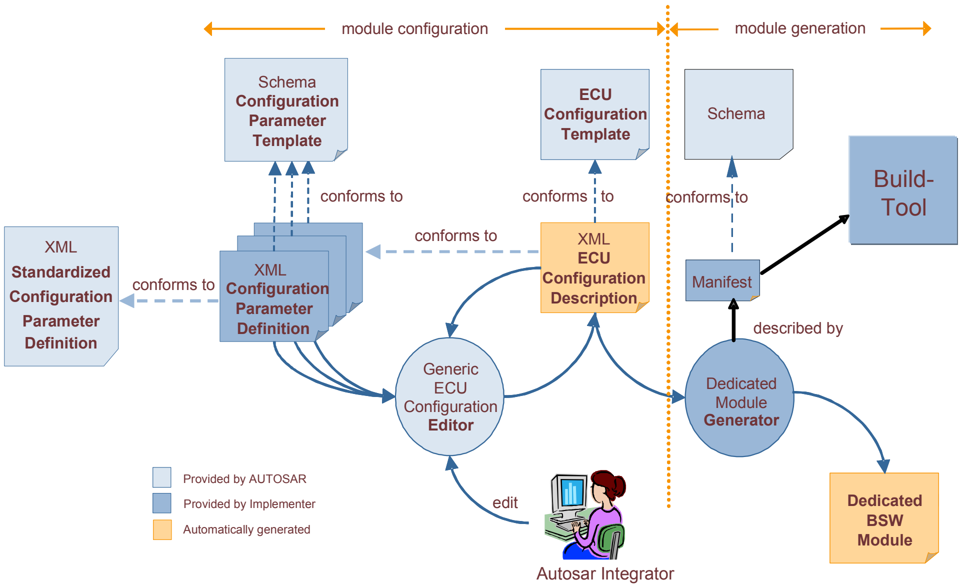


Figure 9.1: Generic Configuration Editor

Mainly the following use cases are addressed:

- A tier 1 supplier has to integrate BSW modules of various BSW vendors.
- A BSW vendor can market and sell not only complete BSW solutions, but also single BSW modules.

`BuildActionManifest` can be denoted in the `Implementation` of the module [TPS_BSWMDT_04085].

A general sequence is:

1. Initialize
2. Perform build
3. Tear down build

The following diagram illustrates the sequence of applied processors.

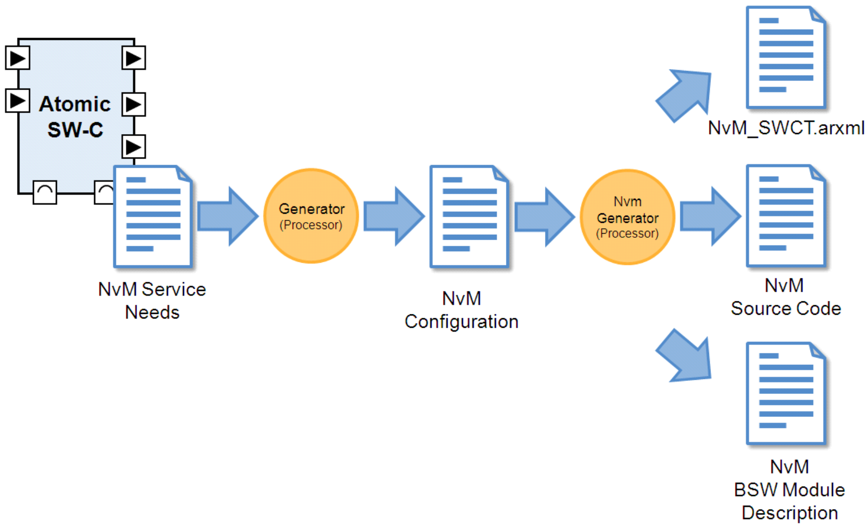


Figure 9.2: Applied Processors

9.2 BuildActionManifest Overview

The following diagram illustrates the basic approach:

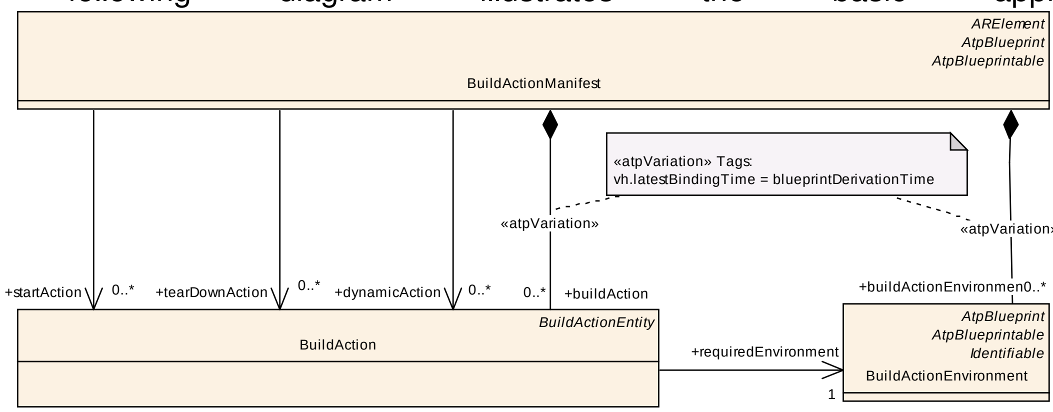


Figure 9.3: Build Action Manifest Overview

Class	**BuildActionManifest**			
Package	M2::AUTOSARTemplates::GenericStructure::BuildActionManifest			
Note	This meta-class represents the ability to specify a manifest for processing artifacts. An example use case is the processing of ECUC parameter values. **Tags:** atp.recommendedPackage=BuildActionManifests xml.globalElement=false			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
buildAction	BuildAction	*	aggr	This represents a particular action in the build chain. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=blueprintDerivationTime
buildActionEnvironment	BuildActionEnvironment	*	aggr	This represents a build action environment. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=blueprintDerivationTime
dynamicAction	BuildAction	*	ref	This denots an Action which is to be executed as part of the dynamic action set.
startAction	BuildAction	*	ref	This specifies the list of actions to be performed at the beginning of the process. **Tags:** xml.sequenceOffset=-90
tearDownAction	BuildAction	*	ref	This specifies the set of action which shall be performed after all other actions in the manifest were performed. **Tags:** xml.sequenceOffset=-80

Table 9.1: BuildActionManifest

[TPS_GST_00294] Build Action Manifest Overview ⌈ The `BuildActionManifest` is an `ARElement` providing the ability to describe particular steps to be performed in a given environment which need to be performed e.g. when an AUTOSAR executable. It mainly consists of the two entities:

- `BuildAction` is one particular action to be performed in order to contribute to the generation of e.g. the ECU executable.
- `BuildActionEnvironment` provides information about the environment, which is used to perform the BuildActions.

⌋*()*

Thereby the manifest defines three groups of actions:

- `startAction`: shall be executed in the given order before any other action is performed.

- tearDownAction: shall be executed in the given order when all other actions have been completed.
- dynamicAction: is part of the essential build process. These actions shall be executed after the completion of the startActions. The sequence of these is determined by the input/output relationship respectively the followUpAction / predecessorAction. If order cannot be determined or is not specified, then the results [of every dynamicAction] must be independent of the execution order.

9.2.1 BuildAction

This represents one particular action which contributes to the activitites generating ECU executable.

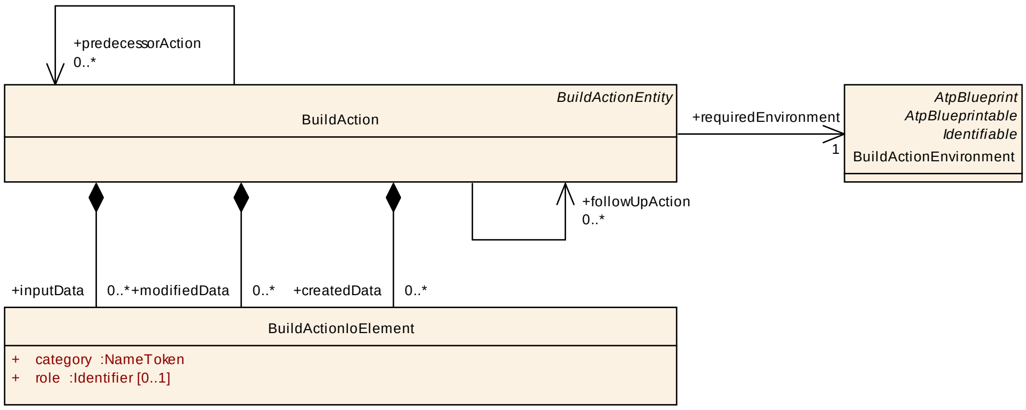


Figure 9.4: Build Action Details

Class	**BuildAction**			
Package	M2::AUTOSARTemplates::GenericStructure::BuildActionManifest			
Note	This meta-class represents the ability to specify a build action.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, BuildActionEntity, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
createdData	BuildActionIoElement	*	aggr	This represents the artifacts which are cated by the processor.
followUpAction	BuildAction	*	ref	This association specifies a set of follow up actions. **Tags:** xml.sequenceOffset=-80
inputData	BuildActionIoElement	*	aggr	This represents the artifacts which are read by the processor.
modifiedData	BuildActionIoElement	*	aggr	This denotes the data which are modifed by the action.

predecessorAction	BuildAction	*	ref	This association specifies a set of predecessors. These actions must be finished before but necessarily immediately after the given action.. These actions need to be performed in the specified order. **Tags:** xml.sequenceOffset=-90
requiredEnvironment	BuildActionEnvironment	1	ref	This represents the environment which is required to use the specified Processor.

Table 9.2: BuildAction

[TPS_GST_00338] Purpose of `BuildActionEnvironment` ⌈ A build action refers to the environment in which it shall be executed. Note that the build action does not provide specific attributes for error handling and abort conditions. This is subject to the environment performing the build actions. ⌋*()*

[TPS_GST_00339] Data involved in Build Actions ⌈ A build action specifies the involved data in terms of aggregated `BuildActionIoElement`s. The role of the aggregation of `BuildActionIoElement` in `BuildAction` determines if data is only read, modified, or created the first time. ⌋*()*

[TPS_GST_00340] Sequence of Build Actions ⌈ The data involved in `BuildAction`s can be used to determine an appropriate execution order. The following hints apply:

- Actions consuming data shall be performed after actions producing or modifying the same data.
- An action consuming and producing the same data shall use `modifiedData`. Otherwise this action would be its own predecessor / successor.
- `modifiedData` in particular supports the case that an action manipulates or verifies existing data. These action shall be performed before any consuming actions.
- Implicit interdependencies between `BuildAction`s can be specified using `predecessorAction` respectively `followUpAction`.

⌋*()*

Details of the implementation / invocation are specified using the properties of the superclass `BuildActionEntity`.

9.2.2 BuildActionIoElement

This represents data which are involved in a `BuildAction`.

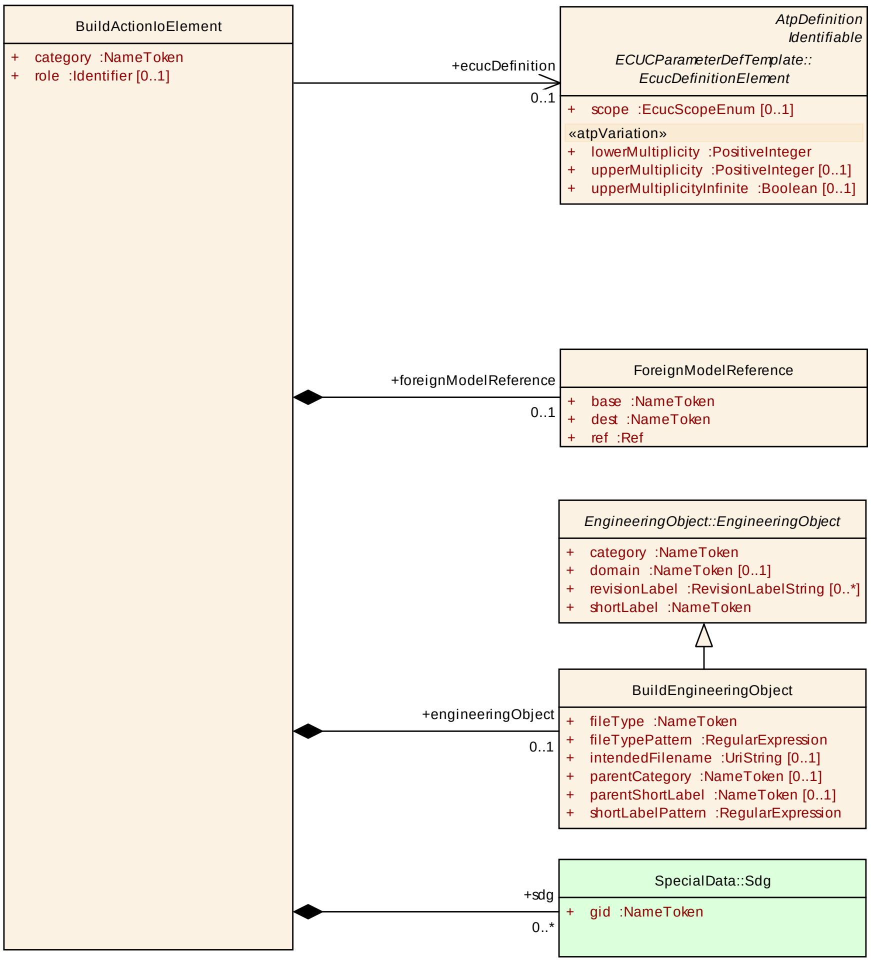


Figure 9.5: Build Action Manifest Input/Output

Class	**BuildActionIoElement**			
Package	M2::AUTOSARTemplates::GenericStructure::BuildActionManifest			
Note	This meta-class represents the ability to specify the input/output entities of a BuildAction.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
category	NameToken	1	attr	This element assigns a category to the parent element. It is intended to specialize the usage and/or the content of the object. Such a specialization may also impose particular semantic constraints on the entire substructure. See also Identifiable. **Tags:** xml.sequenceOffset=-100

ecucDefinition	EcucDefinitionElement	0..1	ref	This association denotes an ECUC parameter definition. The such referenced parameters are subject of the build action input/ouptut. Note that the reference to the definition denotes the right for a build action to read and/or write values for the given defintion and all contained definitions.
engineeringObject	BuildEngineeringObject	0..1	aggr	This represents an artifact applicable to the build action.
foreignModelReference	ForeignModelReference	0..1	aggr	This is a reference to a foreign model element. Note that it is not modeled as an association because it should also be able to refer also to non AUTOSAR models.
role	Identifier	0..1	attr	This attribute allows to denote a particular role of the collection. Note that the applicable semantics shall be mutually agreed between the two parties. **Tags:** xml.sequenceOffset=30
sdg	Sdg	*	aggr	This special data group allows to denote specific data. The structure is subject of mutual agreement. **Tags:** xml.sequenceOffset=-90

Table 9.3: BuildActionIoElement

[TPS_GST_00341] Input Data for Build Actions ⌈ The model covers three kinds of data:

1. Artifacts - denoted as `BuildEngineeringObject`s
2. ECUC-parameters - denoted as references to `EcucDefinitionElement`s
3. reference to any model element - denoted as `GenericModelReference`

⌋*()*

[TPS_GST_00342] ECUC-Parameters in Build Actions ⌈ Note that if containers are referenced, the action may also touch the parameter / subcontainers in this container. ⌋*()*

[TPS_GST_00343] ECUC-Containers in Build Actions ⌈ Note further, that if a container is referenced in a `BuildActionIoElement` playing the role `createdData`, then a new container is created. ⌋*()*

[TPS_GST_00344] General Model Elements in Build Actions ⌈ For General Model Elements it is assumed that model elements can be referenced similar to the references within an AUTOSAR model. This also implies that the referenced model element is in a proprietary model. ⌋*()*

An example for [TPS_GST_00344] is the setting of status information in a work flow model.

[TPS_GST_00345] Special Data in `BuildActionIoElement` ⌈ `sdg` can be used to attach environment specific properties to the `BuildActionIoElement`. ⌋*()*

9.2.3 BuildActionEnvironment

This entity specifies the build environment. Main purpose is to provide the possibility that a build action denotes the required environment. The model supports that arbitary properties are specified which can be used to support the installation and test of the environment.

Class	**BuildActionEnvironment**			
Package	M2::AUTOSARTemplates::GenericStructure::BuildActionManifest			
Note	This meta-class represents the ability to specify a build action environment.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
sdg	Sdg	*	aggr	This represents a general data structure intended to denote parameters for the BuildActionEnvironment.

Table 9.4: BuildActionEnvironment

9.2.4 BuildActionEntity

BuildActionEntity specifies necessary implementation / invocation properties.

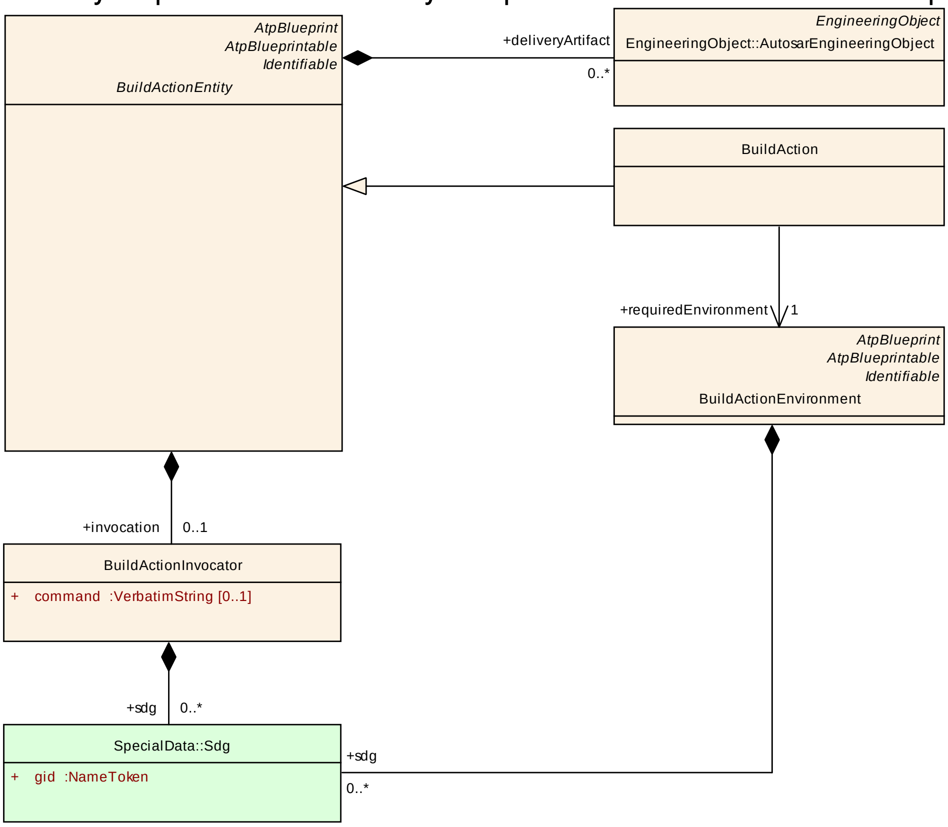


Figure 9.6: Build Action Entity

Class	**BuildActionEntity (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::BuildActionManifest			
Note	This meta-class represents the ability to describe a build action entity which might be specialized to environments as well as to individual build actions.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
deliveryArtifact	AutosarEngineeringObject	*	aggr	This denotes the delivery artifacts for the entity for reference purposes.
invocation	BuildActionInvocator	0..1	aggr	This specifies how to invoke a build action in the given environment.

Table 9.5: BuildActionEntity

9.2.5 Usage of Special Data

[TPS_GST_00357] Usage of Special Data ⌈ The Usage of Special Data (`Sdg`) within the `BuildActionManifest` are specific to the particular application and therefore not standardized. ⌋() Listing 9.1 shows an example how to denote a more specific role of an artifact in a `BuildAction`.

Listing 9.1: Example of Special Data in Build Action Manifest

```
<INPUT-DATAS>
  <BUILD-ACTION-IO-ELEMENT>
    <CATEGORY>ARTIFACT</CATEGORY>
    <SDGS>
      <SDG>
        <SD GID="USED_ACTION_ROLE">PROCESSOR</SD>
      </SDG>
    </SDGS>
    <ENGINEERING-OBJECT>
      <SHORT-LABEL>CanIf_Generator</SHORT-LABEL>
      <CATEGORY>CONFWF</CATEGORY>
      <DOMAIN>ARDEMO</DOMAIN>
      <FILE-TYPE>oaw</FILE-TYPE>
    </ENGINEERING-OBJECT>
  </BUILD-ACTION-IO-ELEMENT>
</INPUT-DATAS>
```

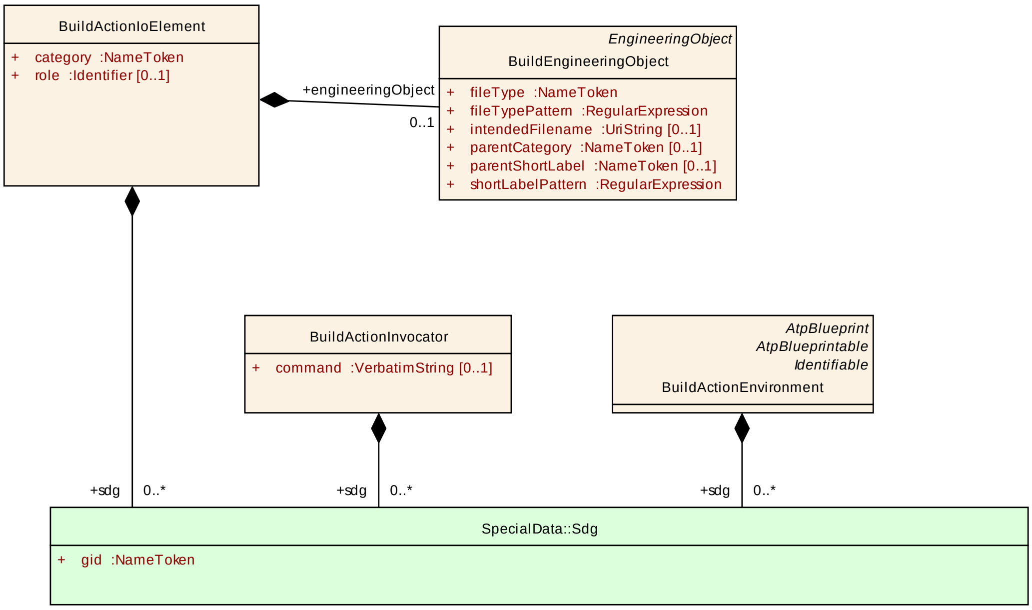


Figure 9.7: BuildAction Usage of Special Data

Class	**BuildActionInvocator**			
Package	M2::AUTOSARTemplates::GenericStructure::BuildActionManifest			
Note	This meta-class represents the ability to specify the invocation of a task in a build action.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

command	VerbatimString	0..1	attr	This represents the command to invocate the processor. Note that this is a generic string which can be interpreted properly in the processor environment. Note that it is optional due to the fact that some actions are hardwired in the environment and do not need an explicit command. On the other hand the properties of an invocator can be complex and not standardized.
sdg	Sdg	*	aggr	This represents a general data structure intended to denote parameters for the BuildAction.

Table 9.6: BuildActionInvocator

Class	**BuildEngineeringObject**			
Package	M2::AUTOSARTemplates::GenericStructure::BuildActionManifest			
Note	This meta-class represents the ability to denote an artifact which is processed within a particular build action.			
Base	ARObject, EngineeringObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
fileType	NameToken	1	attr	This attribute indicates the file type which shall used for the engineering object. Note that an engineering object may deliver multiple representations of the same artifact. This attribute can select one of the provided representations.
fileTypePattern	RegularExpression	1	attr	This attribute allows to define a set of engineering objects as pattern based search applied to the filetype of the individual Engineering objects. **Tags:** xml.sequenceOffset=90
intendedFilename	UriString	0..1	attr	This attribute represents the name of the file if it is created newly. Note that engineering object resolves category + ShortLabel indicate mainly to refer to an existing file. If the file is created newly, the filename can either be determined by built in policy or predefined here. Note that extensions shall part of file name even if it could be derived from fileType.
parentCategory	NameToken	0..1	attr	This represents the category of the parent object.
parentShortLabel	NameToken	0..1	attr	This represents the shortLabel of the parent object. This allows to specify the output position in a hierarchically organized sysyetm
shortLabelPattern	RegularExpression	1	attr	This attribute allows to define a set of engineering objects as pattern based search applied to the shortLabel of the individual Enginering objects. **Tags:** xml.sequenceOffset=80

Table 9.7: BuildEngineeringObject

9.2.6 Example

This example shall illustrate the representation in the arxml file. It follows the definitions [TR_IOAT_00069].

Listing 9.2: Example of Build Action Manifest

```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
   //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
   /r4.0␣AUTOSAR_4-1-3.xsd">
  <ADMIN-DATA>
    <USED-LANGUAGES />
  </ADMIN-DATA>
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>AUTOSAR</SHORT-NAME>
      <AR-PACKAGES>
        <AR-PACKAGE>
          <SHORT-NAME>GenericStructureTemplate</SHORT-NAME>
          <CATEGORY>EXAMPLE</CATEGORY>
          <AR-PACKAGES>
            <AR-PACKAGE>
              <SHORT-NAME>BuildActionManifests</SHORT-NAME>
              <ELEMENTS>
                <BUILD-ACTION-MANIFEST>
                  <SHORT-NAME>CanIf</SHORT-NAME>
                  <BUILD-ACTIONS>
                    <BUILD-ACTION>
                      <SHORT-NAME>CanIf_Generate</SHORT-NAME>
                      <CATEGORY>GENERATOR</CATEGORY>
                      <INVOCATION />
                      <CREATED-DATAS>
                        <BUILD-ACTION-IO-ELEMENT>
                          <CATEGORY>ARTIFACT</CATEGORY>
                          <ENGINEERING-OBJECT>
                            <SHORT-LABEL>CanIf_Cfg</SHORT-LABEL>
                            <CATEGORY>SWSRC</CATEGORY>
                            <DOMAIN>ARDEMO</DOMAIN>
                            <FILE-TYPE>c</FILE-TYPE>
                            <INTENDED-FILENAME>CanIf_Cfg.c</INTENDED-
                               FILENAME>
                          </ENGINEERING-OBJECT>
                        </BUILD-ACTION-IO-ELEMENT>
                        <BUILD-ACTION-IO-ELEMENT>
                          <CATEGORY>ARTIFACT</CATEGORY>
                          <ENGINEERING-OBJECT>
                            <SHORT-LABEL>CanIf_Cfg</SHORT-LABEL>
                            <CATEGORY>SWHDR</CATEGORY>
                            <DOMAIN>ARDEMO</DOMAIN>
```

```
            <FILE-TYPE>h</FILE-TYPE>
            <INTENDED-FILENAME>CanIf_Cfg.h</INTENDED-
               FILENAME>
          </ENGINEERING-OBJECT>
        </BUILD-ACTION-IO-ELEMENT>
        <BUILD-ACTION-IO-ELEMENT>
          <CATEGORY>ARTIFACT</CATEGORY>
          <ENGINEERING-OBJECT>
            <SHORT-LABEL>CanIf_Cfg_Doc</SHORT-LABEL>
            <CATEGORY>Doc</CATEGORY>
            <DOMAIN>ARDEMO</DOMAIN>
            <FILE-TYPE>arxml</FILE-TYPE>
            <INTENDED-FILENAME>CanIf_Cfg_Doc.arxml</
               INTENDED-FILENAME>
          </ENGINEERING-OBJECT>
        </BUILD-ACTION-IO-ELEMENT>
      </CREATED-DATAS>
      <INPUT-DATAS>
        <BUILD-ACTION-IO-ELEMENT>
          <CATEGORY>ARTIFACT</CATEGORY>
          <SDGS>
            <SDG>
              <SD GID="USED_ACTION_ROLE">PROCESSOR</SD>
            </SDG>
          </SDGS>
          <ENGINEERING-OBJECT>
            <SHORT-LABEL>CanIf_Generator</SHORT-LABEL>
            <CATEGORY>CONFWF</CATEGORY>
            <DOMAIN>ARDEMO</DOMAIN>
            <FILE-TYPE>oaw</FILE-TYPE>
          </ENGINEERING-OBJECT>
        </BUILD-ACTION-IO-ELEMENT>
      </INPUT-DATAS>
      <REQUIRED-ENVIRONMENT-REF DEST="BUILD-ACTION-
         ENVIRONMENT">/AUTOSAR/GenericStructureTemplate/
         BuildActionManifests/CanIf/ARDEMO_ENV_CODE</
         REQUIRED-ENVIRONMENT-REF>
    </BUILD-ACTION>
    <BUILD-ACTION>
      <SHORT-NAME>Compile_Doc</SHORT-NAME>
      <CATEGORY>GENERATOR</CATEGORY>
      <INVOCATION>
        <COMMAND>DOC_FORMATTER {CanIf_Static_Doc} {
           CanIf_Doc}</COMMAND>
      </INVOCATION>
      <CREATED-DATAS>
        <BUILD-ACTION-IO-ELEMENT>
          <CATEGORY>ARTIFACT</CATEGORY>
          <ENGINEERING-OBJECT>
            <SHORT-LABEL>CanIf_Doc</SHORT-LABEL>
            <CATEGORY>Doc</CATEGORY>
            <DOMAIN>ARDEMO</DOMAIN>
            <FILE-TYPE>pdf</FILE-TYPE>
            <INTENDED-FILENAME>CanIf_Doc.pdf</INTENDED-
               FILENAME>
            <PARENT-CATEGORY>PRJ</PARENT-CATEGORY>
```

```
                        <PARENT-SHORT-LABEL>CanIf</PARENT-SHORT-LABEL>
                      </ENGINEERING-OBJECT>
                    </BUILD-ACTION-IO-ELEMENT>
                  </CREATED-DATAS>
                  <INPUT-DATAS>
                    <BUILD-ACTION-IO-ELEMENT>
                      <CATEGORY>ARTIFACT</CATEGORY>
                      <ENGINEERING-OBJECT>
                        <SHORT-LABEL>CanIf_Cfg_Doc</SHORT-LABEL>
                        <CATEGORY>Doc</CATEGORY>
                        <DOMAIN>ARDEMO</DOMAIN>
                        <FILE-TYPE>arxml</FILE-TYPE>
                      </ENGINEERING-OBJECT>
                    </BUILD-ACTION-IO-ELEMENT>
                    <BUILD-ACTION-IO-ELEMENT>
                      <CATEGORY>ARTIFACT</CATEGORY>
                      <ENGINEERING-OBJECT>
                        <SHORT-LABEL>CanIf_Static_Doc</SHORT-LABEL>
                        <CATEGORY>Doc</CATEGORY>
                        <DOMAIN>ARDEMO</DOMAIN>
                        <FILE-TYPE>arxml</FILE-TYPE>
                      </ENGINEERING-OBJECT>
                    </BUILD-ACTION-IO-ELEMENT>
                  </INPUT-DATAS>
                  <REQUIRED-ENVIRONMENT-REF DEST="BUILD-ACTION-
                     ENVIRONMENT">/AUTOSAR/GenericStructureTemplate/
                     BuildActionManifests/CanIf/ARDEMO_ENV_DOC</
                     REQUIRED-ENVIRONMENT-REF>
                </BUILD-ACTION>
              </BUILD-ACTIONS>
              <BUILD-ACTION-ENVIRONMENTS>
                <BUILD-ACTION-ENVIRONMENT>
                  <SHORT-NAME>ARDEMO_ENV_CODE</SHORT-NAME>
                </BUILD-ACTION-ENVIRONMENT>
                <BUILD-ACTION-ENVIRONMENT>
                  <SHORT-NAME>ARDEMO_ENV_DOC</SHORT-NAME>
                </BUILD-ACTION-ENVIRONMENT>
              </BUILD-ACTION-ENVIRONMENTS>
            </BUILD-ACTION-MANIFEST>
          </ELEMENTS>
        </AR-PACKAGE>
      </AR-PACKAGES>
    </AR-PACKAGE>
  </AR-PACKAGES>
  </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

9.3 Constraints and assumptions

In case of software exchange, it is necessary also to supply contributions to the build environment of the recipient. It is aslo assumed that mutual agreements are taken for the full details. The manifest helps to formalize these agreements such that - once the environment is established - a software exchange can be performed on a regular basis. The case that software is exchanged which relies on a certain processor is supported too.

10 Roles and Rights

In order to manage a cooperative engineering approach, AUTOSAR supports the specification of access rights to objects for involved parties. The approach applies to use cases such as

- Software Sharing artifacts are delivered to cooperation partners. Depending on the chosen business case and cooperation model by the partners the delivered files shall be used in read-only mode or specified changes/adds on specified attributes are allowed or even expected to be made by the integrator/supplier.
- In cooperative application software development, AUTOSAR descriptions can be split to multiple files. As AUTOSAR does not specify a particular process, there should be a generic way which allows to specify roles in the development process. Based on such roles, an initial split of AUTOSAR XML descriptions can be performed. It also would allow deriving access control based on meta-classes.
- Some ECU parameter values may fall under different category of responsibility. Therefore based on the ECU parameter definition this responsibility can be specified as access control. In addition the access control can be specified in terms of Artifacts. This finally even allows to define a split/merge policy.

[TPS_GST_00226] Access Control Relation ⌈ In general, roles and rights is conceptualized as a relation

$$Permission = f(role, operation, object, context)$$

⌋*()*

Figure 10.1 depicts the meta classes implementing the access control relation according to [TPS_GST_00226]:

- **[TPS_GST_00227] `AclPermission`** ⌈ This represents the relation mentioned in [TPS_GST_00226] ⌋*()*
- **[TPS_GST_00228] `AclRole`** ⌈ This represents the possible roles within the definition of Roles and Rights. This role might have a relationship to the roles defined in the methodology. On the other hand, the technical definition of these roles highly depend on the local environment. On the other hand LDAP-Groups are very common, so `ldapUrl` allows to refer to a previously agreed LDAP group. ⌋*()*
- **[TPS_GST_00229] `AclOperation`** ⌈ This is used to specify the possible activities which are performed by a role on a set of objects. This activity might have a relationship to the activities in the methodology.

  Relationships between operations are expressed such as implies / blocks. For example write-access implies read access

  An Operation also specifies it scope by `aclScope` ⌋*()*

- **[TPS_GST_00230] AclObjectSet** ⌈ This is used to specify the objects to which the permission applies. This definition can be based on meta level M1 as well as based on M2. ⌋ *()*
- **[TPS_GST_00231] Context of AclPermission** ⌈ The context under which an AclPermission can be applied is specified in the attribute aclContext. More complex contexts may be implemented using sdg or via Collection. The possible values are subject to mutual agreement between the stakeholders. ⌋ *()*

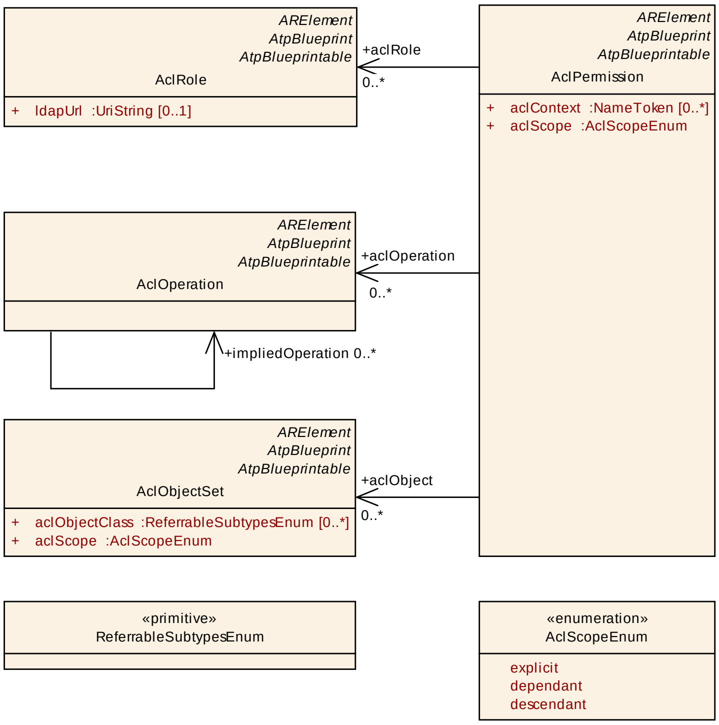


Figure 10.1: Roles and Rights Overview

Figure 10.2 illustrates, how the set of objects is specified. This can be done based on meta level M1 as well as on M2. The following methods are supported:

- **[TPS_GST_00232] aclObjectClass** ⌈ This represents the case that the access controlled objects are defined as a reference to a meta class resp. to an attribute of a meta class (M2). The such defined permissions apply to all model elements (instances) of that meta class. ⌋ *()*
- **[TPS_GST_00233] collection** ⌈ This represents the case that the access controlled objects are defined by a Collection. The objects referenced by the referenced Collection belong to the access controlled object set. ⌋ *()*
- **[TPS_GST_00234] object** ⌈ This represents this case where the M1 objects are explicitly referenced to. Note that in addition to the Collection this can also refer to Referrables. ⌋ *()*
- **[TPS_GST_00235] objectDefintion** ⌈ The AUTOSAR meta model has the pattern that on M1 we have the pair of Definition/Description. In this case all descriptions for a referenced definition are part of the object set. ⌋ *()*

Examples for [TPS_GST_00235] are given as

  - EcucDefinitionElement - Ecuc parameter Value
  - SwSystemconst - SwSystemconstValue
  - PostBuildVariantCriterion - PostBuildVariantCriterionValue

- **[TPS_GST_00236]** **derivedFromBlueprint** ⌈ In this case all objects derived from a referenced blueprint are belong to the object set.

  Note that instanceRefs are not supported, since there was no use case. It could be supported using a FlatMap. ⌋ *()*

- **[TPS_GST_00237]** **engineeringObject** ⌈ This indicates an engineering object. The specified permissions apply to all objects in the partial model which is stored in the denoted AutosarEngineeringObject. ⌋ *()*

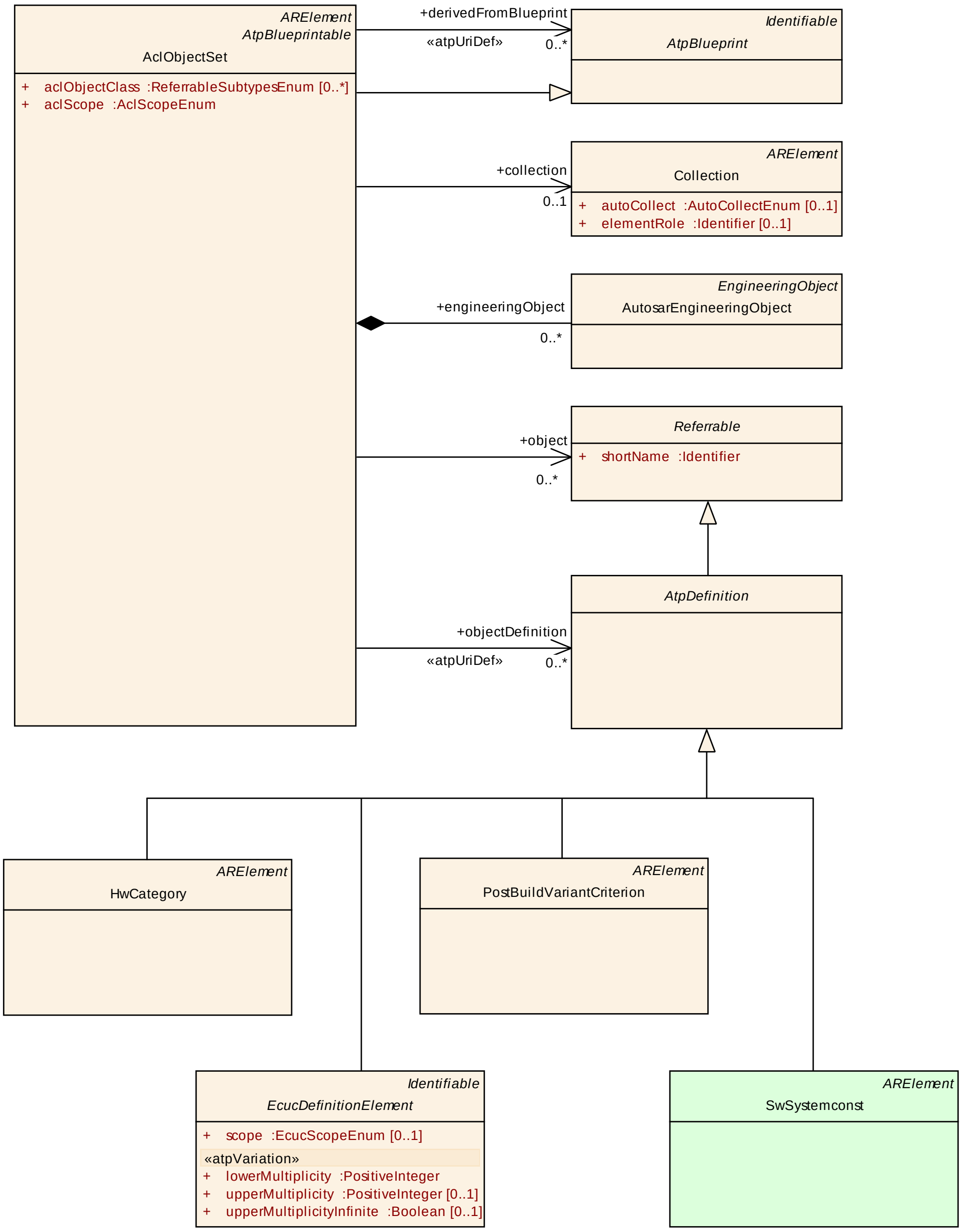


Figure 10.2: Roles and Rights Object Set

Listing 10.1 illustrates how the roles and rights approach can be applied to control the access on objects in an AUTOSAR description. It defines

- a set of permissions named "Integrator" representing the Relation in [TPS_GST_00226] based on the definitions below
- a role named "ECU_Integrator"
- an object set named "MemoryStackConfiguration"
- two operations

Listing 10.1: Example for Access Control

```xml
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0 AUTOSAR_4-2-2.xsd">
  <ADMIN-DATA>
    <LANGUAGE>EN</LANGUAGE>
    <USED-LANGUAGES>
      <L-10 L="EN" xml:space="default">English</L-10>
    </USED-LANGUAGES>
  </ADMIN-DATA>
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>AUTOSAR</SHORT-NAME>
      <AR-PACKAGES>
        <AR-PACKAGE>
          <SHORT-NAME>GenericStructureTemplate</SHORT-NAME>
          <CATEGORY>EXAMPLE</CATEGORY>
          <AR-PACKAGES>
            <AR-PACKAGE>
              <SHORT-NAME>AclPermissions</SHORT-NAME>
              <ELEMENTS>
                <ACL-PERMISSION>
                  <SHORT-NAME>Integrator</SHORT-NAME>
                  <ACL-OBJECT-REFS>
                    <ACL-OBJECT-REF DEST="ACL-OBJECT-SET">/AUTOSAR/
                        GenericStructureTemplate/AccessObjectSets/
                        MemoryStackConfiguration</ACL-OBJECT-REF>
                  </ACL-OBJECT-REFS>
                  <ACL-OPERATION-REFS>
                    <ACL-OPERATION-REF DEST="ACL-OPERATION">/AUTOSAR/
                        GenericStructureTemplate/AclOperations/AssignValue</
                        ACL-OPERATION-REF>
                    <ACL-OPERATION-REF DEST="ACL-OPERATION">/AUTOSAR/
                        GenericStructureTemplate/AclOperations/ReassignValue
                        </ACL-OPERATION-REF>
                  </ACL-OPERATION-REFS>
                  <ACL-ROLE-REFS>
                    <ACL-ROLE-REF DEST="ACL-ROLE">/AUTOSAR/
                        GenericStructureTemplate/AclRoles/ECU_Integrator</
                        ACL-ROLE-REF>
                  </ACL-ROLE-REFS>
                </ACL-PERMISSION>
              </ELEMENTS>
            </AR-PACKAGE>
            <AR-PACKAGE>
              <SHORT-NAME>AccessObjectSets</SHORT-NAME>
              <ELEMENTS>
                <ACL-OBJECT-SET>
                  <SHORT-NAME>MemoryStackConfiguration</SHORT-NAME>
                  <ACL-SCOPE>DESCENDANT</ACL-SCOPE>
                  <OBJECT-DEFINITION-REFS>
                    <OBJECT-DEFINITION-REF DEST="ECUC-MODULE-DEF">/AUTOSAR/
                        EcucDefs/MemIf</OBJECT-DEFINITION-REF>
                    <OBJECT-DEFINITION-REF DEST="ECUC-MODULE-DEF">/AUTOSAR/
                        EcucDefs/MemMap</OBJECT-DEFINITION-REF>
```

```
                <OBJECT-DEFINITION-REF DEST="ECUC-MODULE-DEF">/AUTOSAR/
                    EcucDefs/NvM</OBJECT-DEFINITION-REF>
              </OBJECT-DEFINITION-REFS>
            </ACL-OBJECT-SET>
          </ELEMENTS>
        </AR-PACKAGE>
        <AR-PACKAGE>
          <SHORT-NAME>AclOperations</SHORT-NAME>
          <REFERENCE-BASES>
            <REFERENCE-BASE>
              <SHORT-LABEL>op</SHORT-LABEL>
              <BASE-IS-THIS-PACKAGE>true</BASE-IS-THIS-PACKAGE>
            </REFERENCE-BASE>
          </REFERENCE-BASES>
          <ELEMENTS>
            <ACL-OPERATION>
              <SHORT-NAME>AssignValue</SHORT-NAME>
            </ACL-OPERATION>
            <ACL-OPERATION>
              <SHORT-NAME>ReassignValue</SHORT-NAME>
              <IMPLIED-OPERATION-REFS>
                <IMPLIED-OPERATION-REF DEST="ACL-OPERATION" BASE="op">
                    AssignValue</IMPLIED-OPERATION-REF>
              </IMPLIED-OPERATION-REFS>
            </ACL-OPERATION>
          </ELEMENTS>
        </AR-PACKAGE>
        <AR-PACKAGE>
          <SHORT-NAME>AclRoles</SHORT-NAME>
          <ELEMENTS>
            <ACL-ROLE>
              <SHORT-NAME>ECU_Integrator</SHORT-NAME>
              <LONG-NAME>
                <L-4 L="EN">See <TT>ECU Integrator</TT></L-4>
              </LONG-NAME>
            </ACL-ROLE>
          </ELEMENTS>
        </AR-PACKAGE>
      </AR-PACKAGES>
    </AR-PACKAGE>
  </AR-PACKAGES>
  </AR-PACKAGE>
</AR-PACKAGES>
</AUTOSAR>
```

Class	**AclPermission**			
Package	M2::AUTOSARTemplates::GenericStructure::RolesAndRights			
Note	This meta class represents the ability to represent permissions granted on objects in an AUTOSAR model. **Tags:** atp.recommendedPackage=AclPermissions			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**

aclContext	NameToken	*	attr	This attribute is intended to specify the context under which the AclPemission is applicable. The values are subject to mutual agreement between the involved stakeholders. For examples the values can be the names of binding times.
aclObject	AclObjectSet	*	ref	This denotes an object to which the AclPermission applies.
aclOperation	AclOperation	*	ref	This denotes an operation which is granted by the given AclPermission.
aclRole	AclRole	*	ref	This denotes the role (individual or even organization) for which the AclPermission. is granted.
aclScope	AclScopeEnum	1	attr	This indicates the scope of applied permissions: explicit, descendant, dependent;

Table 10.1: AclPermission

Class	**AclObjectSet**			
Package	M2::AUTOSARTemplates::GenericStructure::RolesAndRights			
Note	This meta class represents the ability to denote a set of objects for which roles and rights (access control lists) shall be defined. It basically can define the objects based on • the nature of objects • the involved blueprints • the artifact in which the objects are serialized • the definition of the object (in a definition - value pattern) • individual reference objects **Tags:** atp.recommendedPackage=AclObjectSets			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
aclObjectClass	ReferrableSubtypesEnum	*	attr	This specifies that the considered objects as instances of the denoted meta class.
aclScope	AclScopeEnum	1	attr	this indicates the scope of the referenced objects.
collection	Collection	0..1	ref	This indicates that the relevant objects are specified via a collection.
derivedFromBlueprint	AtpBlueprint	*	ref	This association indicates that the considered objects are the ones being derived from the associated blueprint. **Stereotypes:** atpUriDef

engineeringObject	AutosarEngineeringObject	*	aggr	This indicates an engineering object. The AclPermission relates to all objects in this partial model. This also implies that the other objects in this set shall be placed in the specified engineering object. Note that semantic constraints apply with respect to «atpSplitable»
object	Referrable	*	ref	This association applies a particular (usually small) set of objects (e.g. a singular package). Main usage is, if one does not want to create a collection specifically for access control.
objectDefinition	AtpDefinition	*	ref	This denotes an object by its definition. For example the right to manipulate the value of a particular ecuc parameter is denoted by reference to the definition of the parameter. Note that this can also be a reference to a Standard Module Definition. Therefore it is stereotyped by atpUriDef. **Stereotypes:** atpUriDef

Table 10.2: AclObjectSet

Class	**AtpDefinition (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::RolesAndRights			
Note	This abstract meta class represents "definition"-elements which identify the respective values. For example the value of a particular system constant is identified by the definition of this system constant.			
Base	ARObject, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 10.3: AtpDefinition

Class	**AclOperation**			
Package	M2::AUTOSARTemplates::GenericStructure::RolesAndRights			
Note	This meta class represents the ability to denote a particular operation which may be performed on objects in an AUTOSAR model. **Tags:** atp.recommendedPackage=AclOperations			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
impliedOperation	AclOperation	*	ref	This indicates that the related operations are also implied. Therefore the permission is also granted for this operation.

Table 10.4: AclOperation

Class	**AclRole**			
Package	M2::AUTOSARTemplates::GenericStructure::RolesAndRights			
Note	This meta class represents the ability to specify a particular role which is used to grant access rights to AUTOSAR model. The purpose of this meta-class is to support the mutual agreements between the involved parties. **Tags:** atp.recommendedPackage=AclRoles			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
ldapUrl	UriString	0..1	attr	This is an URL which allows to represent users or organizations taking the particular role.

Table 10.5: AclRole

Enumeration	**AclScopeEnum**
Package	M2::AUTOSARTemplates::GenericStructure::RolesAndRights
Note	This enumerator represents the scope of a definition in context of access control.
Literal	***Description***
dependant	This specifies that the AclPermission applies to dependant (in particular referenced) operations / objects as well. Note that this includes the descendant ones. **Tags:** atp.EnumerationValue=0
descendant	This specifies that the AclPermission applies to descendant operations / objects as well. **Tags:** atp.EnumerationValue=1
explicit	This is indicates that the AclPermission applies to explicit objects / operations only. **Tags:** atp.EnumerationValue=2

Table 10.6: AclScopeEnum

11 Life Cycle Support

11.1 Introduction

In order to support evolution and backward compatibility of the AUTOSAR model elements like port prototype blueprints, port interfaces, keyword abbreviations, example SW-Cs (in ASW) or of the API of a BSW module etc. AUTOSAR supports life cycles.

The provided approach can also be applied to standardization (See [TPS_STDT_00038]) as well as for vendor specific development. A life cycle presents information like "outdated/deprecated/legacy", "invalid/not part of standard anymore", "obsolete/will be outdated in near future". It is not identical to the version status information like "in work", "released" etc.

The life cycle approach might also be used for intermediate development between two releases, e.g. by attaching a life cycle like "experimental" to it. For the final release however, elements still having such a life cycle would not be part of the release.

Due to backward compatibility requirements it might not be adequate to just delete a model element and add a new one or - even worse - to change the model element without notification. A life cycle state such as "obsolete" can be used to handle such a situation.

It cannot be expected that all existing elements and all new elements are equally "good". So it is supported to give hints to the user which elements are preferable to be used even if some are not forbidden to be used and still part of the standard.

Note that life cycle states will not allow to have two elements with the same `shortName` within the same `ARPackage`. In particular the name space concept of the meta model (see Chapter 4.3.1) is not affected.

[TPS_GST_00239] Definition "Life Cycle" ⌈ Life Cycle is the course of development/evolutionary stages of a model element during its life time.

A life cycle consists of a set of life cycle states. A life cycle state can be attached to an element in parallel to its version information. ⌋*()*

A typical life cycle is {`valid`, `obsolete`} and means that a valid element is up to date when first introduced but is substituted later by a new one and therefore gets the life cycle state "obsolete".

According to Figure 11.1, life cycle support provides two basic means:

- Definition of a life cycle (`LifeCycleStateDefinitionGroup`) see chapter 11.2
- Application of a life cycle (`LifeCycleInfoSet`) see chapter 11.3

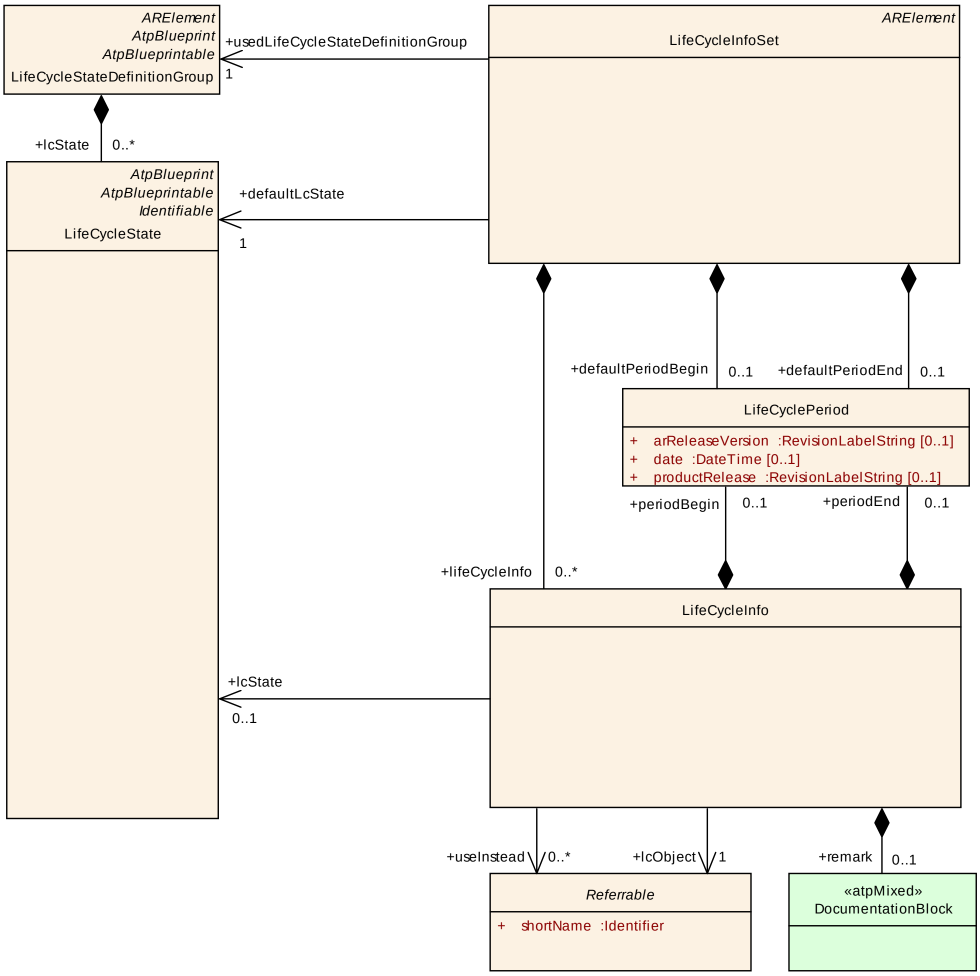


Figure 11.1: Definition of Life Cycles

11.2 Definition of a life cycle

[TPS_GST_00240] `LifeCycleStateDefinitionGroup` ⌈ This is used to define a particular life cycle by specifying a group of `LifeCycleState`s. The purpose of the life cycle is expressed using `desc` of `LifeCycleStateDefinitionGroup`. Particular overview details may be expressed in `introduction` of `LifeCycleStateDefinitionGroup`.

Information about the purpose of a particular `LifeCycleState` is specified in the `introduction` of `LifeCycleState`. ⌋*()*

The following hints apply:

- One model can simultaneously use multiple life cycles in order to support different aspects.
- It is recommended to keep the `shortName` unique across all `LifeCycleStateDefinitionGroup`s.

Listing 11.1 illustrates the ARXML representation of the life cycle definition according to [TPS_GST_00051].

Listing 11.1: AUTOSAR Standard LifeCycleDefintion

```
<ADMIN-DATA>
  <LANGUAGE>EN</LANGUAGE>
  <USED-LANGUAGES>
    <L-10 L="EN" xml:space="default">English</L-10>
  </USED-LANGUAGES>
</ADMIN-DATA>
<AR-PACKAGES>
<!-- AR-Package: AUTOSAR -->
  <AR-PACKAGE>
    <SHORT-NAME>AUTOSAR</SHORT-NAME>
    <AR-PACKAGES>
      <AR-PACKAGE>
    <!-- AR-Package: GenDef -->
        <SHORT-NAME>GenDef</SHORT-NAME>
        <AR-PACKAGES>
          <AR-PACKAGE>
      <!-- AR-Package: LifeCycleStateDefinitionGroups -->
            <SHORT-NAME>LifeCycleStateDefinitionGroups</SHORT-NAME>
            <CATEGORY>STANDARD</CATEGORY>
            <ELEMENTS>
        <!-- LifeCycleStateDefinitionGroup: AutosarLifeCycleStates -->
              <LIFE-CYCLE-STATE-DEFINITION-GROUP>
                <SHORT-NAME>AutosarLifeCycleStates</SHORT-NAME>
                <LONG-NAME>
                  <L-4 L="EN">Life Cycle Definitions used in AUTOSAR
                     Standards</L-4>
                </LONG-NAME>
                <DESC>
                  <L-2 L="EN">This set represents the life cycle
                     definitions used by AUTOSAR on M1 and M2 level. See
                     also [TPS_GST_00051] respectively [TPS_GST_00064].</
                     L-2>
                </DESC>
                <LC-STATES>
          <!-- LifeCycleState: valid -->
                  <LIFE-CYCLE-STATE>
                    <SHORT-NAME>valid</SHORT-NAME>
                    <DESC>
                      <L-2 L="EN">This indicates that the related entity
                         is a valid part of the document. This is the
                         default.</L-2>
                    </DESC>
                  </LIFE-CYCLE-STATE>
        <!-- LifeCycleState: draft -->
                  <LIFE-CYCLE-STATE>
                    <SHORT-NAME>draft</SHORT-NAME>
                    <DESC>
                      <L-2 L="EN">This indicates that the related entity
                         is introduced newly in the (meta) model but
                         still experimental. This information is
```

```
                        published but is subject to be changed without
                        backward compatibility management.</L-2>
                    </DESC>
                  </LIFE-CYCLE-STATE>
        <!-- LifeCycleState: obsolete -->
                  <LIFE-CYCLE-STATE>
                    <SHORT-NAME>obsolete</SHORT-NAME>
                    <DESC>
                      <L-2 L="EN">This indicates that the related entity
                        is obsolete and kept in the (meta) model for
                        compatibility reasons. </L-2>
                    </DESC>
                    <INTRODUCTION>
                      <P>
                        <L-1 L="EN">If this life cycle state is set, the
<TT TYPE="ARMetaClassRole">LifeCycleInfo.remark</TT> shall express the
   recommended alternative solution.</L-1>
                      </P>
                    </INTRODUCTION>
                  </LIFE-CYCLE-STATE>
        <!-- LifeCycleState: preliminary -->
                  <LIFE-CYCLE-STATE>
                    <SHORT-NAME>preliminary</SHORT-NAME>
                    <DESC>
                      <L-2 L="EN">This indicates that the related entity
                        is preliminary in the (meta) model. It is
                        subject to be changed without backwards
                        compatibility management. An AUTOSAR release
                        does not contain such elements. It is intended
                        for AUTOSAR internal development.</L-2>
                    </DESC>
                  </LIFE-CYCLE-STATE>
        <!-- LifeCycleState: removed -->
                  <LIFE-CYCLE-STATE>
                    <SHORT-NAME>removed</SHORT-NAME>
                    <DESC>
                      <L-2 L="EN">This indicates that the related entity
                        is still in the (meta) model for whatever reason
                        . It shall not be used and should not even
                        appear in documents. </L-2>
                    </DESC>
                    <INTRODUCTION>
                      <P>
                        <L-1 L="EN">An AUTOSAR release does not contain
                          such elements. It is intended for AUTOSAR
                          internal development. <BR /> Removed elements
                          are not included in an .arxml delivery but can
                           be referenced in a LifeCycleInformationSet by
                           using the
<TT TYPE="ARStereotype">atpUriDef</TT> attributes of type
<TT TYPE="ARMetaClass">Referrable</TT>:
<TT TYPE="ARMetaClassRole">LifeCycleInfo.lcObject</TT>, respectively
<TT TYPE="ARMetaClassRole">LifeCycleInfo.useInstead</TT>.</L-1>
                      </P>
                    </INTRODUCTION>
                  </LIFE-CYCLE-STATE>
```

```
          <!-- LifeCycleState: shallBecomeMandatory -->
                    <LIFE-CYCLE-STATE>
                      <SHORT-NAME>shallBecomeMandatory</SHORT-NAME>
                      <DESC>
                        <L-2 L="EN">This indicates that the related entity
                            should be mandatory from the semantical
                            perspective and will become mandatory in future.
                             It is yet left optional to avoid backwards
                            compatibility issues. Such elements should be
                            provided whenever possible.</L-2>
                      </DESC>
                    </LIFE-CYCLE-STATE>
                  </LC-STATES>
                </LIFE-CYCLE-STATE-DEFINITION-GROUP>
              </ELEMENTS>
            </AR-PACKAGE>
          </AR-PACKAGES>
        </AR-PACKAGE>
      </AR-PACKAGES>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

Class	**LifeCycleStateDefinitionGroup**			
Package	M2::AUTOSARTemplates::GenericStructure::LifeCycles			
Note	This meta class represents the ability to define the states and properties of one particular life cycle. **Tags:** atp.recommendedPackage=LifeCycleStateDefintionGroups			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
lcState	LifeCycleState	*	aggr	Describes a single life cycle state of this life cycle state definition group.

Table 11.1: LifeCycleStateDefinitionGroup

Class	**LifeCycleState**			
Package	M2::AUTOSARTemplates::GenericStructure::LifeCycles			
Note	This meta class represents one particular state in the LifeCycle.			
Base	ARObject, AtpBlueprint, AtpBlueprintable, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table 11.2: LifeCycleState

11.3 Application of a life cycle

Figure 11.1 also shows the assignment of life cycle states to particular objects. This assignment is done by the meta class LifeCycleInfoSet.

11.3.1 LifeCycleInfoSet

[TPS_GST_00241] LifeCycleInfoSet ⌈ This denotes the actual assignment of life cycle states to particular objects. In addition to this it defines the applicable defaults for the life cycle state and the period of viability. ⌋ *()*

[constr_2581] Default life cycle state shall be defined properly ⌈ defaultLcState in LifeCycleInfoSet shall reference to a lcState defined in the LifeCycleStateDefinitionGroup referenced by usedLifeCycleStateDefinitionGroup. ⌋ *()*

11.3.2 LifeCycleInfo

[TPS_GST_00242] LifeCycleInfo ⌈ This meta class specifies the life cycle state of a particular object denoted by lcObject. If no life cycle state is provided, then the defaultLcState applies. ⌋ *()*

[constr_2585] LifeCycleInfo shall be unambiguous ⌈ Within one particular LifeCycleInfoSet lifeCycleInfo.lcObject shall be unique. This ensures that the association of a LifeCycleState to a Referrable is unambiguous.

This contraint applies for a particular point in time under consideration of the period of viability according to [TPS_GST_00244]. ⌋ *()*

[constr_2583] Used life cycle state shall be defined properly ⌈ defaultLcState in LifeCycleInfo shall reference to a lcState defined in the LifeCycleStateDefinitionGroup referenced by usedLifeCycleStateDefinitionGroup of the containing LifeCycleInfoSet. ⌋ *()*

[TPS_GST_00244] Viability Period of Life Cycle Info ⌈ The viability of LifeCycleInfo can be restricted for a specific period of time by periodBegin respectively periodEnd. The following items apply:

- If no periodBegin is provided then defaultPeriodBegin applies.
- If no periodEnd is provided then defaultPeriodEnd applies.
- If also no defaultPeriodBegin respectively defaultPeriodEnd is specified then the period is unlimited (e.g. from 2013-01-01 until forever).
- Begin and End are considered to be included in the period. Thus at a given point in time t the definitions of LifeCycleInfo is viable if

$$periodBegin <= t <= periodEnd$$

⌋()

[constr_2586] Constraints on LifeCyclePeriod ⌈ The attributes date, arReleaseVersion, productRelease in LifeCyclePeriod are mutually exclusive. ⌋()

[TPS_GST_00238] Specifying replacement approach in LifeCycleInfo ⌈ If the life cycle state indicates that the object is not the recommended one to use any more, LifeCycleInfo.useInstead refers to objects which should be used instead of the one denoted by lcObject. In this case remark may be used to document the details of the replacement. ⌋()

Listing 11.2 shows the assignment of life cycle states to particular objects.

Listing 11.2: Example for a life cycle assignment

```
<LIFE-CYCLE-INFO-SET>
  <SHORT-NAME>AutosarObsoleteKeywords</SHORT-NAME>
  <LIFE-CYCLE-INFOS>
    <LIFE-CYCLE-INFO>
      <LC-OBJECT-REF DEST="KEYWORD">/AUTOSAR/AISpecification/KeywordSets/
          KeywordList/Abs</LC-OBJECT-REF>
      <LC-STATE-REF DEST="LIFE-CYCLE-STATE">/AUTOSAR/GeneralDefinitions/
          LifeCycleStateDefintionGroups/AutosarLifeCycleStates/obsolete</LC-
          STATE-REF>
      <PERIOD-BEGIN>
        <AR-RELEASE-VERSION>3.1.1</AR-RELEASE-VERSION>
      </PERIOD-BEGIN>
      <REMARK>
        <P>
          <L-1 L="EN">use Abs3 instead, obsolete since R3</L-1>
        </P>
      </REMARK>
      <USE-INSTEAD-REFS>
        <USE-INSTEAD-REF DEST="KEYWORD">/AUTOSAR/AISpecification/
            KeywordSets/KeywordList/Abs3</USE-INSTEAD-REF>
      </USE-INSTEAD-REFS>
    </LIFE-CYCLE-INFO>
  </LIFE-CYCLE-INFOS>
```

11.3.3 Propagation of LifeCycleState

[TPS_GST_00361] Propagation of LifeCycleState ⌈ The LifeCycleState implicitly propagates to all contained children. LifeCycleState do not propagate to referenced objects (outgoing references). LifeCycleState do not propagate to referencing objects (incoming references). ⌋()

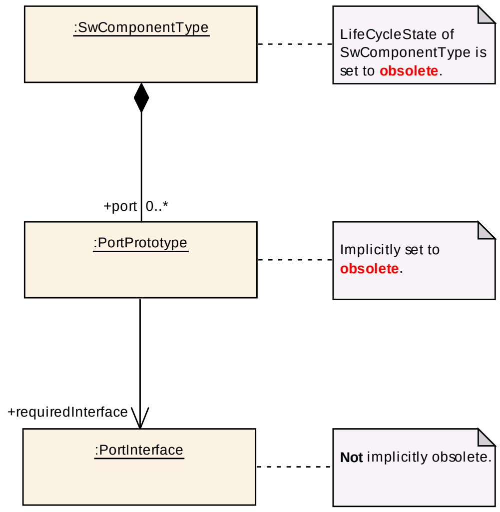


Figure 11.2: Propagation of LifeCycleState

Figure 11.2 illustrates the propagation of `LifeCycleState` in case `SwComponentType` is set to obsolete then:

1. all contained ports are implicitly set to obsolete as well,
2. all referenced objects (outgoing references) `PortInterface`s are not implicitly obsolete,
3. and all referencing objects (incoming references) as `SwComponentPrototype`s that are type by the `SwComponentType` are not implicitly obsolete.

For 1) and 3) a dedicated decision needs to be taken by the software component developer.

Class	**LifeCycleInfoSet**			
Package	M2::AUTOSARTemplates::GenericStructure::LifeCycles			
Note	This meta class represents the ability to attach a life cycle information to a particular set of elements. The information can be defined for a particular period. This supports the definition of transition plans. If no period is specified, the life cycle state applies forever. **Tags:** atp.recommendedPackage=LifeCycleInfoSets			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
defaultLcSt ate	LifeCycleState	1	ref	This denotes the default life cycle state. To be used in all LifeCycleInfo elements within the LifeCycleInfoSet if no life cycle state is stated there explicitly. I.e. the defaultLcState can be overwritten in LifeCycleInfo elements.

defaultPeriodBegin	LifeCyclePeriod	0..1	aggr	Default starting point of period in which all the specified lifeCycleInfo apply. Note that the default period can be overridden for each lifeCycleInfo individually.
defaultPeriodEnd	LifeCyclePeriod	0..1	aggr	Default expiry date, i.e. default end point of period for which all specified lifeCycleInfo apply. Note that the default period can be overridden for each lifeCycleInfo individually.
lifeCycleInfo	LifeCycleInfo	*	aggr	This represents one particular life cycle information.
usedLifeCycleStateDefinitionGroup	LifeCycleStateDefinitionGroup	1	ref	This denotes the life cycle states applicable to the current life cycle info set.

Table 11.3: LifeCycleInfoSet

Class	**LifeCyclePeriod**			
Package	M2::AUTOSARTemplates::GenericStructure::LifeCycles			
Note	This meta class represents the ability to specify a point of time within a specified period, e.g. the starting or end point, in which a specific life cycle state is valid/applies to.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
arReleaseVersion	RevisionLabelString	0..1	attr	Version of the AUTOSAR Release the element referred to is part of. The numbering contains three levels (major, minor, revision) which are defined by AUTOSAR. **Tags:** xml.sequenceOffset=20
date	DateTime	0..1	attr	Date within period. **Tags:** xml.sequenceOffset=10
productRelease	RevisionLabelString	0..1	attr	Version of the product within the period. **Tags:** xml.sequenceOffset=30

Table 11.4: LifeCyclePeriod

Class	**LifeCycleInfo**			
Package	M2::AUTOSARTemplates::GenericStructure::LifeCycles			
Note	LifeCycleInfo describes the life cycle state of an element together with additional information like what to use instead			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
lcObject	Referrable	1	ref	Element(s) have the life cycle as described in lcState.

lcState	LifeCycleState	0..1	ref	This denotes the particular state assigned to the object. If no lcState is given then the default life cycle state of LifeCycleInfoSet is assumed.
periodBegin	LifeCyclePeriod	0..1	aggr	Starting point of period in which the element has the denoted life cycle state lcState. If no periodBegin is given then the default period begin of LifeCycleInfoSet is assumed.
periodEnd	LifeCyclePeriod	0..1	aggr	Expiry date, i.e. end point of period the element does not have the denoted life cycle state lcState any more. If no periodEnd is given then the default period begin of LifeCycleInfoSet is assumed.
remark	DocumentationBlock	0..1	aggr	Remark describing for example • why the element was given the specified life cycle • the semantics of useInstead
useInstead	Referrable	*	ref	Element(s) that should be used instead of the one denoted in referrable. Only relevant in case of life cycle states lcState unlike "valid". In case there are multiple references the exact semantics must be individually described in the remark.

Table 11.5: LifeCycleInfo

12 Collections and Collectable Elements

[TPS_GST_00093] Collections ⌈ For some use cases it is necessary to establish a collection of elements. Such collections are orthogonal to packages. Therefore a collection resides in a package but is established by associations to the collected elements.

A collection consists of `element`s (references to `Identifiable`s) and/or `collectedInstance`s (instance references `AtpFeature`). ⌋*()*

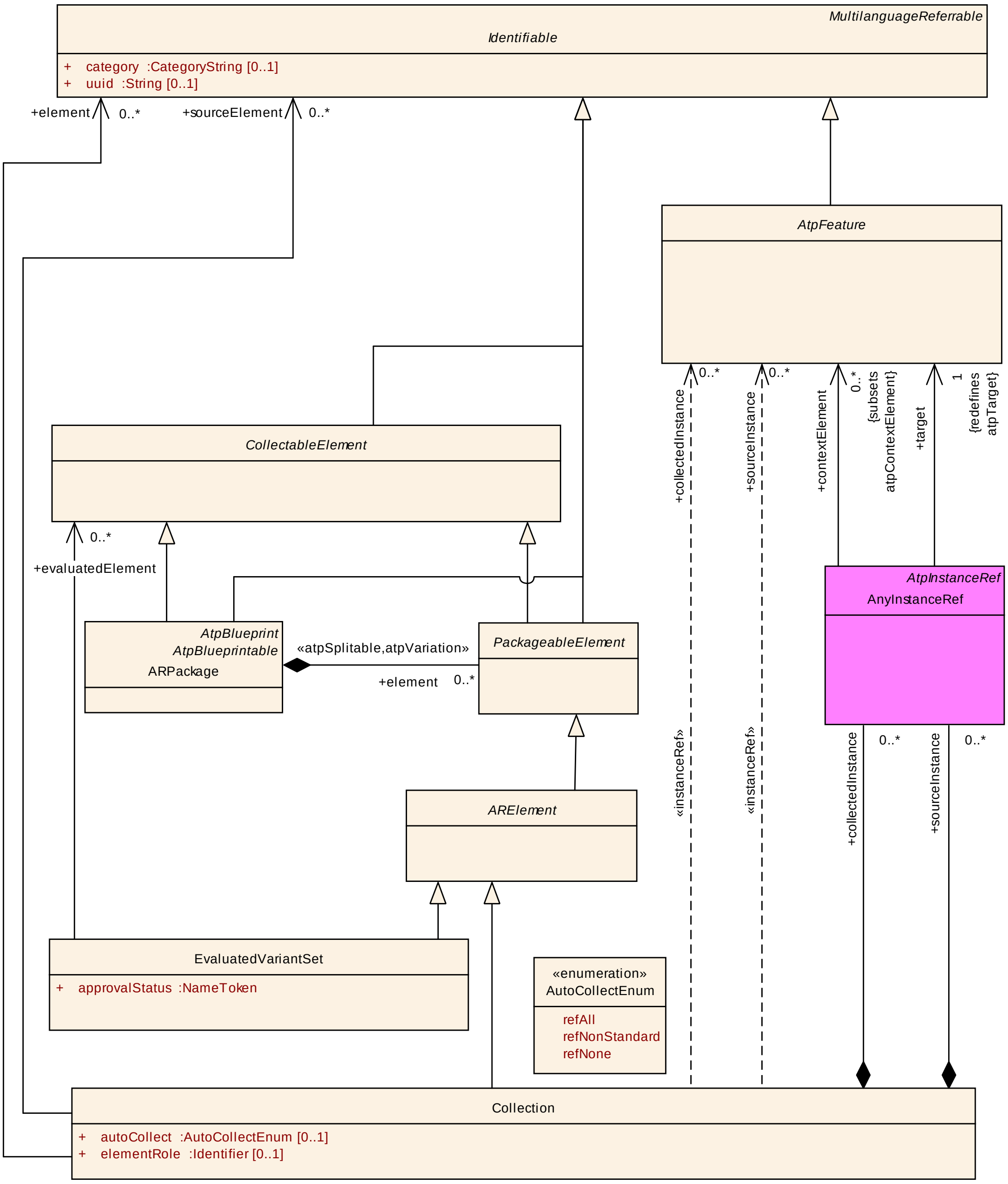


Figure 12.1: Collection

Example use cases for `Collection` are:

- evaluated variants (see Chapter 7.7)
- establish relationships between objects [TPS_GST_00346]
- define subsets of models (VIEWs on model) [TPS_GST_00348]

[TPS_GST_00346] Automatic Collections ⌈ autoCollect denotes if targets of references in the collected elements are also considered part of the collection. See AutoCollectEnum for particular details. ⌋*()*

[TPS_GST_00347] Expressing Relationships by collections ⌈ Collections can also be used to establish relationships between objects. In this case

- category of Collection is RELATION
- sourceElement is mandatory and represents the source end of the relationship
- element (the collected elements) represents the target end of the relationship
- elementRole is mandatory and specifies the role element in the context of sourceElement

⌋*()*

[TPS_GST_00348] Standardized category of Collection ⌈ The following values are standardized for category category of Collection:

RELATION this indicates that the collection is used to express a relation (see [TPS_GST_00347]).

SET this indicates that the collection is simply a set of elements. This is the default if no category is specified.

⌋*()*

[TPS_GST_00349] Standardized elementRole of Collection ⌈ The following values are standardized for elementRole category of Collection:

AUTO_COLLECTED_FROM this is applied if the Collection represents the relationship between two equivalent collections of which one is using automatic inclusion of referenced elements and the other one is the equivalent resolved collection. The category of the Collection is RELATION. [TPS_GST_00347]).

PART_OF_SUBSET this indicates that the elements respectively the collectedInstance in the Collection are part of a particular subset of a model. The category of the Collection is SET.

⌋*()*

Figure 12.2 illustrates an example for a relation according to [TPS_GST_00349][1]. In this case we have two collections, both representing the same view (even if elementRole is not shown in the diagram). One representation uses "auto collect" while the other one is the resolved representation.

[1] Don't be confused by the fact that the collection establishes a relationship between collections.

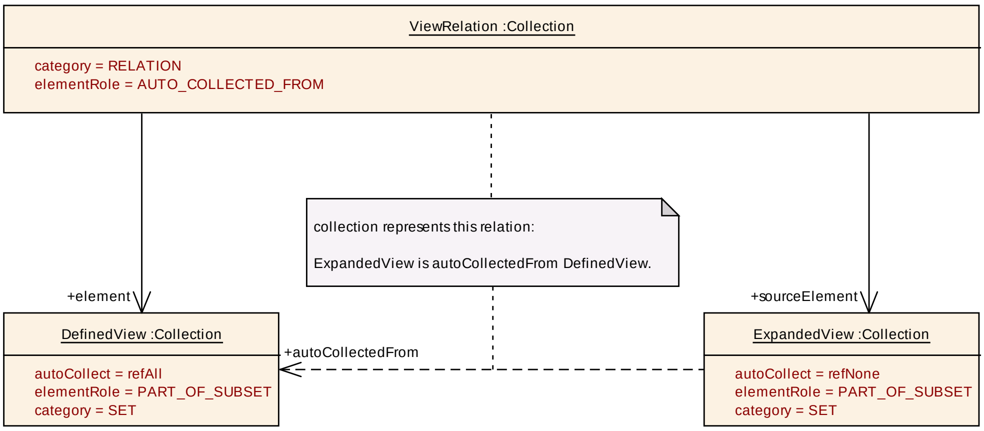


Figure 12.2: Example for Collection as Relation

Listing 12.1 shows the representation in ARXML.

Listing 12.1: Example for Collection as Relation (1)

```
<COLLECTION>
  <SHORT-NAME>DefinedView</SHORT-NAME>
  <CATEGORY>SET</CATEGORY>
  <AUTO-COLLECT>REF-ALL</AUTO-COLLECT>
  <ELEMENT-ROLE>PART_OF_SUBSET</ELEMENT-ROLE>
  <ELEMENT-REFS>
    <ELEMENT-REF BASE="OPEN" DEST="PORT-PROTOTYPE-BLUEPRINT">EngN</ELEMENT
       -REF>
  </ELEMENT-REFS>
</COLLECTION>
<COLLECTION>
  <SHORT-NAME>ExpandedView</SHORT-NAME>
  <CATEGORY>SET</CATEGORY>
  <AUTO-COLLECT>REF-NONE</AUTO-COLLECT>
  <ELEMENT-ROLE>PART_OF_SUBSET</ELEMENT-ROLE>
  <ELEMENT-REFS>
    <ELEMENT-REF BASE="OPEN" DEST="PORT-PROTOTYPE-BLUEPRINT">EngN</ELEMENT
       -REF>
    <ELEMENT-REF BASE="OPEN" DEST="PORT-INTERFACE">EngN1</ELEMENT-REF>
    <ELEMENT-REF BASE="OPEN" DEST="APPLICATION-PRIMITIVE-DATA-TYPE">N1</
       ELEMENT-REF>
    <!-- futher elements are not shown in this example -->
  </ELEMENT-REFS>
</COLLECTION>
<COLLECTION>
  <SHORT-NAME>ViewRelation</SHORT-NAME>
  <CATEGORY>RELATION</CATEGORY>
  <ELEMENT-ROLE>AUTO_COLLECTED_FROM</ELEMENT-ROLE>
  <ELEMENT-REFS>
    <ELEMENT-REF BASE="Coll" DEST="COLLECTION">ExpandedView</ELEMENT-REF>
  </ELEMENT-REFS>
  <SOURCE-ELEMENT-REFS>
    <SOURCE-ELEMENT-REF BASE="Coll" DEST="COLLECTION">DefinedView</SOURCE-
       ELEMENT-REF>
  </SOURCE-ELEMENT-REFS>
</COLLECTION>
```


Listing 12.2 illustrates another example for a relation according to [TPS_GST_00349]. In this case it shows the "stem"-relationship of two keywords.

Listing 12.2: Example for Collection as Relation (2)

```
<COLLECTION>
  <SHORT-NAME>Drv_declinations</SHORT-NAME>
  <CATEGORY>RELATION</CATEGORY>
  <ELEMENT-ROLE>DECLINATION_OF</ELEMENT-ROLE>
  <ELEMENT-REFS>
    <ELEMENT-REF BASE="KW" DEST="KEYWORD">KeywordList/Drvr</ELEMENT-REF>
    <ELEMENT-REF BASE="KW" DEST="KEYWORD">KeywordList/Drvg</ELEMENT-REF>
  </ELEMENT-REFS>
  <SOURCE-ELEMENT-REFS>
    <SOURCE-ELEMENT-REF BASE="KW" DEST="KEYWORD">KeywordList/Drv</SOURCE-
       ELEMENT-REF>
  </SOURCE-ELEMENT-REFS>
</COLLECTION>
```

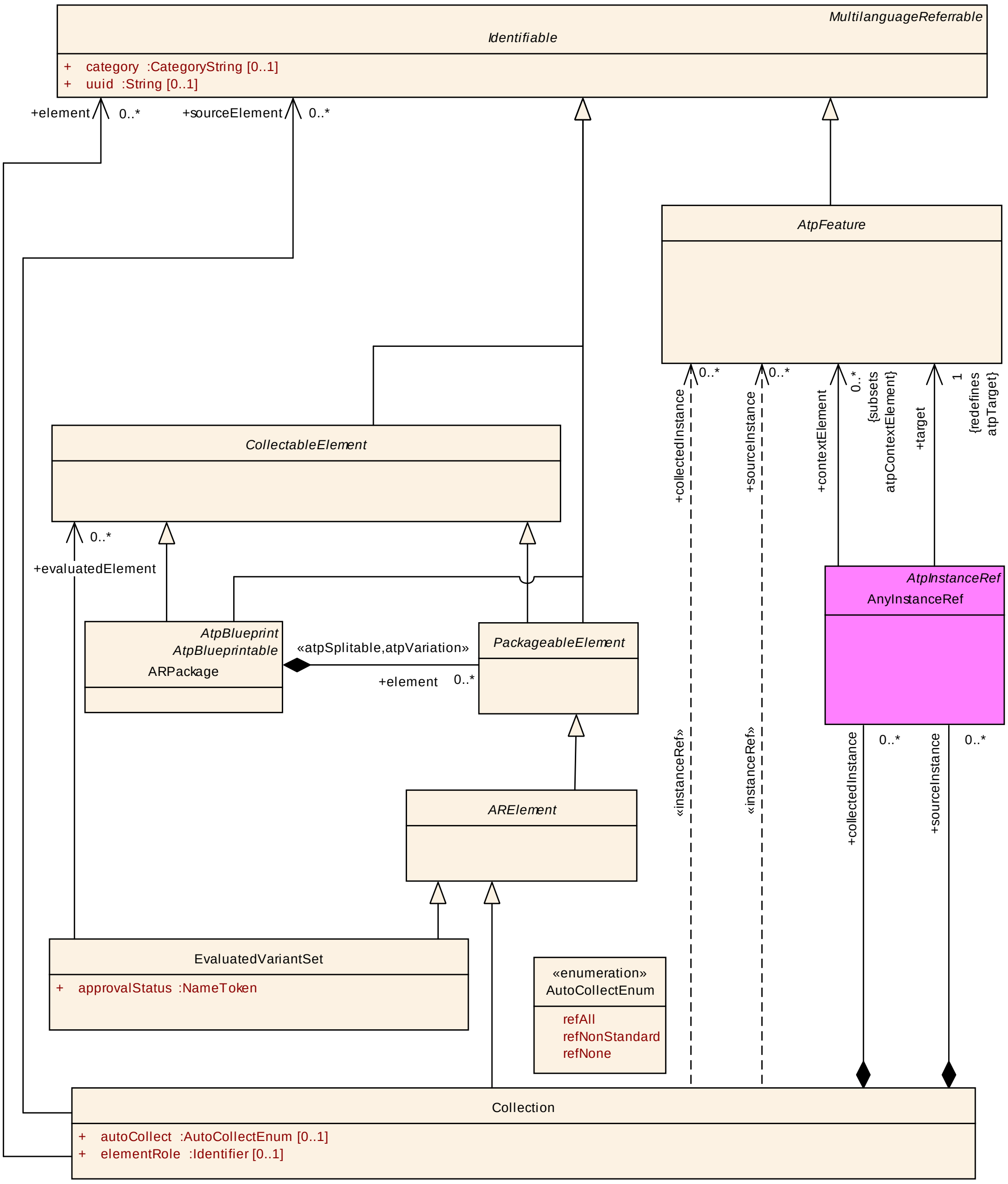


Figure 12.3: Collection of AUTOSAR elements

Class	Collection			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Element Collection			
Note	This meta-class specifies a collection of elements. A collection can be utilized to express additional aspects for a set of elements. Note that Collection is an ARElement. Therefore it is applicable e.g. for EvaluatedVariant, even if this is not obvious. Usually the category of a Collection is "SET". On the other hand, a Collection can also express an arbitrary relationship between elements. This is denoted by the category "RELATION" (see also [TPS_GST_00347]). In this case the collection represents an association from "sourceElement" to "targetElement" in the role "role". **Tags:** atp.recommendedPackage=Collections			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
autoCollect	AutoCollectEnum	0..1	attr	This attribute reflects how far the referenced objects are part of the collection. **Tags:** xml.sequenceOffset=20
collectedInstance	AtpFeature	*	iref	This instance ref supports the use case that a particular instance is part of the collection. **Tags:** xml.sequenceOffset=60
element	Identifiable	*	ref	This is an element in the collection. Note that Collection itself is collectable. Therefore collections can be nested. In case of category="RELATION" this represents the target end of the relation. **Tags:** xml.sequenceOffset=40
elementRole	Identifier	0..1	attr	This attribute allows to denote a particular role of the collection. Note that the applicable semantics shall be mutually agreed between the two parties. In particular it denotes the role of element in the context of sourceElement. **Tags:** xml.sequenceOffset=30
sourceElement	Identifiable	*	ref	Only if Category = "RELATION". This represents the source of a relation. **Tags:** xml.sequenceOffset=50
sourceInstance	AtpFeature	*	iref	Only if Category = "RELATION". This represents the source instance of a relation. **Tags:** xml.sequenceOffset=70

Table 12.1: Collection

Enumeration	**AutoCollectEnum**
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Element Collection
Note	This enumerator defines the possible approaches to determine the final set of elements in a collection.
Literal	**Description**
refAll	All objects being referenced (recursively) from the objects mentioned directly in the collection are also considered as part of the collection. **Tags:** atp.EnumerationValue=0
refNonStan-dard	This indicates that non standard objects ([TPS_GST_00088]) referenced (recursively) by the objects mentioned directly in the collection are also considered to be part of the collection. **Tags:** atp.EnumerationValue=2
refNone	This indicates that only those objects mentioned directly in the collection are part of the collection. No other objects are considered further. **Tags:** atp.EnumerationValue=1

Table 12.2: AutoCollectEnum

Class	**CollectableElement (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Element Collection			
Note	This meta-class specifies the ability to be part of a specific AUTOSAR collection of ARPackages or ARElements. The scope of collection has been extended beyond CollectableElement with Revision 4.0.3. For compatibility reasons the name of this meta Class was not changed.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table 12.3: CollectableElement

13 Mapping Views

Along the development of an AUTOSAR System, various transformations may take place within the model. This leads to the fact that the model represents different views on the same system. These different views can be mapped to each other with the help of ViewMap.

[TPS_GST_00350] Mapping Model Elements of different Views ⌈ ViewMap represents an non directed relationship between two model elements. The general semantics is that the mapped elements are mainly the same entity but represent a different view. A refined semantics of the mapping can be specified in role. ⌋*()*

Note that even if it is called "view", view in DocumentViewSelectable represents another concept and should not be confused with ViewMap.

Note further that ViewMap represents a specific relationship in contrast to Collection according to [TPS_GST_00347] which can be used to represent arbitrary but **directed** relationships.

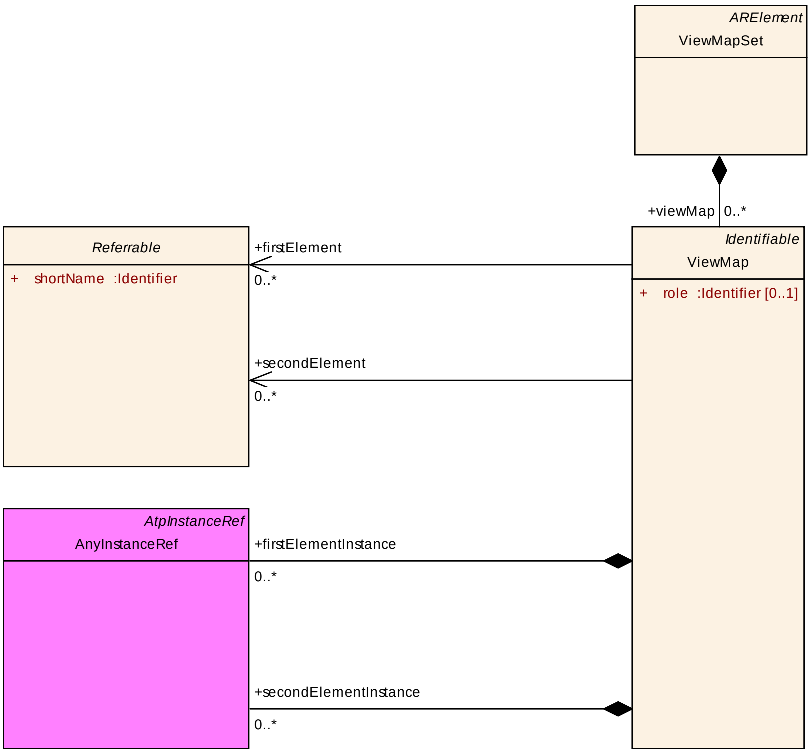


Figure 13.1: View Map

Example use cases for ViewMap are (see [TPS_SYST_01136]):

- Mapping between Abstract System Description to a System Description
- Mapping between System Description and System Extract

Class	**ViewMapSet**			
Package	M2::AUTOSARTemplates::GenericStructure::ViewMapSet			
Note	Collection of ViewMaps that are used to establish relationships between different AUTOSAR artifacts. **Tags:** atp.recommendedPackage=ViewMapSets			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
viewMap	ViewMap	*	aggr	ViewMaps that are collected by the ViewMapSet.

Table 13.1: ViewMapSet

Class	**ViewMap**			
Package	M2::AUTOSARTemplates::GenericStructure::ViewMapSet			
Note	The ViewMap allows to relate any number of elements on the "first" side to any number of elements on the "second" side. Since the ViewMap does not address a specific mapping use-case the roles "first" and "second" shall imply this generality. This mapping allows to trace transformations of artifacts within the AUTOSAR environment. The references to the mapped elements can be plain references and/or InstanceRefs.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
firstElement	Referrable	*	ref	Reference to identifible elements on the first "side". **Tags:** xml.sequenceOffset=20
firstElementInstance	AtpFeature	*	iref	InstanceRefs to elements on the first "side". **Tags:** xml.sequenceOffset=50
role	Identifier	0..1	attr	This attribute is used to describe specific mapping scenarios, e.g. the mappings: AR_AbstractSystemDescription_SystemDescription AR_SystemDescription_SystemExtract **Tags:** xml.sequenceOffset=10
secondElement	Referrable	*	ref	Reference to identifible elements on the second "side". **Tags:** xml.sequenceOffset=30
secondElementInstance	AtpFeature	*	iref	InstanceRefs to elements on the second "side". **Tags:** xml.sequenceOffset=60

Table 13.2: ViewMap

A Glossary

Artifact This is a Work Product Definition that provides a description and definition for tangible work product types. Artifacts may be composed of other artifacts ([22]).

At a high level, an artifact is represented as a single conceptual file.

AUTOSAR Tool This is a software tool which supports one or more tasks defined as AUTOSAR tasks in the methodology. Depending on the supported tasks, an AUTOSAR tool can act as an authoring tool, a converter tool, a processor tool or as a combination of those (see separate definitions).

AUTOSAR Authoring Tool An AUTOSAR Tool used to create and modify AUTOSAR XML Descriptions. Example: System Description Editor.

AUTOSAR Converter Tool An AUTOSAR Tool used to create AUTOSAR XML files by converting information from other AUTOSAR XML files. Example: ECU Flattener

AUTOSAR Definition This is the definition of parameters which can have values. One could say that the parameter values are Instances of the definitions. But in the meta model hierarchy of AUTOSAR, definitions are also instances of the meta model and therefore considered as a description. Examples for AUTOSAR definitions are: `EcucParameterDef`, `PostBuildVariantCriterion`, `SwSystemconst`.

AUTOSAR XML Description In AUTOSAR this means "filled Template". In fact an AUTOSAR XML description is the XML representation of an AUTOSAR model.

The AUTOSAR XML description can consist of several files. Each individual file represents an AUTOSAR partial model and shall validate successfully against the AUTOSAR XML schema.

AUTOSAR Meta-Model This is an UML2.0 model that defines the language for describing AUTOSAR systems. The AUTOSAR meta-model is an UML representation of the AUTOSAR templates. UML2.0 class diagrams are used to describe the attributes and their interrelationships. Stereotypes, UML tags and OCL expressions (object constraint language) are used for defining specific semantics and constraints.

AUTOSAR Meta-Model Tool The AUTOSAR Meta-Model Tool is the tool that generates different views (class tables, list of constraints, diagrams, XML Schema etc.) on the AUTOSAR meta-model.

AUTOSAR Model This is a representation of an AUTOSAR product. The AUTOSAR model represents aspects suitable to the intended use according to the AUTOSAR methodology.

Strictly speaking, this is an instance of the AUTOSAR meta-model. The information contained in the AUTOSAR model can be anything that is representable according to the AUTOSAR meta-model.

AUTOSAR Partial Model In AUTOSAR, the possible partitioning of models is marked in the meta-model by ≪atpSplitable≫. One partial model is represented in an AUTOSAR XML description by one file. The partial model does not need to fulfill all semantic constraints applicable to an AUTOSAR model.

AUTOSAR Processor Tool An AUTOSAR Tool used to create non-AUTOSAR files by processing information from AUTOSAR XML files. Example: RTE Generator

AUTOSAR Specification Element An AUTOSAR Specification Element is a named element that is part of an AUTOSAR specification. Examples: requirement, constraint, specification item, class or attribute in the meta model, methodology, deliverable, methodology activity, model element, bsw module etc.

AUTOSAR Template The term "Template" is used in AUTOSAR to describe the format different kinds of descriptions. The term template comes from the idea, that AUTOSAR defines a kind of form which shall be filled out in order to describe a model. The filled form is then called the description.

In fact the AUTOSAR templates are now defined as a meta-model.

AUTOSAR Validation Tool A specialized `AUTOSAR Tool` which is able to check an AUTOSAR model against the rules defined by a profile.

AUTOSAR XML Schema This is a W3C XML schema that defines the language for exchanging AUTOSAR models. This Schema is derived from the AUTOSAR meta-model. The AUTOSAR XML Schema defines the AUTOSAR data exchange format.

Blueprint This is a model from which other models can be derived by copy and refinement. Note that in contrast to meta model resp. types, this process is *not* an instantiation.

Instance Generally this is a particular exemplar of a model or of a type.

Life Cycle Life Cycle is the course of development/evolutionary stages of a model element during its life time.

Meta-Model This defines the building blocks of a model. In that sense, a Meta-Model represents the language for building models.

Meta-Data This includes pertinent information about data, including information about the authorship, versioning, access-rights, timestamps etc.

Model A Model is an simplified representation of reality. The model represents the aspects suitable for an intended purpose.

Partial Model This is a part of a model which is intended to be persisted in one particular artifact.

Pattern in GST : This is an approach to simplify the definition of the meta model by applying a model transformation. This transformation creates an enhanced model out of an annotated model.

Profile Authoring Support Data Data that is used for efficient authoring of a profile. E.g. list of referable constraints, meta-classes, meta-attributes or other reusable model assets (blueprints)

Profile Authoring Tool A specialized `AUTOSAR Tool` which focuses on the authoring of profiles for data exchange points. It e.g. provides support for the creation of profiles from scratch, modification of existing profiles or composition of existing profiles.

Profile Compatibility Checker Tool A specialized `AUTOSAR Tool` which focuses on checking the compatibility of profiles for data exchange. Note that this compatibility check includes manual compatibility checks by engineers and automated assistance using more formal algorithms.

Profile Consistency Checker Tool A specialized `AUTOSAR Tool` which focuses on checking the consistency of profiles.

Property A property is a structural feature of an object. As an example a “connector” has the properties “receive port” and “send port”

Properties are made variant by the ≪`atpVariation`≫.

Prototype This is the implementation of a role of a type within the definition of another type. In other words a type may contain Prototypes that in turn are typed by "Types". Each one of these prototypes becomes an instance when this type is instantiated.

Type A type provides features that can appear in various roles of this type.

Value This is a particular value assigned to a “Definition”.

Variability Variability of a system is its quality to describe a set of variants. These variants are characterized by variant specific property settings and / or selections. As an example, such a system property selection manifests itself in a particular “receive port” for a connection.

This is implemented using the ≪`atpVariation`≫.

Variant A system variant is a concrete realization of a system, so that all its properties have been set respectively selected. The software system has no variability anymore with respect to the binding time.

This is implemented using `EvaluatedVariantSet`.

Variation Binding A variant is the result of a variation binding process that resolves the variability of the system by assigning particular values/selections to all the system’s properties.

This is implemented by `VariationPoint`.

Variation Binding Time The variation binding time determines the step in the methodology at which the variability given by a set of variable properties is resolved.

This is implemented by `vh.LatestBindingtime` at the related properties .

Variation Definition Time The variation definition time determines the step in the methodology at which the variation points are defined.

Variation Point A variation point indicates that a property is subject to variation. Furthermore, it is associated with a condition and a binding time which define the system context for the selection / setting of a concrete variant.

This is implemented by `VariationPoint`.

B Constraint History

B.1 Constraint History R4.0.1

B.1.1 Added Constraints

Number	Heading
[constr_2501]	Blueprint of blueprints are not supported
[constr_2502]	Merged model must be compliant to the meta-model.
[constr_2503]	Bound model must be compliant to the meta model
[constr_2504]	Constraint to latest binding time
[constr_2505]	Multiplicity after binding
[constr_2506]	Attributes in property set pattern
[constr_2507]	EvaluatedVariantSet
[constr_2508]	shortName
[constr_2509]	ReferenceBase
[constr_2510]	only one default ReferenceBase
[constr_2511]	Named reference bases must be available
[constr_2512]	shortName uniqueness constraint for variants
[constr_2513]	splitted variants must have a shortLabel
[constr_2514]	shortLabel in VariationPoint must be unique
[constr_2515]	Avoid conflicting package categories
[constr_2516]	Return type of Formula
[constr_2517]	postbuildVariantCondition only for PostBuild
[constr_2518]	Binding time is constrained
[constr_2519]	PredefinedVariants need to be consistent
[constr_2520]	Nesting of lists shall be limited
[constr_2521]	The shortLabel in VariationPoint must be unique
[constr_2522]	Notes should not be nested
[constr_2523]	Used languages need to be consistent
[constr_2524]	Non splitable elements in one file
[constr_2525]	Non splitable elements shall not be repeated
[constr_2530]	InstanceRefs must be consistent
[constr_2531]	AtpInstanceRef must be close to the base
[constr_2533]	Documentation context is either a feature or an identifiable
[constr_2534]	Limits of unlimited Integer

Table B.1: Added Constraints in 4.0.1

B.2 Constraint History R4.0.2

B.2.1 Added Constraints

Number	Heading
[constr_2537]	Variation of packagable element is limited to components resp. modules
[constr_2538]	Global reference is limited to certain elements

Table B.2: Added Constraints in 4.0.2

B.2.2 Changed Constraints

Number	Heading
[constr_2511]	Named reference bases must be available
[constr_2519]	PredefinedVariants need to be consistent

Table B.3: Changed Constraints in 4.0.2

B.3 Constraint History R4.0.3

B.3.1 Added Constraints

Number	Heading
[constr_2547]	ordered collections cannot be split into partial models
[constr_2557]	no VariationPoints with latestBindingTime set to BlueprintDerivation in system configurations
[constr_2558]	Only blueprintCondition/blueprintValue if vh.latestBindingTime is BlueprintDerivationTime
[constr_2559]	no nested VariationPoint
[constr_4055]	ICS may not contain blueprints

Table B.4: Added Constraints in 4.0.3

B.3.2 Changed Constraints

Number	Heading
[constr_2530]	InstanceRefs must be consistent
[constr_2508]	Name space of shortName

Table B.5: Changed Constraints in 4.0.3

B.4 Constraint History R4.1.1

B.4.1 Added Constraints

Number	Heading

Table B.6: Added Constraints in 4.1.1

B.4.2 Changed Constraints

Number	Heading

Table B.7: Changed Constraints in 4.1.1

B.4.3 Deleted Constraints

Number	Heading

Table B.8: Deleted Constraints in 4.1.1

B.4.4 Added Specification Items

Number	Heading
[TPS_GST_00045]	Inherited properties in mixed content
[TPS_GST_00046]	Splitable collections
[TPS_GST_00047]	Identification of Partial Models
[TPS_GST_00048]	Splitable up to the Root
[TPS_GST_00049]	atp.recommendedPackage
[TPS_GST_00050]	atp.Splitkey
[TPS_GST_00051]	atp.Status
[TPS_GST_00052]	vh.latestBindingTime
[TPS_GST_00053]	xml.xsd.* etc.
[TPS_GST_00054]	xml.xsd.customType
[TPS_GST_00055]	xml.attribute
[TPS_GST_00056]	xml.attributeRef
[TPS_GST_00057]	xml.enforceMinMultiplicity
[TPS_GST_00058]	xml.enforceMaxMultiplicity
[TPS_GST_00059]	xml.globalElement
[TPS_GST_00060]	xml.mds.type
[TPS_GST_00061]	xml.name
[TPS_GST_00062]	xml.nsPrefix
[TPS_GST_00063]	xml.nsUri
[TPS_GST_00064]	xml.roleElement, xml.roleWrapperElement, xml.typeElement, xml.typeWrapperElement
[TPS_GST_00065]	xml.sequenceOffset
[TPS_GST_00066]	xml.systemIdentifier
[TPS_GST_00067]	admin.documentClassification
[TPS_GST_00068]	admin.documentIdentificationNo
[TPS_GST_00069]	admin.documentOwner
[TPS_GST_00070]	admin.documentResponsibility
[TPS_GST_00071]	admin.documentStatus
[TPS_GST_00072]	admin.documentTitle
[TPS_GST_00073]	admin.documentVersion
[TPS_GST_00074]	admin.partOfRelease
[TPS_GST_00075]	admin.releaseDate
[TPS_GST_00076]	admin.revision
[TPS_GST_00077]	Top-Level Structure of an AUTOSAR Model
[TPS_GST_00078]	AUTOSAR top level AdminData
[TPS_GST_00079]	Language Status of an Artifact
[TPS_GST_00080]	Package Structure for AUTOSAR delivered Models
[TPS_GST_00081]	Pattern for AUTOSAR delivered Models
[TPS_GST_00082]	Package Structure for ECUC parameter definitions
[TPS_GST_00083]	Pattern for AUTOSAR defined Model Elements
[TPS_GST_00084]	Pattern for AUTOSAR defined Model Elements
[TPS_GST_00085]	Pattern for AUTOSAR defined Model Elements
[TPS_GST_00086]	Category of ARPackage
[TPS_GST_00087]	BLUEPRINT
[TPS_GST_00088]	STANDARD

[TPS_GST_00089]	EXAMPLE
[TPS_GST_00090]	Non Standardized Category of ARPackage
[TPS_GST_00091]	ARObject
[TPS_GST_00092]	The purpose of a ARPackage
[TPS_GST_00093]	Collections
[TPS_GST_00095]	Main Purpose of Identifiable
[TPS_GST_00096]	Main Purpose of Referrable
[TPS_GST_00097]	Purpose of shortName
[TPS_GST_00098]	Recommendation to Choose Human Readable shortNames
[TPS_GST_00099]	Purpose of longName
[TPS_GST_00100]	Purpose of desc
[TPS_GST_00101]	Purpose of adminData
[TPS_GST_00102]	Purpose of category
[TPS_GST_00103]	Purpose of introduction
[TPS_GST_00104]	Purpose of annotation
[TPS_GST_00105]	Control of the Document Language by AdminData
[TPS_GST_00106]	Version Management
[TPS_GST_00107]	Merge Operations in Version Management
[TPS_GST_00108]	Special Information in Version Management
[TPS_GST_00109]	Abstraction of Artifacts from Physical File Syetms
[TPS_GST_00110]	EngineeringObject can be resolved via a container catalog as defined in [14] in order to find the physical File.
[TPS_GST_00111]	Negation Operator
[TPS_GST_00112]	Exponentiation Operator
[TPS_GST_00113]	Multiplicative Operator / division
[TPS_GST_00114]	Additive Operator
[TPS_GST_00115]	Shift Operator
[TPS_GST_00116]	Ranking Operator
[TPS_GST_00117]	Comparison: equality
[TPS_GST_00118]	Bit-wise AND
[TPS_GST_00119]	Bit-wise XOR
[TPS_GST_00120]	Bit-wise OR
[TPS_GST_00121]	Boolean AND
[TPS_GST_00122]	Boolean XOR
[TPS_GST_00123]	Boolean OR
[TPS_GST_00124]	Round Function
[TPS_GST_00125]	Round Up Function
[TPS_GST_00126]	Round Down Function
[TPS_GST_00127]	Absolute Value
[TPS_GST_00128]	Natural Logarithm
[TPS_GST_00129]	Decimal Logarithm
[TPS_GST_00130]	Square Root
[TPS_GST_00131]	Sinus
[TPS_GST_00132]	Arcus Sinus
[TPS_GST_00133]	Cosinus
[TPS_GST_00134]	Arcus Cosiuns
[TPS_GST_00135]	Sinus Hyperbolicus
[TPS_GST_00136]	Cosinus Hyperbolicus
[TPS_GST_00137]	Tangens
[TPS_GST_00138]	Arcus Tangens
[TPS_GST_00139]	Tangens Hyperbolicus
[TPS_GST_00140]	Exponential
[TPS_GST_00141]	Is Defined

[TPS_GST_00142]	Signum
[TPS_GST_00143]	Maximum Value
[TPS_GST_00144]	Minium Value
[TPS_GST_00145]	Power Function
[TPS_GST_00146]	Case Sensitive String Compare
[TPS_GST_00147]	Non Case Insensitive String Compare
[TPS_GST_00148]	Annotation
[TPS_GST_00149]	Usage of MultiDimensionalTime
[TPS_GST_00150]	Derived Attributes Do not Appear in the XML Schema
[TPS_GST_00151]	Specializations of Derived Relations
[TPS_GST_00152]	Derived Union
[TPS_GST_00153]	Applying Abstract Structures
[TPS_GST_00154]	Specialization of Relations
[TPS_GST_00155]	Representation of Classifier and Feature
[TPS_GST_00156]	Purpose of AtpClassifier
[TPS_GST_00157]	Purpose of AtpPrototype
[TPS_GST_00158]	Purpose of AtpStructureElement
[TPS_GST_00159]	Deriving features in abstract structures
[TPS_GST_00160]	Instance Reference
[TPS_GST_00161]	Definition of an instance ref
[TPS_GST_00162]	Context path in instance ref
[TPS_GST_00163]	Annotated meta model
[TPS_GST_00164]	Extended meta model
[TPS_GST_00165]	specification of a transformation pattern
[TPS_GST_00166]	Model Transformation for Primitives
[TPS_GST_00167]	Case Sensitivity of References
[TPS_GST_00168]	Representation of Type Reference
[TPS_GST_00169]	Absolute shortName-Path
[TPS_GST_00170]	Relative ShortName-path
[TPS_GST_00171]	Identifying the ReferenceBase of a Relative Reference
[TPS_GST_00172]	ReferenceBase in Partial Models
[TPS_GST_00173]	Destination Type
[TPS_GST_00174]	Variant Handling Terminology
[TPS_GST_00175]	Variant rich M1 model
[TPS_GST_00176]	Bound M1 model
[TPS_GST_00177]	Remove Deselected Objects
[TPS_GST_00178]	Remove Binding Function upon Binding
[TPS_GST_00179]	Scope of Variant Handling Specification
[TPS_GST_00180]	Resolving Variation Points along the Development Steps
[TPS_GST_00181]	Annotated MetaModel for Variant Handling
[TPS_GST_00182]	Notation of Latest Binding time on M2
[TPS_GST_00183]	Representation of Binding Time
[TPS_GST_00185]	Transformation on Meta Model
[TPS_GST_00186]	Description of Variation on M1
[TPS_GST_00187]	Choosing a Particular Variant
[TPS_GST_00188]	Resolving Variation Points
[TPS_GST_00189]	Variation is Restricted to Specific Elements.
[TPS_GST_00190]	Semantic of bindingTime
[TPS_GST_00191]	Variant Handling Patterns can be Mixed
[TPS_GST_00192]	Variant Handling Extends Upper Multiplicity
[TPS_GST_00193]	Order of Pattern Resolution in Variant Handling
[TPS_GST_00194]	Variation Points are Optional
[TPS_GST_00195]	Annotated Meta Model Defines Applicable Variation Points

[TPS_GST_00196]	ICS
[TPS_GST_00197]	Pure meta model
[TPS_GST_00198]	Attributes for all Meta Classes
[TPS_GST_00199]	Transformation defined by Aggregation Pattern
[TPS_GST_00200]	Schema Generator avoids duplicate VariationPoints
[TPS_GST_00201]	Aggregation Pattern on Primitives
[TPS_GST_00202]	Limitation of non post build
[TPS_GST_00203]	Transformation defined by Association Pattern
[TPS_GST_00204]	Handling of non variant associations
[TPS_GST_00205]	Transformation defined by Attribute Value Pattern
[TPS_GST_00206]	Special Meta Classes for AttriuteValueVariationPoint
[TPS_GST_00207]	No Binding time required for Constants
[TPS_GST_00209]	No postbuild variation for attribute values
[TPS_GST_00210]	Multiplicity of AttributeValueVariationPoint
[TPS_GST_00211]	AttributeValueVariationPoint does not support PostBuild Variation
[TPS_GST_00212]	Existence of Attribute cannot be subject to Variation
[TPS_GST_00213]	Arrays should have the same Binding Time
[TPS_GST_00214]	Extending the Application of Attribute Value Pattern
[TPS_GST_00215]	Rationale for BindingTime being optional in AttributeValueVariationPoint
[TPS_GST_00216]	Approach on Property Set Pattern
[TPS_GST_00217]	Transformation defined by Property Set Pattern
[TPS_GST_00218]	Property Set pattern and Inheritance
[TPS_GST_00219]	Binding Time for Property Set Pattern
[TPS_GST_00220]	Attachment of Binding Time
[TPS_GST_00221]	Attachment of Latest Binding Time
[TPS_GST_00222]	Multiplicity in Property Set Pattern
[TPS_GST_00223]	Use Cases for Sdg
[TPS_GST_00224]	Applicable modeling support in Special Data
[TPS_GST_00225]	Specifiation of roles in Special Data
[TPS_GST_00226]	Access Control Relation
[TPS_GST_00227]	AclPermission
[TPS_GST_00228]	AclRole
[TPS_GST_00229]	AclOperation
[TPS_GST_00230]	AclObjectSet
[TPS_GST_00231]	Context of AclPermission
[TPS_GST_00232]	aclObjectClass
[TPS_GST_00233]	collection
[TPS_GST_00234]	object
[TPS_GST_00235]	objectDefintion
[TPS_GST_00236]	derivedFromBlueprint
[TPS_GST_00237]	engineeringObject
[TPS_GST_00238]	Specifying replacement approach in LifeCycleInfo
[TPS_GST_00239]	Definition "Life Cycle"
[TPS_GST_00240]	LifeCycleStateDefinitionGroup
[TPS_GST_00241]	LifeCycleInfoSet
[TPS_GST_00242]	LifeCycleInfo
[TPS_GST_00243]	Informal references to traceable text
[TPS_GST_00244]	Viability Period of Life Cycle Info
[TPS_GST_00245]	PreBuild variation point
[TPS_GST_00246]	PostBuild Variation Point
[TPS_GST_00247]	BlueprintDerivation Variation Point
[TPS_GST_00248]	Combined PreBuild and PostBuild Variation Point

[TPS_GST_00249]	Variation Point without Conditions
[TPS_GST_00250]	Multiplicity of VariationPoint
[TPS_GST_00251]	Variant Rich Model Violates [constr_2508]
[TPS_GST_00252]	Split/Merge of Variant Rich Model
[TPS_GST_00253]	Distinguish CodeGenerationTime Variation Points in RTE
[TPS_GST_00254]	Referring to Variation Points from Outside
[TPS_GST_00255]	Definition of *PreBuild* Variation Point
[TPS_GST_00256]	Definition of *PostBuild* Variation Point
[TPS_GST_00257]	BindingTime constrained by vh.latestBindingTime
[TPS_GST_00258]	Binding VariationPoints early
[TPS_GST_00259]	Evaluating PostBuildVariantCondition
[TPS_GST_00260]	PreBuild configuration of PostBuild criteria
[TPS_GST_00261]	Possible Values for PostBuildVariantCriterion
[TPS_GST_00262]	Representation of SwSystemconst
[TPS_GST_00263]	Assigning values to SwSystemconst
[TPS_GST_00264]	Purpose of SwSystemconstDependentFormula
[TPS_GST_00265]	System Constants in Formula
[TPS_GST_00266]	PreBuild Disabling PostBuild support
[TPS_GST_00267]	Only one BindingTime
[TPS_GST_00268]	Rationale for Different Approach for PreBuild and PostBuild Variation
[TPS_GST_00269]	Reference from invariant to variant parts.
[TPS_GST_00270]	Variation Point in Blueprints
[TPS_GST_00271]	blueprintCondition cannot be variant
[TPS_GST_00272]	Semantics of BlueprintDerivationTime
[TPS_GST_00273]	Resolve BlueprintVariationPoints on time
[TPS_GST_00274]	atp.StatusComment
[TPS_GST_00275]	Float Literals INF, NaN
[TPS_GST_00276]	Power of Null
[TPS_GST_00277]	Purpose of Evaluated Variants
[TPS_GST_00278]	Establishing Multiple Validities with EvaluatedVariantSet for Different Aspects
[TPS_GST_00279]	Definition of a Predefined Variant
[TPS_GST_00280]	SwSystemConstantValueSets from different sources
[TPS_GST_00281]	Indirect value assignment for system constants
[TPS_GST_00282]	Analogy between Predefined Variant for Pre Build and Post Build branch
[TPS_GST_00283]	Validity of Post Build combined with Pre Build Variant
[TPS_GST_00284]	Semantics of approvalStatus
[TPS_GST_00285]	Purpose of includedVariant in PredefinedVariant
[TPS_GST_00286]	REJECTED precedes APPROVED
[TPS_GST_00287]	APPROVED for CollectableElement
[TPS_GST_00288]	REJECTED for CollectableElement
[TPS_GST_00289]	Definition of a Variant
[TPS_GST_00290]	Defintion of Valid Variants
[TPS_GST_00291]	UML-tags for Configuration of XML schema production
[TPS_GST_00292]	Adminstrative UML Tags
[TPS_GST_00293]	Use Case Specific Extension of Formula Language
[TPS_GST_00294]	Build Action Manifest Overview
[TPS_GST_00295]	atp.StatusRevisionBegin
[TPS_GST_00296]	atp.StatusRevisionEnd
[TPS_GST_00297]	Tags to denote life cycle information
[TPS_GST_00298]	Tags to denote Variant Handling Properties
[TPS_GST_00299]	Tags to specify Upstream Mapping
[TPS_GST_00305]	Single Paragraph

[TPS_GST_00306]	Documentation Block
[TPS_GST_00307]	Standalone Documentation
[TPS_GST_00308]	Purpose of Chapter
[TPS_GST_00309]	Purpose of Topic1
[TPS_GST_00310]	Synopsis of Chapters and Topics
[TPS_GST_00311]	DocumentationBlock fits in a table cell
[TPS_GST_00312]	Variation in Documentation
[TPS_GST_00313]	Types of Paragraph
[TPS_GST_00314]	Purpoes of Verbatim
[TPS_GST_00315]	Rendering of inline elements of Verbatim
[TPS_GST_00316]	Plain List
[TPS_GST_00317]	Labeled List
[TPS_GST_00318]	Definition List
[TPS_GST_00319]	Figures in Documentation
[TPS_GST_00320]	Details of Figures in Documentation
[TPS_GST_00321]	Mathematical Subjects in Documentation
[TPS_GST_00322]	Various Formula Representation
[TPS_GST_00323]	Purpose of Note
[TPS_GST_00324]	Inline Elements in Documentation
[TPS_GST_00325]	Standalone Documentation
[TPS_GST_00326]	Context of Standalone Documentation
[TPS_GST_00327]	Chapter
[TPS_GST_00328]	Predefined Chapter
[TPS_GST_00329]	Tables in Documentation
[TPS_GST_00330]	Partitions of a Table
[TPS_GST_00331]	Table Row
[TPS_GST_00332]	Topics in Documentation
[TPS_GST_00333]	Parameter Tables
[TPS_GST_00334]	Support of Pagination of Documents
[TPS_GST_00335]	View Approach
[TPS_GST_00336]	Including generated Documentation Parts
[TPS_GST_00337]	Multiple Languages
[TPS_GST_00338]	Purpose of BuildActionEnvironment
[TPS_GST_00339]	Data involved in Build Actions
[TPS_GST_00340]	Sequence of Build Actions
[TPS_GST_00341]	Input Data for Build Actions
[TPS_GST_00342]	ECUC-Parameters in Build Actions
[TPS_GST_00343]	ECUC-Containers in Build Actions
[TPS_GST_00344]	General Model Elements in Build Actions
[TPS_GST_00345]	Special Data in BuildActionIoElement
[TPS_GST_00346]	Automatic Collections
[TPS_GST_00347]	Expressing Relationships by collections
[TPS_GST_00348]	Standardized category of Collection
[TPS_GST_00349]	Standardized elementRole of Collection
[TPS_GST_00351]	Model Transformation on Assosications
[TPS_GST_00352]	Associations in Splitkeys
[TPS_GST_00353]	mmt.templateTable
[TPS_GST_00354]	Semantics of CseCodeType
[TPS_GST_00355]	Specialization of FormulaExpression
[TPS_GST_00356]	Application of Sdg
[TPS_GST_00357]	Usage of Special Data
[TPS_GST_00358]	TagWithOptionalValue
[TPS_GST_02501]	Compatibility of Numerical Values

Table B.9: Added Specification Items in 4.1.1

B.4.5 Changed Specification Items

Number	Heading
[TPS_GST_00007]	Shift operation
[TPS_GST_00008]	Types in Formula Expressions
[TPS_GST_00009]	Keyword 'epsilon'
[TPS_GST_00014]	Error handling in Formula Evaluator
[TPS_GST_00017]	{module} denotes a Module Designator
[TPS_GST_00020]	Establishing References
[TPS_GST_00023]	≪atpDerived≫ applicable to relations (associations, aggregations)

Table B.10: Changed Specification Items in 4.1.1

B.4.6 Deleted Specification Items

Number	Heading

Table B.11: Deleted Specification Items in 4.1.1

B.5 Constraint History R4.1.2

B.5.1 Added Constraints

Number	Heading

Table B.12: Added Constraints in 4.1.2

B.5.2 Changed Constraints

Number	Heading
[constr_2552]	Index attribute is only valid for arrays
[constr_2514]	shortLabel in VariationPoint must be unique

Table B.13: Changed Constraints in 4.1.2

B.5.3 Deleted Constraints

Number	Heading
[constr_2513]	splitted variants must have a shortLabel

Table B.14: Deleted Constraints in 4.1.2

B.5.4 Added Specification Items

Number	Heading
[TPS_GST_00012]	AUTOSAR Formula language
[TPS_GST_00094]	Return values of the BlueprintFormula.ecuc query
[TPS_GST_00359]	Handling of the Sign

Table B.15: Added Specification Items in 4.1.2

B.5.5 Changed Specification Items

Number	Heading
[TPS_GST_00008]	Types in Formula Expressions
[TPS_GST_00047]	Identification of Partial Models

Table B.16: Changed Specification Items in 4.1.2

B.5.6 Deleted Specification Items

Number	Heading

Table B.17: Deleted Specification Items in 4.1.2

B.6 Constraint History R4.1.3

B.6.1 Added Constraints from 4.1.2 to 4.1.3

none

B.6.2 Changed Constraints from 4.1.2 to 4.1.3

Id	Heading
[constr_2502]	Merged model must be compliant to the meta-model.

Table B.18: Changed Constraints from 4.1.2 to 4.1.3

B.6.3 Deleted Constraints from 4.1.2 to 4.1.3

none

B.6.4 Added Traceables from 4.1.2 to 4.1.3

Id	Heading
[TPS_GST_00208]	Representation of return type in float

Table B.19: Added Traceables from 4.1.2 to 4.1.3

B.6.5 Changed Traceables from 4.1.2 to 4.1.3

Id	Heading
[TPS_GST_00003]	true and false
[TPS_GST_00051]	atp.Status
[TPS_GST_00063]	xml.nsUri
[TPS_GST_00066]	xml.systemIdentifier
[TPS_GST_00094]	Return values of the BlueprintFormula.ecuc query
[TPS_GST_00209]	No postbuild variation for attribute values
[TPS_GST_00211]	AttributeValueVariationPoint does not support PostBuild Variation
[TPS_GST_00253]	Distinguish codeGenerationTime Variation Points in RTE
[TPS_GST_00255]	Definition of *PreBuild* Variation Point
[TPS_GST_00258]	Binding VariationPoints early
[TPS_GST_00260]	PreBuild configuration of PostBuild criteria
[TPS_GST_00270]	Variation Point in Blueprints
[TPS_GST_00271]	blueprintCondition cannot be variant
[TPS_GST_00273]	Resolve BlueprintVariationPoints on time
[TPS_GST_00354]	Semantics of CseCodeType

Table B.20: Changed Traceables from 4.1.2 to 4.1.3

B.6.6 Deleted Traceables from 4.1.2 to 4.1.3

none

B.7 Constraint History R4.2.1

B.7.1 Added Constraints in 4.2.1

none

B.7.2 Changed Constraints in 4.2.1

Id	Heading
[constr_2502]	Merged model shall be compliant to the meta-model
[constr_2575]	blueprintValue in blueprints only
[constr_2578]	Binding Time in Association Pattern

Table B.21: Changed Constraints in 4.2.1

B.7.3 Deleted Constraints in 4.2.1

none

B.7.4 Added Traceables in 4.2.1

Id	Heading
[TPS_GST_00360]	Definition of *PreBuild* Variation Point with Blueprint conditions
[TPS_GST_00361]	Propagation of LifeCycleState
[TPS_GST_00362]	map.Status
[TPS_GST_00363]	map.Id

Table B.22: Added Traceables in 4.2.1

B.7.5 Changed Traceables in 4.2.1

Id	Heading
[TPS_GST_00094]	Return values of the BlueprintFormula.ecuc query
[TPS_GST_00206]	Special Meta Classes for AttributeValueVariationPoint
[TPS_GST_00257]	BindingTime constrained by vh.latestBindingTime
[TPS_GST_00259]	Evaluating PostBuildVariantCondition
[TPS_GST_00297]	Tags to denote life cycle information
[TPS_GST_00322]	Various Formula Representation
[TPS_GST_00354]	Semantics of CseCodeType

Table B.23: Changed Traceables in 4.2.1

B.7.6 Deleted Traceables in 4.2.1

none

B.8 Constraint History R4.2.2

B.8.1 Added Constraints in 4.2.2

Id	Heading
[constr_2594]	Cyclic value assignments to SwSystemconst is not allowed
[constr_2595]	Footnotes should not be nested
[constr_2596]	Used colors of attributes color and bgcolor

Table B.24: Added Constraints in 4.2.2

B.8.2 Changed Constraints in 4.2.2

Id	Heading
[constr_2505]	Multiplicity after binding
[constr_2577]	Binding Time in Aggregation Pattern

Table B.25: Changed Constraints in 4.2.2

B.8.3 Deleted Constraints in 4.2.2

none

B.8.4 Added Traceables in 4.2.2

Id	Heading
[TPS_GST_00364]	UML tags are attached to the target end of relations if suitable
[TPS_GST_00365]	Purpose of uuid
[TPS_GST_00366]	No View Specified
[TPS_GST_00367]	Dedicated View Specified
[TPS_GST_00368]	Multiple Views Specified
[TPS_GST_00369]	Exclude content

Table B.26: Added Traceables in 4.2.2

B.8.5 Changed Traceables in 4.2.2

Id	Heading
[TPS_GST_00331]	Table Row
[TPS_GST_00335]	View Approach
[TPS_GST_00336]	Including generated Documentation Parts

Table B.27: Changed Traceables in 4.2.2

B.8.6 Deleted Traceables in 4.2.2

none

B.9 Constraint History R4.3.0

B.9.1 Added Constraints in 4.3.0

Id	Heading
[constr_2599]	Maximum one VariationPoints in ≪atpMixed≫
[constr_2601]	Value of AbstractEnumerationValueVariationPoint
[constr_2602]	Completeness of AnyInstanceRef referencing ImplementationDataType-Element
[constr_2605]	If a SdgClass is referenced then it shall have a caption
[constr_2606]	Existence of upperMultiplicityInfinite and upperMultiplicity of Ab-stractMultiplicityRestriction is mutually exclusive
[constr_2607]	lowerMultiplicity of AbstractMultiplicityRestriction shall be smaller or equal to upperMultiplicity

Table B.28: Added Constraints in 4.3.0

B.9.2 Changed Constraints in 4.3.0

Id	Heading
[constr_2595]	Footnotes should not be nested

Table B.29: Changed Constraints in 4.3.0

B.9.3 Deleted Constraints in 4.3.0

none

B.9.4 Added Traceables in 4.3.0

Id	Heading
[TPS_GST_00370]	atp.EnumerationValue
[TPS_GST_00371]	Tag to control the production of specification documents
[TPS_GST_00372]	mmt.RestrictToStandards
[TPS_GST_00373]	Default EnumerationMappingTable
[TPS_GST_00374]	Purpose of SdgDef
[TPS_GST_00375]	Purpose of SdgClass
[TPS_GST_00376]	Purpose of Model Restriction Types
[TPS_GST_00377]	Purpose of AbstractValueRestriction
[TPS_GST_00378]	Purpose of AbstractMultiplicityRestriction
[TPS_GST_00379]	Purpose of AbstractVariationRestriction
[TPS_GST_00380]	Countably infinite number of elements

Table B.30: Added Traceables in 4.3.0

B.9.5 Changed Traceables in 4.3.0

Id	Heading
[TPS_GST_00001]	Connection between Formula and Model Elements
[TPS_GST_00002]	aborting logical expressions
[TPS_GST_00012]	AUTOSAR Formula language
[TPS_GST_00013]	Function defined
[TPS_GST_00046]	Splitable collections
[TPS_GST_00061]	xml.name
[TPS_GST_00063]	xml.nsUri
[TPS_GST_00064]	xml.roleElement, xml.roleWrapperElement, xml.typeElement, xml.typeWrapperElement
[TPS_GST_00066]	xml.systemIdentifier
[TPS_GST_00201]	Aggregation Pattern on Primitives
[TPS_GST_00205]	Transformation defined by Attribute Value Pattern
[TPS_GST_00206]	Special Meta Classes for AttributeValueVariationPoint
[TPS_GST_00291]	UML-tags for Configuration of XML schema production
[TPS_GST_00313]	Types of Paragraph
[TPS_GST_00353]	mmt.templateTable

Table B.31: Changed Traceables in 4.3.0

B.9.6 Deleted Traceables in 4.3.0

none

C All Variation Points in Meta Model

Variation Point	Latest Binding Time
AccessCount.value	preCompileTime
AccessCountSet.accessCount	preCompileTime
AliasNameSet.aliasName	preCompileTime
ApplicationArrayElement.maxNumberOfElements	preCompileTime
ApplicationRecordDataType.element	preCompileTime
ARPackage.arPackage	blueprintDerivationTime
ARPackage.element	systemDesignTime
ArrayValueSpecification.element	preCompileTime
AtomicSwComponentType.internalBehavior	preCompileTime
AUTOSAR.arPackage	blueprintDerivationTime
BlueprintPolicyList.maxNumberOfElements	blueprintDerivationTime
BlueprintPolicyList.minNumberOfElements	blueprintDerivationTime
BswInternalBehavior.arTypedPerInstanceMemory	preCompileTime
BswInternalBehavior.bswPerInstanceMemoryPolicy	preCompileTime
BswInternalBehavior.clientPolicy	preCompileTime
BswInternalBehavior.distinguishedPartition	preCompileTime
BswInternalBehavior.entity	preCompileTime
BswInternalBehavior.event	preCompileTime
BswInternalBehavior.exclusiveAreaPolicy	preCompileTime
BswInternalBehavior.internalTriggeringPoint	preCompileTime
BswInternalBehavior.internalTriggeringPointPolicy	preCompileTime
BswInternalBehavior.modeReceiverPolicy	preCompileTime
BswInternalBehavior.modeSenderPolicy	preCompileTime
BswInternalBehavior.parameterPolicy	preCompileTime
BswInternalBehavior.perInstanceParameter	preCompileTime
BswInternalBehavior.receptionPolicy	preCompileTime
BswInternalBehavior.releasedTriggerPolicy	preCompileTime
BswInternalBehavior.schedulerNamePrefix	preCompileTime
BswInternalBehavior.sendPolicy	preCompileTime
BswInternalBehavior.serviceDependency	preCompileTime
BswInternalBehavior.triggerDirectImplementation	preCompileTime
BswModuleDependency.targetModuleRef	preCompileTime
BswModuleDescription.bswModuleDependency	preCompileTime
BswModuleDescription.bswModuleDocumentation	preCompileTime
BswModuleDescription.expectedEntry	preCompileTime
BswModuleDescription.implementedEntry	preCompileTime
BswModuleDescription.providedClientServerEntry	preCompileTime
BswModuleDescription.providedData	preCompileTime
BswModuleDescription.providedModeGroup	preCompileTime
BswModuleDescription.releasedTrigger	preCompileTime
BswModuleDescription.requiredClientServerEntry	preCompileTime
BswModuleDescription.requiredData	preCompileTime
BswModuleDescription.requiredModeGroup	preCompileTime
BswModuleDescription.requiredTrigger	preCompileTime
BswModuleEntity.accessedModeGroup	preCompileTime
BswModuleEntity.activationPoint	preCompileTime
BswModuleEntity.calledEntry	preCompileTime
BswModuleEntity.callPoint	preCompileTime
BswModuleEntity.dataReceivePoint	preCompileTime
BswModuleEntity.dataSendPoint	preCompileTime

BswModuleEntity.issuedTrigger	preCompileTime
BswModuleEntity.managedModeGroup	preCompileTime
BswModuleEntry.argument	blueprintDerivationTime
BswServiceDependency.assignedData	preCompileTime
BswServiceDependency.assignedEntryRole	preCompileTime
BuildActionManifest.buildAction	blueprintDerivationTime
BuildActionManifest.buildActionEnvironment	blueprintDerivationTime
CalibrationParameterValueSet.calibrationParameterValue	preCompileTime
CanTpConfig.tpAddress	postBuild
CanTpConfig.tpChannel	postBuild
CanTpConfig.tpConnection	postBuild
CanTpConfig.tpEcu	postBuild
CanTpConfig.tpNode	postBuild
ChapterOrMsrQuery.chapter	postBuild
ClientIdDefinitionSet.clientIdDefinition	postBuild
ClientIdRange.lowerLimit	postBuild
ClientIdRange.upperLimit	postBuild
ClientServerInterface.operation	blueprintDerivationTime
ClientServerInterfaceToBswModuleEntryBlueprintMapping.operationMapping	preCompileTime
ClientServerInterfaceToBswModuleEntryBlueprintMapping.portDefinedArgumentBlueprint	preCompileTime
ClientServerOperation.argument	blueprintDerivationTime
CommunicationCluster.physicalChannel	systemDesignTime
CommunicationConnector.ecuCommPortInstance	postBuild
CompositionSwComponentType.component	postBuild
CompositionSwComponentType.connector	postBuild
CompositionSwComponentType.instantiationRTEEventProps	codeGenerationTime
CompuConstFormulaContent.vf	codeGenerationTime
CompuNominatorDenominator.v	preCompileTime
CompuScale.lowerLimit	preCompileTime
CompuScale.upperLimit	preCompileTime
CompuScales.compuScale	blueprintDerivationTime
ConsistencyNeeds.dpgDoesNotRequireCoherency	preCompileTime
ConsistencyNeeds.dpgRequiresCoherency	preCompileTime
ConsistencyNeeds.regDoesNotRequireStability	preCompileTime
ConsistencyNeeds.regRequiresStability	preCompileTime
ConsistencyNeedsBlueprintSet.consistencyNeeds	preCompileTime
CouplingElement.couplingPort	postBuild
DataPrototypeGroup.dataPrototypeGroup	preCompileTime
DataPrototypeGroup.implicitDataAccess	preCompileTime
DataTransformationSet.dataTransformation	codeGenerationTime
DataTransformationSet.transformationTechnology	codeGenerationTime
DefList.defItem	postBuild
DiagnosticAging.agingCycle	preCompileTime
DiagnosticAging.threshold	preCompileTime
DiagnosticContributionSet.element	postBuild
DiagnosticContributionSet.serviceTable	postBuild
DiagnosticDataIdentifier.dataElement	postBuild
DiagnosticEnableConditionGroup.enableCondition	postBuild
DiagnosticEvent.connectedIndicator	postBuild
DiagnosticEvent.eventFailureCycleCounterThreshold	postBuild
DiagnosticFreezeFrame.recordNumber	preCompileTime

DiagnosticIndicator.healingCycleCounterThreshold	preCompileTime
DiagnosticParameter.dataElement	postBuild
DiagnosticParameterIdentifier.dataElement	postBuild
DiagnosticProtocol.diagnosticConnection	postBuild
DiagnosticProtocol.serviceTable	postBuild
DiagnosticRoutine.id	preCompileTime
DiagnosticServiceTable.diagnosticConnection	postBuild
DiagnosticStorageConditionGroup.storageCondition	postBuild
DiagnosticTroubleCodeGroup.dtc	postBuild
DiagnosticTroubleCodeGroup.groupNumber	preCompileTime
DiagnosticTroubleCodeObd.considerPtoStatus	preCompileTime
DiagnosticTroubleCodeObd.obdDTCValue	preCompileTime
DiagnosticTroubleCodeProps.extendedDataRecord	preCompileTime
DiagnosticTroubleCodeProps.freezeFrame	preCompileTime
DocumentationBlock.defList	postBuild
DocumentationBlock.figure	postBuild
DocumentationBlock.formula	postBuild
DocumentationBlock.labeledList	postBuild
DocumentationBlock.list	postBuild
DocumentationBlock.note	postBuild
DocumentationBlock.p	postBuild
DocumentationBlock.structuredReq	postBuild
DocumentationBlock.trace	postBuild
DocumentationBlock.verbatim	postBuild
EcucBooleanParamDef.defaultValue	codeGenerationTime
EcucContainerValue.parameterValue	postBuild
EcucContainerValue.referenceValue	postBuild
EcucContainerValue.subContainer	postBuild
EcucDefinitionElement.lowerMultiplicity	codeGenerationTime
EcucDefinitionElement.upperMultiplicity	codeGenerationTime
EcucDefinitionElement.upperMultiplicityInfinite	codeGenerationTime
EcucFloatParamDef.defaultValue	codeGenerationTime
EcucFloatParamDef.max	codeGenerationTime
EcucFloatParamDef.min	codeGenerationTime
EcucIntegerParamDef.defaultValue	codeGenerationTime
EcucIntegerParamDef.max	codeGenerationTime
EcucIntegerParamDef.min	codeGenerationTime
EcucModuleConfigurationValues.container	postBuild
EcucNumericalParamValue.value	preCompileTime
EcucValueCollection.ecucValue	preCompileTime
EndToEndProtection.endToEndProtectionISignalIPdu	preCompileTime
EndToEndProtection.endToEndProtectionVariablePrototype	preCompileTime
EndToEndProtectionSet.endToEndProtection	preCompileTime
ErrorTracerNeeds.tracedFailure	preCompileTime
EthernetCluster.couplingPortConnection	postBuild
FlatMap.instance	postBuild
FlexrayArTpConfig.tpAddress	postBuild
FlexrayArTpConfig.tpChannel	postBuild
FlexrayArTpConfig.tpNode	postBuild
FlexrayTpConfig.pduPool	postBuild
FlexrayTpConfig.tpAddress	postBuild
FlexrayTpConfig.tpConnection	postBuild
FlexrayTpConfig.tpConnectionControl	postBuild

FlexrayTpConfig.tpEcu	postBuild
FlexrayTpConfig.tpNode	postBuild
Frame.pduToFrameMapping	postBuild
FrameTriggering.pduTriggering	postBuild
Gateway.frameMapping	postBuild
Gateway.iPduMapping	postBuild
Gateway.signalMapping	postBuild
HwAttributeValue.v	systemDesignTime
HwDescriptionEntity.hwAttributeValue	systemDesignTime
HwElement.hwElementConnection	systemDesignTime
HwElement.hwPinGroup	systemDesignTime
HwElement.nestedElement	systemDesignTime
HwElementConnector.hwPinConnection	systemDesignTime
HwElementConnector.hwPinGroupConnection	systemDesignTime
HwPinGroupConnector.hwPinConnection	systemDesignTime
HwPinGroupContent.hwPin	systemDesignTime
HwPinGroupContent.hwPinGroup	systemDesignTime
Implementation.buildActionManifest	codeGenerationTime
Implementation.generatedArtifact	preCompileTime
Implementation.requiredArtifact	preCompileTime
Implementation.requiredGeneratorTool	preCompileTime
ImplementationDataType.subElement	preCompileTime
ImplementationDataTypeElement.arraySize	preCompileTime
ImplementationDataTypeElement.subElement	preCompileTime
InternalBehavior.constantMemory	preCompileTime
InternalBehavior.exclusiveArea	preCompileTime
InternalBehavior.exclusiveAreaNestingOrder	preCompileTime
InternalBehavior.staticMemory	preCompileTime
InternalConstrs.lowerLimit	preCompileTime
InternalConstrs.upperLimit	preCompileTime
ISignal.dataTransformation	codeGenerationTime
ISignalGroup.comBasedSignalGroupTransformation	codeGenerationTime
ISignalIPdu.iPduTimingSpecification	postBuild
ISignalIPdu.iSignalToPduMapping	postBuild
ISignalIPdu.pduCounter	preCompileTime
ISignalIPdu.pduReplication	preCompileTime
ISignalIPduGroup.iSignalIPdu	postBuild
ISignalIPduGroup.nmPdu	postBuild
J1939TpConfig.tpAddress	postBuild
J1939TpConfig.tpConnection	postBuild
J1939TpConfig.tpNode	postBuild
LabeledList.labeledItem	postBuild
LinPhysicalChannel.scheduleTable	postBuild
LinTpConfig.tpAddress	postBuild
LinTpConfig.tpConnection	postBuild
LinTpConfig.tpNode	postBuild
List.item	postBuild
McDataInstance.subElement	preCompileTime
McSupportData.emulationSupport	preCompileTime
McSupportData.mcParameterInstance	postBuild
McSupportData.mcVariableInstance	postBuild
ModeDeclarationGroup.modeDeclaration	blueprintDerivationTime
MultiplexedIPdu.dynamicPart	postBuild

MultiplexedIPdu.staticPart	postBuild
NmCluster.nmNode	postBuild
NmConfig.nmCluster	postBuild
NmConfig.nmClusterCoupling	postBuild
NmConfig.nmIfEcu	preCompileTime
NumericalOrText.vf	preCompileTime
NumericalValueSpecification.value	preCompileTime
NvBlockDescriptor.clientServerPort	preCompileTime
NvBlockDescriptor.instantiationDataDefProps	preCompileTime
NvBlockDescriptor.modeSwitchEventTriggeredActivity	preCompileTime
NvBlockDescriptor.nvBlockDataMapping	preCompileTime
NvBlockSwComponentType.nvBlockDescriptor	preCompileTime
ParameterSwComponentType.instantiationDataDefProps	preCompileTime
PdurIPduGroup.iPdu	postBuild
PduTriggering.iSignalTriggering	postBuild
PerInstanceMemorySize.size	preCompileTime
PhysConstrs.lowerLimit	preCompileTime
PhysConstrs.upperLimit	preCompileTime
PhysicalChannel.commConnector	postBuild
PhysicalChannel.frameTriggering	postBuild
PhysicalChannel.iSignalTriggering	postBuild
PhysicalChannel.pduTriggering	postBuild
PortGroup.outerPort	preCompileTime
PortInterfaceMappingSet.portInterfaceMapping	blueprintDerivationTime
PostBuildVariantCondition.value	preCompileTime
PostBuildVariantCriterionValue.value	preCompileTime
RapidPrototypingScenario.rptContainer	preCompileTime
ReceiverComSpec.maxDeltaCounterInit	preCompileTime
ReceiverComSpec.usesEndToEndProtection	preCompileTime
RecordValueSpecification.field	preCompileTime
ResourceConsumption.accessCountSet	preCompileTime
ResourceConsumption.executionTime	preCompileTime
ResourceConsumption.heapUsage	preCompileTime
ResourceConsumption.memorySection	preCompileTime
ResourceConsumption.sectionNamePrefix	preCompileTime
ResourceConsumption.stackUsage	preCompileTime
RptComponent.rptExecutableEntity	preCompileTime
RptContainer.byPassPoint	preCompileTime
RptContainer.rptContainer	preCompileTime
RptContainer.rptHook	preCompileTime
RptExecutableEntity.rptExecutableEntityEvent	preCompileTime
RptExecutableEntity.rptRead	preCompileTime
RptExecutableEntity.rptWrite	preCompileTime
RptSupportData.rptComponent	preCompileTime
RptSupportData.rptServicePoint	preCompileTime
RuleArguments.vf	preCompileTime
RuleArguments.vtf	preCompileTime
RuleBasedValueSpecification.arguments	preCompileTime
RunnableEntity.asynchronousServerCallResultPoint	preCompileTime
RunnableEntity.dataReadAccess	preCompileTime
RunnableEntity.dataReceivePointByArgument	preCompileTime
RunnableEntity.dataReceivePointByValue	preCompileTime
RunnableEntity.dataSendPoint	preCompileTime

RunnableEntity.dataWriteAccess	preCompileTime
RunnableEntity.externalTriggeringPoint	preCompileTime
RunnableEntity.internalTriggeringPoint	preCompileTime
RunnableEntity.modeAccessPoint	preCompileTime
RunnableEntity.modeSwitchPoint	preCompileTime
RunnableEntity.parameterAccess	preCompileTime
RunnableEntity.readLocalVariable	preCompileTime
RunnableEntity.serverCallPoint	preCompileTime
RunnableEntity.writtenLocalVariable	preCompileTime
RunnableEntityGroup.runnableEntity	preCompileTime
RunnableEntityGroup.runnableEntityGroup	preCompileTime
ScaleConstr.lowerLimit	preCompileTime
ScaleConstr.upperLimit	preCompileTime
Sdf.value	preCompileTime
SdgContents.sdg	postBuild
SdgContents.sdxf	postBuild
SenderComSpec.usesEndToEndProtection	preCompileTime
ServiceDependency.assignedDataType	preCompileTime
SoAdConfig.connectionBundle	postBuild
SoAdConfig.socketAddress	postBuild
SubElementMapping.firstElement	preCompileTime
SubElementMapping.secondElement	preCompileTime
SupervisedEntityNeeds.checkpoints	preCompileTime
SwAxisIndividual.swMaxAxisPoints	preCompileTime
SwAxisIndividual.swMinAxisPoints	preCompileTime
SwcBswMapping.runnableMapping	preCompileTime
SwcBswMapping.synchronizedModeGroup	preCompileTime
SwcBswMapping.synchronizedTrigger	preCompileTime
SwcImplementation.perInstanceMemorySize	preCompileTime
SwcInternalBehavior.arTypedPerInstanceMemory	preCompileTime
SwcInternalBehavior.event	preCompileTime
SwcInternalBehavior.exclusiveAreaPolicy	preCompileTime
SwcInternalBehavior.explicitInterRunnableVariable	preCompileTime
SwcInternalBehavior.implicitInterRunnableVariable	preCompileTime
SwcInternalBehavior.instantiationDataDefProps	preCompileTime
SwcInternalBehavior.perInstanceMemory	preCompileTime
SwcInternalBehavior.perInstanceParameter	preCompileTime
SwcInternalBehavior.portAPIOption	preCompileTime
SwcInternalBehavior.runnable	preCompileTime
SwcInternalBehavior.serviceDependency	preCompileTime
SwcInternalBehavior.sharedParameter	preCompileTime
SwComponentDocumentation.chapter	postBuild
SwComponentType.consistencyNeeds	preCompileTime
SwComponentType.port	preCompileTime
SwComponentType.portGroup	preCompileTime
SwComponentType.swComponentDocumentation	preCompileTime
SwcServiceDependency.assignedData	preCompileTime
SwcServiceDependency.assignedPort	preCompileTime
SwDataDefProps.swValueBlockSize	preCompileTime
SwGenericAxisParam.vf	preCompileTime
SwSystemconstValue.value	preCompileTime
SwTextProps.swMaxTextSize	preCompileTime
SwValues.vf	preCompileTime

SwValues.vtf	preCompileTime
System.fibexElement	postBuild
System.j1939SharedAddressCluster	postBuild
System.mapping	postBuild
System.rootSoftwareComposition	systemDesignTime
System.systemDocumentation	systemDesignTime
SystemMapping.applicationPartitionToEcuPartitionMapping	postBuild
SystemMapping.dataMapping	postBuild
SystemMapping.ecuResourceMapping	systemDesignTime
SystemMapping.mappingConstraint	systemDesignTime
SystemMapping.pncMapping	systemDesignTime
SystemMapping.resourceEstimation	systemDesignTime
SystemMapping.signalPathConstraint	systemDesignTime
SystemMapping.swcToApplicationPartitionMapping	postBuild
SystemMapping.swImplMapping	preCompileTime
SystemMapping.swMapping	preCompileTime
Tbody.row	postBuild
TextTableMapping.bitfieldTextTableMaskFirst	preCompileTime
TextTableMapping.bitfieldTextTableMaskSecond	preCompileTime
TextTableValuePair.firstValue	preCompileTime
TextTableValuePair.secondValue	preCompileTime
TimingExtension.timingCondition	postBuild
TimingExtension.timingDescription	postBuild
TimingExtension.timingGuarantee	postBuild
TimingExtension.timingRequirement	postBuild
TimingExtensionResource.timingArgument	postBuild
TimingExtensionResource.timingMode	postBuild
TimingExtensionResource.timingVariable	postBuild
TopicContent.table	postBuild
TopicOrMsrQuery.topic1	postBuild
TransformationTechnology.transformationDescription	postBuild
ValueList.vf	preCompileTime

Table C.1: Usage of variation points

D Splitable Elements in this Template

Name of splitable element	Splitkey
ARPackage.arPackage	shortName, variationPoint.shortLabel
ARPackage.element	shortName, variationPoint.shortLabel
ARPackage.referenceBase	shortLabel
AUTOSAR.arPackage	shortName, variationPoint.shortLabel

Table D.1: Usage of splitable elements

E Mentioned Class Tables

For the sake of completeness, this chapter contains a set of class tables representing meta-classes mentioned in the context of this document but which are not contained directly in the scope of describing specific meta-model semantics.

Class	≪atpMixedString≫ **AbstractEnumerationValueVariationPoint (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariationPoints			
Note	This is an abstract EnumerationValueVariationPoint. It is introduced to support the case that additional attributes are required for particular purposes.			
Base	ARObject, AttributeValueVariationPoint, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
base	Identifier	0..1	attr	This attribute reflects the base to be used in context of EnumerationMappingTable for this reference. **Tags:** xml.attribute=true
enumTable	Ref	0..1	attr	This represents the assigned enumeration table. **Tags:** xml.attribute=true

Table E.1: AbstractEnumerationValueVariationPoint

Class	**AbstractMultiplicityRestriction (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::ModelRestrictionTypes			
Note	Restriction that specifies the valid number of occurrences of an element in the current context.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
lowerMultiplicity	PositiveInteger	0..1	attr	Specifies the minimal number of times an object shall occur. If this primitive attribute is not set, then the object is optional.
upperMultiplicity	PositiveInteger	0..1	attr	Specifies the maximum number of times an object may occur. If this primitive attribute is not set, then there is no limit with respect to the maximum occurrence.
upperMultiplicityInfinite	Boolean	0..1	attr	This explicitly specifies, that the upper multiplicity is NOT restricted. Note: The use of 'upperMultiplicityInfinite' and 'upperMultiplicity' is mutual exclusive.

Table E.2: AbstractMultiplicityRestriction

Class	AbstractRequiredPortPrototype (abstract)			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	This abstract class provides the ability to become a required PortPrototype.			
Base	ARObject, AtpBlueprintable, AtpFeature, AtpPrototype, Identifiable, Multilanguage Referrable, PortPrototype, Referrable			
Attribute	Type	Mul.	Kind	Note
requiredComSpec	RPortComSpec	*	aggr	Required communication attributes, one for each interface element.

Table E.3: AbstractRequiredPortPrototype

Enumeration	AdditionalBindingTimeEnum
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling
Note	This enumeration specifies the additional binding times applicable for vh.latestBindingTime of variation points.
Literal	Description
blueprint Derivation Time	The point in time when an object is created from a blueprint. **Tags:** atp.EnumerationValue=0
postBuild	After the executable has been built. **Tags:** atp.EnumerationValue=1

Table E.4: AdditionalBindingTimeEnum

Class	ApplicationSwComponentType			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	The ApplicationSwComponentType is used to represent the application software. **Tags:** atp.recommendedPackage=SwComponentTypes			
Base	ARElement, ARObject, AtomicSwComponentType, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable, SwComponentType			
Attribute	Type	Mul.	Kind	Note
–	–	–	–	–

Table E.5: ApplicationSwComponentType

Class	AssemblySwConnector			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	AssemblySwConnectors are exclusively used to connect SwComponentPrototypes in the context of a CompositionSwComponentType.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable, MultilanguageReferrable, Referrable, SwConnector			
Attribute	Type	Mul.	Kind	Note
provider	AbstractProvidedPortPrototype	0..1	iref	Instance of providing port.

requester	AbstractRequiredPortPrototype	0..1	iref	Instance of requiring port.

Table E.6: AssemblySwConnector

Class	**AtomicSwComponentType (abstract)**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	An atomic software component is atomic in the sense that it cannot be further decomposed and distributed across multiple ECUs.			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable, SwComponentType			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
internalBehavior	SwcInternalBehavior	0..1	aggr	The SwcInternalBehaviors owned by an AtomicSwComponentType can be located in a different physical file. Therefore the aggregation is «atpSplitable». **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=internalBehavior, variationPoint.shortLabel vh.latestBindingTime=preCompileTime
symbolProps	SymbolProps	0..1	aggr	This represents the SymbolProps for the AtomicSwComponentType. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=shortName

Table E.7: AtomicSwComponentType

Class	**AtpBlueprint (abstract)**			
Package	M2::AUTOSARTemplates::StandardizationTemplate::AbstractBlueprintStructure			
Note	This meta-class represents the ability to act as a Blueprint. As this class is an abstract one, particular blueprint meta-classes inherit from this one.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
blueprintPolicy	BlueprintPolicy	*	aggr	This role indicates whether the blueprintable element will be modifiable or not motifiable.

Table E.8: AtpBlueprint

Class	**AtpBlueprintable (abstract)**			
Package	M2::AUTOSARTemplates::StandardizationTemplate::AbstractBlueprintStructure			
Note	This meta-class represents the ability to be derived from a Blueprint. As this class is an abstract one, particular blueprintable meta-classes inherit from this one.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table E.9: AtpBlueprintable

Enumeration	**BindingTimeEnum**
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling
Note	This enumerator specifies the applicable binding times for the pre build variation points.
Literal	***Description***
codeGenerationTime	• Coding by hand, based on requirements document. • Tool based code generation, e.g. from a model. • The model may contain variants. • Only code for the selected variant(s) is actually generated. **Tags:** atp.EnumerationValue=0
linkTime	Configure what is included in object code, and what is omitted Based on which variant(s) are selected E.g. for modules that are delivered as object code (as opposed to those that are delivered as source code) **Tags:** atp.EnumerationValue=1
preCompile Time	This is typically the C-Preprocessor. Exclude parts of the code from the compilation process, e.g., because they are not required for the selected variant, because they are incompatible with the selected variant, because they require resources that are not present in the selected variant. Object code is only generated for the selected variant(s). The code that is excluded at this stage code will not be available at later stages. **Tags:** atp.EnumerationValue=2
systemDesignTime	• Designing the VFB. • Software Component types (PortInterfaces). • SWC Prototypes and the Connections between SWCprototypes. • Designing the Topology • ECUs and interconnecting Networks • Designing the Communication Matrix and Data Mapping **Tags:** atp.EnumerationValue=3

Table E.10: BindingTimeEnum

Class	≪atpMixedString≫ **BlueprintFormula**			
Package	M2::AUTOSARTemplates::StandardizationTemplate::BlueprintFormula			
Note	This class express the extension of the Formula Language to provide formalized blueprint-Value resp. blueprintCondition.			
Base	ARObject, FormulaExpression, SwSystemconstDependentFormula			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
ecuc	EcucDefinitionElement	1	ref	The EcucDefinitionElement serves as a argument for the formular.
verbatim	MultiLanguageVerbatim	1	aggr	This represents an informal term in the expression as verbatim text. Note that the result of this is same as formula keyword "undefined".

Table E.11: BlueprintFormula

Class	**BswModuleDescription**			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswOverview			
Note	Root element for the description of a single BSW module or BSW cluster. In case it describes a BSW module, the short name of this element equals the name of the BSW module. **Tags:** atp.recommendedPackage=BswModuleDescriptions			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpFeature, AtpStructureElement, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
bswModuleDependency	BswModuleDependency	*	aggr	Describes the dependency to another BSW module. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=20
bswModuleDocumentation	SwComponentDocumentation	0..1	aggr	This adds a documentation to the BSW module. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=bswModuleDocumentation, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=6
expectedEntry	BswModuleEntry	*	ref	Indicates an entry which is required by this module. Replacement of outgoingCallback / requiredEntry. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=expectedEntry, variationPoint.shortLabel vh.latestBindingTime=preCompileTime

implementedEntry	BswModuleEntry	*	ref	Specifies an entry provided by this module which can be called by other modules. This includes "main" functions, interrupt routines, and callbacks. Replacement of providedEntry / expectedCallback. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=implementedEntry, variationPoint.shortLabel vh.latestBindingTime=preCompileTime
internalBehavior	BswInternalBehavior	*	aggr	The various BswInternalBehaviors associated with a BswModuleDescription can be distributed over several physical files. Therefore the aggregation is «atpSplitable». **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=shortName xml.sequenceOffset=65
moduleId	PositiveInteger	0..1	attr	Refers to the BSW Module Identifier defined by the AUTOSAR standard. For non-standardized modules, a proprietary identifier can be optionally chosen. **Tags:** xml.sequenceOffset=5
providedClientServerEntry	BswModuleClientServerEntry	*	aggr	Specifies that this module provides a client server entry which can be called from another parition or core.This entry is declared locally to this context and will be connected to the requiredClientServerEntry of another or the same module via the configuration of the BSW Scheduler. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=45
providedData	VariableDataPrototype	*	aggr	Specifies a data prototype provided by this module in order to be read from another partition or core.The providedData is declared locally to this context and will be connected to the requiredData of another or the same module via the configuration of the BSW Scheduler. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=55

providedModeGroup	ModeDeclarationGroupPrototype	*	aggr	A set of modes which is owned and provided by this module or cluster. It can be connected to the requiredModeGroups of other modules or clusters via the configuration of the BswScheduler. It can also be synchronized with modes provided via ports by an associated ServiceSwComponentType, EcuAbstractionSwComponentType or ComplexDeviceDriverSwComponentType. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=25
releasedTrigger	Trigger	*	aggr	A Trigger released by this module or cluster. It can be connected to the requiredTriggers of other modules or clusters via the configuration of the BswScheduler. It can also be synchronized with Triggers provided via ports by an associated ServiceSwComponentType, EcuAbstractionSwComponentType or ComplexDeviceDriverSwComponentType. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=35
requiredClientServerEntry	BswModuleClientServerEntry	*	aggr	Specifies that this module requires a client server entry which can be implemented on another parition or core.This entry is declared locally to this context and will be connected to the providedClientServerEntry of another or the same module via the configuration of the BSW Scheduler. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=50
requiredData	VariableDataPrototype	*	aggr	Specifies a data prototype required by this module in oder to be provided from another partition or core.The requiredData is declared locally to this context and will be connected to the providedData of another or the same module via the configuration of the BswScheduler. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=60

requiredModeGroup	ModeDeclarationGroupPrototype	*	aggr	Specifies that this module or cluster depends on a certain mode group. The requiredModeGroup is local to this context and will be connected to the providedModeGroup of another module or cluster via the configuration of the BswScheduler. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=30
requiredTrigger	Trigger	*	aggr	Specifies that this module or cluster reacts upon an external trigger.This requiredTrigger is declared locally to this context and will be connected to the providedTrigger of another module or cluster via the configuration of the BswScheduler. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=40

Table E.12: BswModuleDescription

Class	**BswModuleEntity (abstract)**			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswBehavior			
Note	Specifies the smallest code fragment which can be described for a BSW module or cluster within AUTOSAR.			
Base	ARObject, ExecutableEntity, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
accessedModeGroup	ModeDeclarationGroupPrototype	*	ref	A mode group which is accessed via API call by this entity. It must be a ModeDeclarationGroupPrototype required by this module or cluster. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
activationPoint	BswInternalTriggeringPoint	*	ref	Activation point used by the module entity to activate one or more internal triggers. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
callPoint	BswModuleCallPoint	*	aggr	A call point used in the code of this entitiy. The variablity of this association is especially targeted at debug scenarios: It is possible to have one variant calling into the AUTOSAR debug module and another one which doesn't. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime

calledEntry	BswModuleEntry	*	ref	The entry of another (or the same) BSW module which is called by this entry (usually via C function call). This information allows to set up a model of call chains. The variablity of this association is especially targeted at debug scenarios: It is possible to have one variant calling into the AUTOSAR debug module and another one which doesn't. Note that this relation has been merked as obsolete, since the more powerful definition of a callPoint should be used. **Stereotypes:** atpVariation **Tags:** atp.Status=removed vh.latestBindingTime=preCompileTime
dataReceivePoint	BswVariableAccess	*	aggr	The data is received via the BSW Scheduler. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
dataSendPoint	BswVariableAccess	*	aggr	The data is sent via the BSW Scheduler. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
implementedEntry	BswModuleEntry	1	ref	The entry which is implemented by this module entity.
issuedTrigger	Trigger	*	ref	A trigger issued by this entity via BSW Scheduler API call. It must be a BswTrigger released (i.e. owned) by this module or cluster. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
managedModeGroup	ModeDeclarationGroupPrototype	*	ref	A mode group which is managed by this entity. It must be a ModeDeclarationGroupPrototype provided by this module or cluster. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
schedulerNamePrefix	BswSchedulerNamePrefix	0..1	ref	A prefix to be used in generated names for the BswModuleScheduler in the context of this BswModuleEntity, for example entry point prototypes, macros for dealing with exclusive areas, header file names. Details are defined in the SWS RTE. The prefix supersedes default rules for the prefix of those names.

Table E.13: BswModuleEntity

Class	BswModuleEntry			
Package	M2::AUTOSARTemplates::BswModuleTemplate::BswInterfaces			
Note	This class represents a single API entry (C-function prototype) into the BSW module or cluster. The name of the C-function is equal to the short name of this element with one exception: In case of multiple instances of a module on the same CPU, special rules for "infixes" apply, see description of class BswImplementation. **Tags:** atp.recommendedPackage=BswModuleEntrys			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
argument (ordered)	SwServiceArg	*	aggr	An argument belonging to this BswModuleEntry. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=blueprintDerivationTime xml.sequenceOffset=45
bswEntryKind	BswEntryKindEnum	0..1	attr	This describes whether the entry is concrete or abstract. If the attribute is missing the entry is considered as concrete. **Tags:** xml.sequenceOffset=40
callType	BswCallType	1	attr	The type of call associated with this service. **Tags:** xml.sequenceOffset=25
executionContext	BswExecutionContext	1	attr	Specifies the execution context which is required (in case of entries into this module) or guaranteed (in case of entries called from this module) for this service. **Tags:** xml.sequenceOffset=30
functionPrototypeEmitter	NameToken	0..1	attr	This attribute is used to control the generation of function prototypes. If set to "RTE", the RTE generates the function prototypes in the Module Interlink Header File.
isReentrant	Boolean	1	attr	Reentrancy from the viewpoint of function callers: • True: Enables the service to be invoked again, before the service has finished. • False: It is prohibited to invoke the service again before is has finished. **Tags:** xml.sequenceOffset=15

isSynchronous	Boolean	1	attr	Synchronicity from the viewpoint of function callers: • True: This calls a synchronous service, i.e. the service is completed when the call returns. • False: The service (on semantical level) may not be complete when the call returns. **Tags:** xml.sequenceOffset=20
returnType	SwServiceArg	0..1	aggr	The return type belonging to this bswModuleEntry. **Tags:** xml.sequenceOffset=40
role	Identifier	0..1	attr	Specifies the role of the entry in the given context. It shall be equal to the standardized name of the service call, especially in cases where no ServiceIdentifier is specified, e.g. for callbacks. Note that the ShortName is not always sufficient because it maybe vendor specific (e.g. for callbacks which can have more than one instance). **Tags:** xml.sequenceOffset=10
serviceId	PositiveInteger	0..1	attr	Refers to the service identifier of the Standardized Interfaces of AUTOSAR basic software. For non-standardized interfaces, it can optionally be used for proprietary identification. **Tags:** xml.sequenceOffset=5
swServiceImplPolicy	SwServiceImplPolicyEnum	1	attr	Denotes the implementation policy as a standard function call, inline function or macro. This has to be specified on interface level because it determines the signature of the call. **Tags:** xml.sequenceOffset=35

Table E.14: BswModuleEntry

Class	**Caption**			
Package	M2::MSR::Documentation::BlockElements			
Note	This meta-class represents the ability to express a caption which is a title, and a shortName.			
Base	ARObject, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
–	–	–	–	–

Table E.15: Caption

Class	**Colspec**			
Package	M2::MSR::Documentation::BlockElements::OasisExchangeTable			
Note	This meta-class represents the ability to specify the properties of a column in a table.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
align	AlignEnum	0..1	attr	Specifies how the cell entries shall be horizontally aligned within the specified column. Default is "LEFT" **Tags:** xml.attribute=true
colname	String	0..1	attr	Specifies the name of the column. **Tags:** xml.attribute=true
colnum	String	0..1	attr	column number (allows to sort the columns). **Tags:** xml.attribute=true
colsep	TableSeparatorString	0..1	attr	Indicates whether a line should be displayed right of this column in the column specification. **Tags:** xml.attribute=true
colwidth	String	0..1	attr	Width of the column. You can enter absolute values such as 4 cm, or relative values marked with * (e.g., 2* for column widths double those of other columns with 1*). The unit can be added to the number in the string. Possible units are: cm, mm, px, pt. **Tags:** xml.attribute=true
rowsep	TableSeparatorString	0..1	attr	Indicates whether a line should be displayed at the bottom end of the cells of the column defined in the Colspec. **Tags:** xml.attribute=true

Table E.16: Colspec

Class	**CompositionSwComponentType**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	A CompositionSwComponentType aggregates SwComponentPrototypes (that in turn are typed by SwComponentTypes) as well as SwConnectors for primarily connecting SwComponentPrototypes among each others and towards the surface of the CompositionSwComponentType. By this means hierarchical structures of software-components can be created. **Tags:** atp.recommendedPackage=SwComponentTypes			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable, SwComponentType			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

component	SwComponentPrototype	*	aggr	The instantiated components that are part of this composition. The aggregation of SwComponentPrototype is subject to variability with the purpose to support the conditional existence of a SwComponentPrototype. Please be aware: if the conditional existence of SwComponentPrototypes is resolved post-build the deselected SwComponentPrototypes are still contained in the ECUs build but the instances are inactive in in that they are not scheduled by the RTE. The aggregation is marked as atpSplitable in order to allow the addition of service components to the ECU extract during the ECU integration. The use case for having 0 components owned by the CompositionSwComponentType could be to deliver an empty CompositionSwComponentType to e.g. a supplier for filling the internal structure. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild
connector	SwConnector	*	aggr	SwConnectors have the principal ability to establish a connection among PortPrototypes. They can have many roles in the context of a CompositionSwComponentType. Details are refined by subclasses. The aggregation of SwConnectors is subject to variability with the purpose to support variant data flow. The aggregation is marked as atpSplitable in order to allow the extension of the ECU extract with AssemblySwConnectors between ApplicationSwComponentTypes and ServiceSwComponentTypes during the ECU integration. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild
constantValueMapping	ConstantSpecificationMappingSet	*	ref	Reference to the ConstantSpecificationMapping to be applied for initValues of PPortComSpecs and RPortComSpec. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=constantValueMapping

dataTypeMapping	DataTypeMappingSet	*	ref	Reference to the DataTypeMapping to be applied for the used ApplicationDataTypes in PortInterfaces. Background: when developing subsystems it may happen that ApplicationDataTypes are used on the surface of CompositionSwComponentTypes. In this case it would be reasonable to be able to also provide the intended mapping to the ImplementationDataTypes. However, this mapping shall be informal and not technically binding for the implementers mainly because the RTE generator is not concerned about the CompositionSwComponentTypes. Rationale: if the mapping of ApplicationDataTypes on the delegated and inner PortPrototype matches then the mapping to ImplementationDataTypes is not impacting compatibility. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=dataTypeMapping
instantiationRTEEventProps	InstantiationRTEEventProps	*	aggr	This allows to define instantiation specific properties for RTE Events, in particular for instance specific scheduling. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortLabel, variationPoint.shortLabel vh.latestBindingTime=codeGenerationTime

Table E.17: CompositionSwComponentType

Class	**CompuMethod**			
Package	M2::MSR::AsamHdo::ComputationMethod			
Note	This meta-class represents the ability to express the relationship between a physical value and the mathematical representation. Note that this is still independent of the technical implementation in data types. It only specifies the formula how the internal value corresponds to its physical pendant. **Tags:** atp.recommendedPackage=CompuMethods			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
compuInternalToPhys	Compu	0..1	aggr	This specifies the computation from internal values to physical values. **Tags:** xml.sequenceOffset=80
compuPhysToInternal	Compu	0..1	aggr	This represents the computation from physical values to the internal values. **Tags:** xml.sequenceOffset=90

displayFormat	DisplayFormatString	0..1	attr	This property specifies, how the physical value shall be displayed e.g. in documents or measurement and calibration tools. **Tags:** xml.sequenceOffset=20
unit	Unit	0..1	ref	This is the physical unit of the Physical values for which the CompuMethod applies. **Tags:** xml.sequenceOffset=30

Table E.18: CompuMethod

Class	**Describable (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable			
Note	This meta-class represents the ability to add a descriptive documentation to non identifiable elements.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
desc	MultiLanguageOverviewParagraph	0..1	aggr	This represents a general but brief (one paragraph) description what the object in question is about. It is only one paragraph! Desc is intended to be collected into overview tables. This property helps a human reader to identify the object in question. More elaborate documentation, (in particlar how the object is built or used) should go to "introduction". **Tags:** xml.sequenceOffset=-60
category	CategoryString	0..1	attr	The category is a keyword that specializes the semantics of the Describable. It affects the expected existence of attributes and the applicability of constraints. **Tags:** xml.sequenceOffset=-50
adminData	AdminData	0..1	aggr	This represents the administrative data for the describable object. **Tags:** xml.sequenceOffset=-20
introduction	DocumentationBlock	0..1	aggr	This represents more information about how the object in question is built or is used. Therefore it is a DocumentationBlock. **Tags:** xml.sequenceOffset=-30

Table E.19: Describable

Class	Documentation			
Package	M2::AUTOSARTemplates::GenericStructure::DocumentationOnM1			
Note	This meta-class represents the ability to handle a so called standalone documentation. Standalone means, that such a documentation is not embedded in another ARElement or identifiable object. The standalone documentation is an entity of its own which denotes its context by reference to other objects and instances. **Tags:** atp.recommendedPackage=Documentations			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	Type	Mul.	Kind	Note
context	DocumentationContext	*	aggr	This is the context of the particular documentation.
documentationContent	PredefinedChapter	0..1	aggr	This is the content of the documentation related to the specified contexts. **Tags:** xml.sequenceOffset=200

Table E.20: Documentation

Class	≪atpVariation≫ EcucAbstractStringParamDef (abstract)			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Abstract class that is used to collect the common properties for StringParamDefs, LinkerSymbolDef, FunctionNameDef and MultilineStringParamDefs. atpVariation: [RS_ECUC_0083] **Tags:** vh.latestBindingTime=codeGenerationTime			
Base	ARObject, AtpDefinition, EcucCommonAttributes, EcucDefinitionElement, EcucParameterDef, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mul.	Kind	Note
defaultValue	VerbatimString	0..1	attr	Default value of the string configuration parameter.
maxLength	PositiveInteger	0..1	attr	Max length allowed for this string.
minLength	PositiveInteger	0..1	attr	Min length allowed for this string.
regularExpression	RegularExpression	0..1	attr	This represents the regular expression which shall be used to validate the string parameter value.

Table E.21: EcucAbstractStringParamDef

Class	EcucBooleanParamDef			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Configuration parameter type for Boolean. Allowed values are true and false. **Tags:** xml.sequenceOffset=0			
Base	ARObject, AtpDefinition, EcucCommonAttributes, EcucDefinitionElement, EcucParameterDef, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mul.	Kind	Note

defaultValue	Boolean	0..1	attr	Default value of the boolean configuration parameter. atpVariation: [RS_ECUC_00083] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime

Table E.22: EcucBooleanParamDef

Class	**EcucChoiceReferenceDef**			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Specify alternative references where in the ECU Configuration description only one of the specified references will actually be used.			
Base	ARObject, AtpDefinition, EcucAbstractInternalReferenceDef, EcucAbstractReferenceDef, EcucCommonAttributes, EcucDefinitionElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
destination	EcucContainerDef	*	ref	All the possible parameter containers for the reference are specified. **Stereotypes:** atpUriDef

Table E.23: EcucChoiceReferenceDef

Class	**EcucContainerDef (abstract)**			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Base class used to gather common attributes of configuration container definitions.			
Base	ARObject, AtpDefinition, EcucDefinitionElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
destinationUri	EcucDestinationUriDef	*	ref	Several destinationUris can be defined for an EcucContainerDef. With such destinationUris an EcucContainerDef is applicable for several EcucUriReferenceDefs. **Stereotypes:** atpUriDef
multiplicityConfigClass	EcucMultiplicityConfigurationClass	*	aggr	Specifies which MultiplicityConfigurationClass this container is available for which ConfigurationVariant. This aggregation is optional if the surrounding EcucModuleDef has the Category STANDARDIZED_MODULE_DEFINITION. If the category attribute of the EcucModuleDef is set to VENDOR_SPECIFIC_MODULE_DEFINITION, then this aggregation is mandatory. **Tags:** xml.namePlural=MULTIPLICITY-CONFIG-CLASSES

postBuildVariantMultiplicity	Boolean	0..1	attr	Indicates if a container may have different number of instances in different post-build variants (previously known as post-build selectable configuration sets). TRUE means yes, FALSE means no.
requiresIndex	Boolean	0..1	attr	Used to define whether the value element for this definition shall be provided with an index.

Table E.24: EcucContainerDef

Class	**EcucContainerValue**			
Package	M2::AUTOSARTemplates::ECUCDescriptionTemplate			
Note	Represents a Container definition in the ECU Configuration Description.			
Base	ARObject, EcucIndexableValue, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
definition	EcucContainerDef	1	ref	Reference to the definition of this Container in the ECU Configuration Parameter Definition. **Tags:** xml.sequenceOffset=-10
parameterValue	EcucParameterValue	*	aggr	Aggregates all ECU Configuration Values within this Container. atpVariation: [RS_ECUC_00079] **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=definition, variationPoint.shortLabel vh.latestBindingTime=postBuild
referenceValue	EcucAbstractReferenceValue	*	aggr	Aggregates all References with this container. atpVariation: [RS_ECUC_00079] **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=definition, variationPoint.shortLabel vh.latestBindingTime=postBuild
subContainer	EcucContainerValue	*	aggr	Aggregates all sub-containers within this container. atpVariation: [RS_ECUC_00078] **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=definition, shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild

Table E.25: EcucContainerValue

Class	**EcucDefinitionElement (abstract)**			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Common class used to express the commonalities of configuration parameters, references and containers. If not stated otherwise the default multiplicity is exactly one mandatory occurrence of the specified element.			
Base	ARObject, AtpDefinition, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
ecucCond	EcucConditionSpecification	0..1	aggr	If it evaluates to true the Ecu Parameter definition shall be processed as specified. Otherwise the parameter definition shall be ignored. **Tags:** xml.sequenceOffset=100
ecucValidationCond	EcucValidationCondition	*	aggr	Collection of validation conditions which all need to evaluate to true in order to indicate a valid validation condition of the EcucDefinitionElement.
lowerMultiplicity	PositiveInteger	1	attr	The lower multiplicity of the specified element. 0: optional 1: at least one occurrence n: at least n occurrences atpVariation: [RS_ECUC_00082] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime xml.sequenceOffset=110
relatedTraceItem	Traceable	0..1	ref	This contains a sloppy reference to the Autosar compatible identifier of the element (EcucId). **Stereotypes:** atpUriDef **Tags:** xml.sequenceOffset=-10
scope	EcucScopeEnum	0..1	attr	Specifies the scope of this configuration element. **Tags:** xml.sequenceOffset=150
upperMultiplicity	PositiveInteger	0..1	attr	The upper multiplicity of the specified element. 0: no occurrence (used for VSMD) 1: at most one occurrence m: at most m occurrences If upperMultiplicity is set than upperMultiplicityInfinite shall not be used. atpVariation: [RS_ECUC_00082] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime xml.sequenceOffset=120

upperMultiplicityInfinite	Boolean	0..1	attr	To express an infinite number of occurrences of this element this attribute has to be set to true. If upperMultiplicityInfinite is set than upperMultiplicity shall not be used. atpVariation: [RS_ECUC_00082] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime xml.sequenceOffset=130

Table E.26: EcucDefinitionElement

Class	**EcucEnumerationParamDef**			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Configuration parameter type for Enumeration. **Tags:** xml.sequenceOffset=0			
Base	ARObject, AtpDefinition, EcucCommonAttributes, EcucDefinitionElement, EcucParameterDef, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
defaultValue	Identifier	0..1	attr	Default value of the enumeration configuration parameter. This string needs to be one of the literals specified for this enumeration.
literal	EcucEnumerationLiteralDef	*	aggr	Aggregation on the literals used to define this enumeration parameter. This aggregation is optional if the surrounding EcucModuleDef has the category STANDARDIZED_MODULE_DEFINITION. If the category attribute of the EcucModuleDef is set to VENDOR_SPECIFIC_MODULE_DEFINITION then this aggregation is mandatory. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=shortName

Table E.27: EcucEnumerationParamDef

Class	**EcucFloatParamDef**			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Configuration parameter type for Float. **Tags:** xml.sequenceOffset=0			
Base	ARObject, AtpDefinition, EcucCommonAttributes, EcucDefinitionElement, EcucParameterDef, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

defaultValue	Float	0..1	attr	Default value of the float configuration parameter. atpVariation: [RS_ECUC_00083] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime
max	Limit	0..1	attr	Max value allowed for the parameter defined. atpVariation: [RS_ECUC_00084] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime
min	Limit	0..1	attr	Min value allowed for the parameter defined. atpVariation: [RS_ECUC_00084] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime

Table E.28: EcucFloatParamDef

Class	**EcucIntegerParamDef**			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Configuration parameter type for Integer. **Tags:** xml.sequenceOffset=0			
Base	ARObject, AtpDefinition, EcucCommonAttributes, EcucDefinitionElement, EcucParameterDef, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
defaultValue	UnlimitedInteger	0..1	attr	Default value of the integer configuration parameter. atpVariation: [RS_ECUC_00083] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime
max	UnlimitedInteger	0..1	attr	Max value allowed for the parameter defined. atpVariation: [RS_ECUC_00084] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime
min	UnlimitedInteger	0..1	attr	Min value allowed for the parameter defined. atpVariation: [RS_ECUC_00084] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime

Table E.29: EcucIntegerParamDef

Class	**EcucNumericalParamValue**			
Package	M2::AUTOSARTemplates::ECUCDescriptionTemplate			
Note	Holding the value which is subject to variant handling.			
Base	ARObject, EcucIndexableValue, EcucParameterValue			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
value	Numerical	1	attr	Value which is subject to variant handling. atpVariation: [RS_ECUC_00080] **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime

Table E.30: EcucNumericalParamValue

Class	**EcucParameterDef (abstract)**			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Abstract class used to define the similarities of all ECU Configuration Parameter types defined as subclasses.			
Base	ARObject, AtpDefinition, EcucCommonAttributes, EcucDefinitionElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
derivation	EcucDerivation Specification	0..1	aggr	A derivation of a Configuration Parameter value can be specified by an informal Calculation Formula or by a formal language that can be used to specify the computational rules.
symbolicN ameValue	Boolean	1	attr	Specifies that this parameter's value is used, together with the aggregating container, to derive a symbolic name definition. See chapter "Representation of Symbolic Names" in Ecuc specification for more details.
withAuto	Boolean	0..1	attr	Specifies whether it shall be allowed on the value side to specify this parameter value as "AUTO". If withAuto is "true" it shall be possible to set the "isAutoValue" attribute of the respective parameter to "true". This means that the actual value will not be considered during ECU Configuration but will be (re-)calculated by the code generator and stored in the value attribute afterwards. These implicit updated values might require a re-generation of other modules which reference these values. If withAuto is "false" it shall not be possible to set the "isAutoValue" attribute of the respective parameter to "true". If withAuto is not present the default is "false".

Table E.31: EcucParameterDef

Class	**EcucParameterValue (abstract)**			
Package	M2::AUTOSARTemplates::ECUCDescriptionTemplate			
Note	Common class to all types of configuration values.			
Base	ARObject, EcucIndexableValue			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
annotation	Annotation	*	aggr	Possibility to provide additional notes while defining the ECU Configuration Parameter Values. These are not intended as documentation but are mere design notes. **Tags:** xml.sequenceOffset=10
definition	EcucParameterDef	1	ref	Reference to the definition of this EcucParameterValue subclasses in the ECU Configuration Parameter Definition. **Tags:** xml.sequenceOffset=-10
isAutoValue	Boolean	0..1	attr	If withAuto is set to "true" for this parameter definition the isAutoValue can be set to "true". If isAutoValue is set to "true" the actual value will not be considered during ECU Configuration but will be (re-)calculated by the code generator and stored in the value attribute afterwards. These implicit updated values might require a re-generation of other modules which reference these values. If isAutoValue is not present the default is "false". **Tags:** xml.sequenceOffset=20

Table E.32: EcucParameterValue

Class	**EcucReferenceDef**			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Specify references within the ECU Configuration Description between parameter containers.			
Base	ARObject, AtpDefinition, EcucAbstractInternalReferenceDef, EcucAbstractReferenceDef, EcucCommonAttributes, EcucDefinitionElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
destination	EcucContainerDef	1	ref	Exactly one reference to a parameter container is allowed as destination. **Stereotypes:** atpUriDef

Table E.33: EcucReferenceDef

Class	EcucReferenceValue			
Package	M2::AUTOSARTemplates::ECUCDescriptionTemplate			
Note	Used to represent a configuration value that has a parameter definition of type EcucAbstractReferenceDef (used for all of its specializations excluding EcucInstanceReferenceDef).			
Base	ARObject, EcucAbstractReferenceValue, EcucIndexableValue			
Attribute	Type	Mul.	Kind	Note
value	Referrable	1	ref	Specifies the destination of the reference.

Table E.34: EcucReferenceValue

Class	EcucSymbolicNameReferenceDef			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	This meta-class specifies that the implementation of the reference is done using a symbolic name defined by the referenced Container's shortName.			
Base	ARObject, AtpDefinition, EcucAbstractInternalReferenceDef, EcucAbstractReferenceDef, EcucCommonAttributes, EcucDefinitionElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mul.	Kind	Note
destination	EcucParamConfContainerDef	1	ref	Exactly one reference to a parameter container is allowed as destination. **Stereotypes:** atpUriDef

Table E.35: EcucSymbolicNameReferenceDef

Class	EcucTextualParamValue			
Package	M2::AUTOSARTemplates::ECUCDescriptionTemplate			
Note	Holding a value which is not subject to variation.			
Base	ARObject, EcucIndexableValue, EcucParameterValue			
Attribute	Type	Mul.	Kind	Note
value	VerbatimString	1	attr	Value of the parameter, not subject to variant handling.

Table E.36: EcucTextualParamValue

Class	EcucUriReferenceDef			
Package	M2::AUTOSARTemplates::ECUCParameterDefTemplate			
Note	Definition of reference with a destination that is specified via a destinationUri. With such a reference it is possible to define a reference to a EcucContainerDef in a different module independent from the concrete definition of the target container.			
Base	ARObject, AtpDefinition, EcucAbstractInternalReferenceDef, EcucAbstractReferenceDef, EcucCommonAttributes, EcucDefinitionElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	Type	Mul.	Kind	Note

destination Uri	EcucDestination UriDef	1	ref	Any EcucContainerDef with a destinationUri that is identical to the destinationUri that is referenced here defines a valid target. **Stereotypes:** atpUriDef

Table E.37: EcucUriReferenceDef

Class	**EnumerationMappingEntry**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariation Points			
Note	This class specifies the entry elements of the enumeration mapping table. Note that this class might be used in the extended meta-model only.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
enumeratorValue	NameToken	1	attr	This attribute specifies the symbolic value (e.g. in, out) of the enumeration entry. **Tags:** xml.sequenceOffset=20
numericalValue	PositiveInteger	1	attr	This attribute specifies the numerical value (e.g. 0, 1) of the enumeration entry. **Tags:** xml.sequenceOffset=10

Table E.38: EnumerationMappingEntry

Class	**EnumerationMappingTable**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling::AttributeValueVariation Points			
Note	This class represents an attribute value variation point for Enumeration attributes. Note that this class might be used in the extended meta-model only. **Tags:** atp.recommendedPackage=EnumerationMappingTables			
Base	ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
entry	EnumerationMappingEntry	*	aggr	**Tags:** xml.roleElement=true; xml.roleWrapperElement=true; xml.typeElement=false; xml.typeWrapperElement=false

Table E.39: EnumerationMappingTable

Class	**FibexElement (abstract)**			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore			
Note	ASAM FIBEX elements specifying Communication and Topology.			
Base	ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
–	–	–	–	–

Table E.40: FibexElement

Class	**FlatMap**			
Package	M2::AUTOSARTemplates::CommonStructure::FlatMap			
Note	Contains a flat list of references to software objects. This list is used to identify instances and to resolve name conflicts. The scope is given by the RootSwCompositionPrototype for which it is used, i.e. it can be applied to a system, system extract or ECU-extract. An instance of FlatMap may also be used in a preliminary context, e.g. in the scope of a software component before integration into a system. In this case it is not referred by a RootSwCompositionPrototype. **Tags:** atp.recommendedPackage=FlatMaps			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
instance	FlatInstanceDescriptor	1..*	aggr	A descriptor instance aggregated in the flat map. The variation point accounts for the fact, that the system in scope can be subject to variability, and thus the existence of some instances is variable. The aggregation has been made splitable because the content might be contributed by different stakeholders at different times in the workflow. Plus, the overall size might be so big that eventually it becomes more manageable if it is distributed over several files. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild

Table E.41: FlatMap

Class	≪atpVariation≫ **FlexrayCommunicationController**			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::Fibex4Flexray::FlexrayTopology			
Note	FlexRay bus specific communication port attributes.			
Base	ARObject, CommunicationController, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
acceptedStartupRange	Integer	1	attr	Expanded range of measured clock deviation allowed for startup frames during integration. Unit:microtick
allowHaltDueToClock	Boolean	1	attr	Boolean flag that controls the transition to the POC:halt state due to a clock synchronization errors. If set to true, the Communication Controller is allowed to transition to POC:halt. If set to false, the Communication Controller will not transition to the POC:halt state but will enter or remain in the normal POC (passive State).
allowPassiveToActive	Integer	0..1	attr	Number of consecutive even/odd cycle pairs that must have valid clock correction terms before the Communication Controller will be allowed to transition from the POC:normal passive state to POC:normal active state. If set to 0, the Communication Controller is not allowed to transition from POC:norm
clusterDriftDamping	Integer	1	attr	The cluster drift damping factor used in clock synchronization rate correction in microticks
decodingCorrection	Integer	1	attr	Value used by the receiver to calculate the difference between primary time reference point and secondary time reference point. Unit: Microticks (pDecodingCorrection)
delayCompensationA	Integer	0..1	attr	Value used to compensate for reception delays on channel A Unit: Microticks. This optional parameter shall only be filled out if channel A is used.
delayCompensationB	Integer	0..1	attr	Value used to compensate for reception delays on channel B. Unit: Microticks. This optional parameter shall only be filled out if channel B is used.
externOffsetCorrection	Integer	0..1	attr	Fixed amount added or subtracted to the calculated offset correction term to facilitate external offset correction, expressed in node-local microticks.
externRateCorrection	Integer	0..1	attr	Fixed amount added or subtracted to the calculated rate correction term to facilitate external rate correction, expressed in node-local microticks.
externalSync	Boolean	0..1	attr	Flag indicating whether the node is externally synchronized (operating as Time Gateway Sink in an TT-E Time Triggered External Sync cluster) or locally synchronized.

fallBackInternal	Boolean	0..1	attr	Flag indicating whether a Time Gateway Sink node will switch to local clock operation when synchronization with the Time Gateway Source node is lost (pFallBackInternal = true) or will instead go to POC:ready (pFallBackInternal = false).
flexrayFifo	FlexrayFifoConfiguration	*	aggr	One First In First Out (FIFO) queued receive structure, defining the admittance criteria to the FIFO.
keySlotID	PositiveInteger	0..1	attr	ID of the slot used to transmit the startup frame, sync frame, or designated single slot frame. If the attributes keySlotUsedForStartUp, keySlotUsedForSync, or keySlotOnlyEnabled are set to true the key slot value is mandatory.
keySlotOnlyEnabled	Boolean	1	attr	Flag indicating whether or not the node shall enter key slot only mode following startup.
keySlotUsedForStartUp	Boolean	1	attr	Flag indicating whether the Key Slot is used to transmit a startup frame.
keySlotUsedForSync	Boolean	1	attr	Flag indicating whether the Key Slot is used to transmit a sync frame.
latestTX	Integer	1	attr	The number of the last minislot in which a transmission can start in the dynamic segment for the respective node
listenTimeout	Integer	1	attr	Value for the startup listen timeout and wakeup listen timeout. Although this is a node local parameter, the real time equivalent of this value should be the same for all nodes in the cluster. Unit: Microticks
macroInitialOffsetA	Integer	0..1	attr	Integer number of macroticks between the static slot boundary and the closest macrotick boundary of the secondary time reference point based on the nominal macrotick duration. (pMacroInitialOffset). This optional parameter shall only be filled out if channel A is used.
macroInitialOffsetB	Integer	0..1	attr	Integer number of macroticks between the static slot boundary and the closest macrotick boundary of the secondary time reference point based on the nominal macrotick duration. (pMacroInitialOffset). This optional parameter shall only be filled out if channel B is used.
maximumDynamicPayloadLength	Integer	1	attr	Maximum payload length for the dynamic channel of a frame in 16 bit WORDS.

microInitial OffsetA	Integer	0..1	attr	Number of microticks between the closest macrotick boundary described by gMacroInitialOffset and the secondary time reference point. The parameter depends on pDelayCompensationA and therefore it has to be set independently for each channel. This optional parameter shall only be filled out if channel A is used.
microInitial OffsetB	Integer	0..1	attr	Number of microticks between the closest macrotick boundary described by gMacroInitialOffset and the secondary time reference point. The parameter depends on pDelayCompensationB and therefore it has to be set independently for each channel. This optional parameter shall only be filled out if channel B is used.
microPerC ycle	Integer	1	attr	The nominal number of microticks in a communication cycle
microtickD uration	TimeValue	0..1	attr	Duration of a microtick. This attribute can be derived from samplePerMicrotick and gdSampleClockPeriod. Unit: seconds
nmVectorE arlyUpdate	Boolean	0..1	attr	Flag indicating when the update of the Network Management Vector in the CHI shall take place. If set to false, the update shall take place after the NIT. If set to true, the update shall take place after the end of the static segment.
offsetCorre ctionOut	Integer	1	attr	Magnitude of the maximum permissible offset correction value. Unit:microtick (pOffsetCorrectionOut)
rateCorrect ionOut	Integer	1	attr	Magnitude of the maximum permissible rate correction value and the maximum drift offset between two nodes operating with unsynchronized clocks for one communication cycle. Unit:Microticks (pRateCorrectionOut) Remarks: This parameter maps to FlexRay Protocol 2.1 Rev. A parameter pdMaxDrift.
samplesPe rMicrotick	Integer	0..1	attr	Number of samples per microtick
secondKey SlotId	PositiveInteger	0..1	attr	ID of the second Key slot, in which a second startup frame shall be sent in TT-L Time Triggered Local Master Sync or TT-E Time Triggered External Sync mode. If this parameter is set to zero the node does not have a second key slot.
twoKeySlot Mode	Boolean	0..1	attr	Flag indicating whether node operates as a startup node in a TT-E Time Triggered External Sync or TT-L Time Triggered Local Master Sync cluster.
wakeUpPa ttern	Integer	1	attr	Number of repetitions of the Tx-wakeup symbol to be sent during the CC_WakeupSend state of this Node in the cluster

Table E.42: FlexrayCommunicationController

Class	≪atpMixedString≫ **FormulaExpression (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::FormulaLanguage			
Note	This class represents the syntax of the formula language. The class is modeled as an abstract class in order to be specialized into particular use cases. For each use case the referable objects might be specified in the specialization.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
atpReference	Referrable	*	ref	The referable object shall yield a numerical / boolean value. **Stereotypes:** atpAbstract
atpStringReference	Referrable	*	ref	The referable object shall yield a string value. **Stereotypes:** atpAbstract

Table E.43: FormulaExpression

Class	**GenericModelReference**			
Package	M2::AUTOSARTemplates::GenericStructure::BuildActionManifest			
Note	This meta-class represents the ability to express a late binding reference to a model element. The model element can be from every model. Even if it is modeled according to the association representation, it is not limited to refer to AUTOSAR model elements.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
base	NameToken	1	attr	This establishes the reference base. **Tags:** xml.attribute=true
dest	NameToken	1	attr	This attribute represents the class of the referenced model element. It is a String, since the model element can be in any model. Therefore we cannot have any assumption here. **Tags:** xml.attribute=true
ref	Ref	1	attr	This is the full qualified name of the model element **Tags:** xml.roleElement=true; xml.roleWrapperElement=false; xml.typeElement=false; xml.typeWrapperElement=false

Table E.44: GenericModelReference

Class	**Implementation (abstract)**			
Package	M2::AUTOSARTemplates::CommonStructure::Implementation			
Note	Description of an implementation a single software component or module.			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**

buildActionManifest	BuildActionManifest	0..1	ref	A manifest specifying the intended build actions for the software delivered with this implementation. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=codeGenerationTime
codeDescriptor	Code	1..*	aggr	Specifies the provided implementation code.
compiler	Compiler	*	aggr	Specifies the compiler for which this implementation has been released
generatedArtifact	DependencyOnArtifact	*	aggr	Relates to an artifact that will be generated during the integration of this Implementation by an associated generator tool. Note that this is an optional information since it might not always be in the scope of a single module or component to provide this information. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
hwElement	HwElement	*	ref	The hardware elements (e.g. the processor) required for this implementation.
linker	Linker	*	aggr	Specifies the linker for which this implementation has been released.
mcSupport	McSupportData	0..1	aggr	The measurement & calibration support data belonging to this implementation. The aggregtion is «atpSplitable» because in case of an already exisiting BSW Implementation model, this description will be added later in the process, namely at code generation time. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=mcSupport
programmingLanguage	ProgramminglanguageEnum	1	attr	Programming language the implementation was created in.
requiredArtifact	DependencyOnArtifact	*	aggr	Specifies that this Implementation depends on the existance of another artifact (e.g. a library). This aggregation of DependencyOnArtifact is subject to variability with the purpose to support variability in the implementations. Different algorithms in the implementation might cause different dependencies, e.g. the number of used libraries. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
requiredGeneratorTool	DependencyOnArtifact	*	aggr	Relates this Implementation to a generator tool in order to generate additional artifacts during integration. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime

resourceConsumption	ResourceConsumption	1	aggr	All static and dynamic resources for each implementation are described within the ResourceConsumption class. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=shortName
swVersion	RevisionLabelString	1	attr	Software version of this implementation. The numbering contains three levels (like major, minor, patch), its values are vendor specific.
swcBswMapping	SwcBswMapping	0..1	ref	This allows a mapping between an SWC and a BSW behavior to be attached to an implementation description (for AUTOSAR Service, ECU Abstraction and Complex Driver Components). It is up to the methodology to define whether this reference has to be set for the Swc- or BswImplementtion or for both.
usedCodeGenerator	String	0..1	attr	Optional: code generator used.
vendorId	PositiveInteger	1	attr	Vendor ID of this Implementation according to the AUTOSAR vendor list

Table E.45: Implementation

Class	**ImplementationDataType**			
Package	M2::AUTOSARTemplates::CommonStructure::ImplementationDataTypes			
Note	Describes a reusable data type on the implementation level. This will typically correspond to a typedef in C-code. **Tags:** atp.recommendedPackage=ImplementationDataTypes			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, AutosarDataType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
dynamicArraySizeProfile	String	0..1	attr	Specifies the profile which the array will follow in case this data type is a variable size array.
subElement (ordered)	ImplementationDataTypeElement	*	aggr	Specifies an element of an array, struct, or union data type. The aggregation of ImplementionDataTypeElement is subject to variability with the purpose to support the conditional existence of elements inside a ImplementationDataType representing a structure. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
symbolProps	SymbolProps	0..1	aggr	This represents the SymbolProps for the ImplementationDataType. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=shortName

typeEmitter	NameToken	0..1	attr	This attribute is used to control which part of the AUTOSAR toolchain is supposed to trigger data type definitions.

Table E.46: ImplementationDataType

Class	**ImplementationDataTypeElement**			
Package	M2::AUTOSARTemplates::CommonStructure::ImplementationDataTypes			
Note	Declares a data object which is locally aggregated. Such an element can only be used within the scope where it is aggregated. This element either consists of further subElements or it is further defined via its swDataDefProps. There are several use cases within the system of ImplementationDataTypes fur such a local declaration: • It can represent the elements of an array, defining the element type and array size • It can represent an element of a struct, defining its type • It can be the local declaration of a debug element.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
arraySize	PositiveInteger	0..1	attr	The existence of this attributes (if bigger than 0) defines the size of an array and declares that this ImplementationDataTypeElement represents the type of each single array element. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
arraySizeHandling	ArraySizeHandlingEnum	0..1	attr	The way how the size of the array is handled in case of a variable size array.
arraySizeSemantics	ArraySizeSemanticsEnum	0..1	attr	This attribute controls the meaning of the value of the array size.
subElement (ordered)	ImplementationDataTypeElement	*	aggr	Element of an array, struct, or union in case of a nested declaration (i.e. without using "typedefs"). The aggregation of ImplementionDataTypeElement is subject to variability with the purpose to support the conditional existence of elements inside a ImplementationDataType representing a structure. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime
swDataDefProps	SwDataDefProps	0..1	aggr	The properties of this ImplementationDataTypeElementt.

Table E.47: ImplementationDataTypeElement

Class	**InternalBehavior (abstract)**			
Package	M2::AUTOSARTemplates::CommonStructure::InternalBehavior			
Note	Common base class (abstract) for the internal behavior of both software components and basic software modules/clusters.			
Base	ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
constantMemory	ParameterDataPrototype	*	aggr	Describes a read only memory object containing characteristic value(s) implemented by this InternalBehavior. The shortName of ParameterDataPrototype has to be equal to the "C' identifier of the described constant. The characteristic value(s) might be shared between SwComponentPrototypes of the same SwComponentType. The aggregation of constantMemory is subject to variability with the purpose to support variability in the software component or module implementations. Typically different algorithms in the implementation are requiring different number of memory objects. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime
constantValueMapping	ConstantSpecificationMappingSet	*	ref	Reference to the ConstanSpecificationMapping to be applied for the particular InternalBehavior **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=constantValueMapping
dataTypeMapping	DataTypeMappingSet	*	ref	Reference to the DataTypeMapping to be applied for the particular InternalBehavior **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=dataTypeMapping
exclusiveArea	ExclusiveArea	*	aggr	This specifies an ExclusiveArea for this InternalBehavior. The exclusiveArea is local to the component resp. module. The aggregation of ExclusiveAreas is subject to variability. Note: the number of ExclusiveAreas might vary due to the conditional existence of RunnableEntities or BswModuleEntities. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime

exclusiveAreaNestingOrder	ExclusiveAreaNestingOrder	*	aggr	This represents the set of ExclusiveAreaNestingOrder owned by the InternalBehavior. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime
staticMemory	VariableDataPrototype	*	aggr	Describes a read and writeable static memory object representing measurerment variables implemented by this software component. The term "static" is used in the meaning of "non-temporary" and does not necessarily specify a linker encapsulation. This kind of memory is only supported if supportsMultipleInstantiation is FALSE. The shortName of the VariableDataPrototype has to be equal with the "C' identifier of the described variable. The aggregation of staticMemory is subject to variability with the purpose to support variability in the software component's implementations. Typically different algorithms in the implementation are requiring different number of memory objects. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime

Table E.48: InternalBehavior

Class	**Keyword**			
Package	M2::AUTOSARTemplates::StandardizationTemplate::Keyword			
Note	This meta-class represents the ability to predefine keywords which may subsequently be used to construct names following a given naming convention, e.g. the AUTOSAR naming conventions. Note that such names is not only shortName. It could be symbol, or even longName. Application of keywords is not limited to particular names.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
abbrName	NameToken	1	attr	This attribute specifies an abbreviated name of a keyword. This abbreviation may e.g. be used for constructing valid shortNames according to the AUTOSAR naming conventions. Unlike shortName, it may contain any name token. E.g. it may consist of digits only.

classification	NameToken	*	attr	This attribute allows to attach classification to the Keyword such as MEAN, ACTION, CONDITION, INDEX, PREPOSITION

Table E.49: Keyword

Class	≪atpMixedString≫ **MixedContentForPlainText (abstract)**			
Package	M2::MSR::Documentation::TextModel::InlineTextModel			
Note	This represents a plain text which conceptually is handled as mixed contents. It is modeled as such for symmetry reasons.			
Base	ARObject, WhitespaceControlled			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
–	–	–	–	–

Table E.50: MixedContentForPlainText

Class	≪atpMixedString≫ **MixedContentForUnitNames (abstract)**			
Package	M2::MSR::Documentation::TextModel::InlineTextModel			
Note	This is the text model for items with subscript and superscripts such as measurement unit designations. It is intended, that such models can easily be transcribed to a plain text model either by using appropriate characters or by transcribing like mˆ 2.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
sub	Superscript	1	attr	This is subscript text. **Tags:** xml.sequenceOffset=40
sup	Superscript	1	attr	This is superscript text. **Tags:** xml.sequenceOffset=30

Table E.51: MixedContentForUnitNames

Class	**MsrQueryP2**			
Package	M2::MSR::Documentation::MsrQuery			
Note	This meta-class represents the ability to express a query which yields the content of a DocumentationBlock as a result.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
msrQueryProps	MsrQueryProps	1	aggr	This is argument and properties of the DocumentationBlock query. **Tags:** xml.sequenceOffset=20
msrQueryResultP2	DocumentationBlock	0..1	aggr	This represents the result of the query. **Tags:** xml.sequenceOffset=30

Table E.52: MsrQueryP2

Class	**MultidimensionalTime**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::MultidimensionalTime			
Note	This is used to specify a multidimensional time value based on ASAM CSE codes. It is specified by a code which defined the basis of the time and a scaling factor which finally determines the time value. If for example the cseCode is 100 and the cseCodeFactor is 360, it represents 360 angular degrees. If the cseCode is 0 and the cseCodeFactor is 50 it represents 50 microseconds.			
Base	ARObject			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
cseCode	CseCodeType	1	attr	Specifies the time base by means of CSE codes.
cseCodeFactor	Integer	1	attr	The scaling factor for the time value based on the specified CSE code.

Table E.53: MultidimensionalTime

Class	**PPortPrototype**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	Component port providing a certain port interface.			
Base	ARObject, AbstractProvidedPortPrototype, AtpBlueprintable, AtpFeature, AtpPrototype, Identifiable, MultilanguageReferrable, PortPrototype, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
providedInterface	PortInterface	1	tref	The interface that this port provides. **Stereotypes:** isOfType

Table E.54: PPortPrototype

Class	**ParameterDataPrototype**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Datatype::DataPrototypes			
Note	A parameter element used for parameter interface and internal behavior, supporting signal like parameter and characteristic value communication patterns and parameter and characteristic value definition.			
Base	ARObject, AtpFeature, AtpPrototype, AutosarDataPrototype, DataPrototype, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
initValue	ValueSpecification	0..1	aggr	Specifies initial value(s) of the ParameterDataPrototype

Table E.55: ParameterDataPrototype

Class	**PhysicalChannel (abstract)**			
Package	M2::AUTOSARTemplates::SystemTemplate::Fibex::FibexCore::CoreTopology			
Note	A physical channel is the transmission medium that is used to send and receive information between communicating ECUs. Each CommunicationCluster has at least one physical channel. Bus systems like CAN and LIN only have exactly one PhysicalChannel. A FlexRay cluster may have more than one PhysicalChannels that may be used in parallel for redundant communication. An ECU is part of a cluster if it contains at least one controller that is connected to at least one channel of the cluster.			
Base	ARObject, Identifiable, MultilanguageReferrable, Referrable			
Attribute	*Type*	*Mul.*	*Kind*	*Note*
commConnector	CommunicationConnector	1..*	ref	Reference to the ECUInstance via a CommunicationConnector to which the channel is connected. atpVariation: Variable assignment of Physical Channels to different CommunicationConnectors is expressed with this variation. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild
frameTriggering	FrameTriggering	*	aggr	One frame triggering is defined for exactly one channel. Channels may have assigned an arbitrary number of frame triggerings. atpVariation: If signals/PDUs/frames are variable, the corresponding triggerings must be variable, too. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild
iSignalTriggering	ISignalTriggering	*	aggr	One ISignalTriggering is defined for exactly one channel. Channels may have assigned an arbitrary number of ISignaltriggerings. atpVariation: If signals/PDUs/frames are variable, the corresponding triggerings must be variable, too. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild

pduTriggering	PduTriggering	*	aggr	One PduTriggering is defined for exactly one channel. Channels may have assigned an arbitrary number of I-Pdu triggerings. atpVariation: If signals/PDUs/frames are variable, the corresponding triggerings must be variable, too. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild

Table E.56: PhysicalChannel

Class	**PortInterface (abstract)**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::PortInterface			
Note	Abstract base class for an interface that is either provided or required by a port of a software component.			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
isService	Boolean	1	attr	This flag is set if the PortInterface is to be used for communication between an • ApplicationSwComponentType or • ServiceProxySwComponentType or • SensorActuatorSwComponentType or • ComplexDeviceDriverSwComponentType • ServiceSwComponentType • EcuAbstractionSwComponentType and a ServiceSwComponentType (namely an AUTOSAR Service) located on the same ECU. Otherwise the flag is not set.
serviceKind	ServiceProviderEnum	0..1	attr	This attribute provides further details about the nature of the applied service.

Table E.57: PortInterface

Class	**PortPrototype (abstract)**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	Base class for the ports of an AUTOSAR software component. The aggregation of PortPrototypes is subject to variability with the purpose to support the conditional existence of ports.			
Base	ARObject, AtpBlueprintable, AtpFeature, AtpPrototype, Identifiable, Multilanguage Referrable, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
clientServerAnnotation	ClientServerAnnotation	*	aggr	Annotation of this PortPrototype with respect to client/server communication.
delegatedPortAnnotation	DelegatedPortAnnotation	0..1	aggr	Annotations on this delegated port.
ioHwAbstractionServerAnnotation	IoHwAbstractionServerAnnotation	*	aggr	Annotations on this IO Hardware Abstraction port.
modePortAnnotation	ModePortAnnotation	*	aggr	Annotations on this mode port.
nvDataPortAnnotation	NvDataPortAnnotation	*	aggr	Annotations on this non voilatile data port.
parameterPortAnnotation	ParameterPortAnnotation	*	aggr	Annotations on this parameter port.
senderReceiverAnnotation	SenderReceiverAnnotation	*	aggr	Collection of annotations of this ports sender/receiver communication.
triggerPortAnnotation	TriggerPortAnnotation	*	aggr	Annotations on this trigger port.

Table E.58: PortPrototype

Class	**PortPrototypeBlueprint**			
Package	M2::AUTOSARTemplates::StandardizationTemplate::BlueprintDedicated::PortProtoypeBlueprint			
Note	This meta-class represents the ability to express a blueprint of a PortPrototype by referring to a particular PortInterface. This blueprint can then be used as a guidance to create particular PortPrototypes which are defined according to this blueprint. By this it is possible to standardize application interfaces without the need to also standardize software-components with PortPrototypes typed by the standardized PortInterfaces. **Tags:** atp.recommendedPackage=PortPrototypeBlueprints			
Base	ARElement, ARObject, AtpBlueprint, AtpClassifier, AtpFeature, AtpStructureElement, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
initValue	PortPrototypeBlueprintInitValue	*	aggr	This specifies the init values for the dataElements in the particular PortPrototypeBlueprint.

interface	PortInterface	1	ref	This is the interface for which the blueprint is defined. It may be a blueprint itself or a standardized PortInterface
providedComSpec	PPortComSpec	*	aggr	Provided communication attributes per interface element (data element or operation).
requiredComSpec	RPortComSpec	*	aggr	Required communication attributes, one for each interface element.

Table E.59: PortPrototypeBlueprint

Class	**PostBuildVariantCriterion**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This class specifies one particular PostBuildVariantSelector. **Tags:** atp.recommendedPackage=PostBuildVariantCriterions			
Base	ARElement, ARObject, AtpDefinition, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
compuMethod	CompuMethod	1	ref	The compuMethod specifies the possible values for the variant criterion serving as an enumerator.

Table E.60: PostBuildVariantCriterion

Class	**RPortInCompositionInstanceRef**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition::InstanceRefs			
Note				
Base	ARObject,AtpInstanceRef,PortInCompositionTypeInstanceRef			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
contextComponent	SwComponentPrototype	1	ref	**Tags:** xml.sequenceOffset=20
targetRPort	AbstractRequiredPortPrototype	1	ref	**Tags:** xml.sequenceOffset=30

Table E.61: RPortInCompositionInstanceRef

Class	**SingleLanguageReferrable (abstract)**			
Package	M2::AUTOSARTemplates::GenericStructure::GeneralTemplateClasses::Identifiable			
Note	Instances of this class can be referred to by their identifier (while adhering to namespace borders). They also may have a longName but in one language only. Specializations of this class only occur as inline elements in one particular language. Therefore they aggregate But they are not considered to contribute substantially to the overall structure of an AUTOSAR description. In particular it does not contain other Referrables.			
Base	ARObject, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

longName1	SingleLanguageLongName	0..1	aggr	This specifies the long name of the object. The role is longName1 for compatibilty to ASAM FSX

Table E.62: SingleLanguageReferrable

Class	**SwComponentPrototype**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Composition			
Note	Role of a software component within a composition.			
Base	ARObject, AtpFeature, AtpPrototype, Identifiable, MultilanguageReferrable, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
type	SwComponentType	1	tref	Type of the instance. **Stereotypes:** isOfType

Table E.63: SwComponentPrototype

Class	**SwComponentType (abstract)**			
Package	M2::AUTOSARTemplates::SWComponentTemplate::Components			
Note	Base class for AUTOSAR software components.			
Base	ARElement, ARObject, AtpBlueprint, AtpBlueprintable, AtpClassifier, AtpType, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
consistencyNeeds	ConsistencyNeeds	*	aggr	This represents the colelction of ConsistencyNeeds owned by the enclosing SwComponentType. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime
port	PortPrototype	*	aggr	The PortPrototypes through which this SwComponentType can communicate. The aggregation of PortPrototype is subject to variability with the purpose to support the conditional existence of PortPrototypes. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=preCompileTime
portGroup	PortGroup	*	aggr	A port group being part of this component. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime

swComponentDocumentation	SwComponentDocumentation	0..1	aggr	This adds a documentation to the SwComponentType. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=swComponentDocumentation, variationPoint.shortLabel vh.latestBindingTime=preCompileTime xml.sequenceOffset=-10
unitGroup	UnitGroup	*	ref	This allows for the specification of which UnitGroups are relevant in the context of referencing SwComponentType.

Table E.64: SwComponentType

Class	≪**atpVariation**≫ **SwDataDefProps**			
Package	M2::MSR::DataDictionary::DataDefProperties			
Note	This class is a collection of properties relevant for data objects under various aspects. One could consider this class as a "pattern of inheritance by aggregation". The properties can be applied to all objects of all classes in which SwDataDefProps is aggregated. Note that not all of the attributes or associated elements are useful all of the time. Hence, the process definition (e.g. expressed with an OCL or a Document Control Instance MSR-DCI) has the task of implementing limitations. SwDataDefProps covers various aspects: • Structure of the data element for calibration use cases: is it a single value, a curve, or a map, but also the recordLayouts which specify how such elements are mapped/converted to the DataTypes in the programming language (or in AUTOSAR). This is mainly expressed by properties like swRecordLayout and swCalprmAxisSet • Implementation aspects, mainly expressed by swImplPolicy, swVariableAccessImplPolicy, swAddrMethod, swPointerTagetProps, baseType, implementationDataType and additionalNativeTypeQualifier • Access policy for the MCD system, mainly expressed by swCalibrationAccess • Semantics of the data element, mainly expressed by compuMethod and/or unit, dataConstr, invalidValue • Code generation policy provided by swRecordLayout **Tags:** vh.latestBindingTime=codeGenerationTime			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

additionalNativeTypeQualifier	NativeDeclarationString	0..1	attr	This attribute is used to declare native qualifiers of the programming language which can neither be deduced from the baseType (e.g. because the data object describes a pointer) nor from other more abstract attributes. Examples are qualifiers like "volatile", "strict" or "enum" of the C-language. All such declarations have to be put into one string. **Tags:** xml.sequenceOffset=235
annotation	Annotation	*	aggr	This aggregation allows to add annotations (yellow pads ...) related to the current data object. **Tags:** xml.roleElement=true; xml.roleWrapperElement=true; xml.sequenceOffset=20; xml.typeElement=false; xml.typeWrapperElement=false
baseType	SwBaseType	0..1	ref	Base type associated with the containing data object. **Tags:** xml.sequenceOffset=50
compuMethod	CompuMethod	0..1	ref	Computation method associated with the semantics of this data object. **Tags:** xml.sequenceOffset=180
dataConstr	DataConstr	0..1	ref	Data constraint for this data object. **Tags:** xml.sequenceOffset=190
displayFormat	DisplayFormatString	0..1	attr	This property describes how a number is to be rendered e.g. in documents or in a measurement and calibration system. **Tags:** xml.sequenceOffset=210
implementationDataType	ImplementationDataType	0..1	ref	This association denotes the ImplementationDataType of a data declaration via its aggregated SwDataDefProps. It is used whenever a data declaration is not directly referring to a base type. Especially • redefinition of an ImplementationDataType via a "typedef" to another ImplementationDatatype • the target type of a pointer (see SwPointerTargetProps), if it does not refer to a base type directly • the data type of an array or record element within an ImplementationDataType, if it does not refer to a base type directly • the data type of an SwServiceArg, if it does not refer to a base type directly **Tags:** xml.sequenceOffset=215

invalidValue	ValueSpecification	0..1	aggr	Optional value to express invalidity of the actual data element. **Tags:** xml.sequenceOffset=255
stepSize	Float	0..1	attr	This attribute can be used to define a value which is added to or subtracted from the value of a DataPrototype when using up/down keys while calibrating.
swAddrMethod	SwAddrMethod	0..1	ref	Addressing method related to this data object. Via an association to the same SwAddrMethod it can be specified that several DataPrototypes shall be located in the same memory without already specifying the memory section itself. **Tags:** xml.sequenceOffset=30
swAlignment	AlignmentType	0..1	attr	The attribute describes the intended alignment of the DataPrototype. If the attribute is not defined the alignment is determined by the swBaseType size and the memoryAllocationKeywordPolicy of the referenced SwAddrMethod. **Tags:** xml.sequenceOffset=33
swBitRepresentation	SwBitRepresentation	0..1	aggr	Description of the binary representation in case of a bit variable. **Tags:** xml.sequenceOffset=60
swCalibrationAccess	SwCalibrationAccessEnum	0..1	attr	Specifies the read or write access by MCD tools for this data object. **Tags:** xml.sequenceOffset=70
swCalprmAxisSet	SwCalprmAxisSet	0..1	aggr	This specifies the properties of the axes in case of a curve or map etc. This is mainly applicable to calibration parameters. **Tags:** xml.sequenceOffset=90
swComparisonVariable	SwVariableRefProxy	*	aggr	Variables used for comparison in an MCD process. **Tags:** xml.sequenceOffset=170; xml.typeElement=false
swDataDependency	SwDataDependency	0..1	aggr	Describes how the value of the data object has to be calculated from the value of another data object (by the MCD system). **Tags:** xml.sequenceOffset=200
swHostVariable	SwVariableRefProxy	0..1	aggr	Contains a reference to a variable which serves as a host-variable for a bit variable. Only applicable to bit objects. **Tags:** xml.sequenceOffset=220; xml.typeElement=false

swImplPolicy	SwImplPolicyEnum	0..1	attr	Implementation policy for this data object. **Tags:** xml.sequenceOffset=230
swIntendedResolution	Numerical	0..1	attr	The purpose of this element is to describe the requested quantization of data objects early on in the design process. The resolution ultimately occurs via the conversion formula present (compuMethod), which specifies the transition from the physical world to the standardized world (and vice-versa) (here, "the slope per bit" is present implicitly in the conversion formula). In the case of a development phase without a fixed conversion formula, a pre-specification can occur through swIntendedResolution. The resolution is specified in the physical domain according to the property "unit". **Tags:** xml.sequenceOffset=240
swInterpolationMethod	Identifier	0..1	attr	This is a keyword identifying the mathematical method to be applied for interpolation. The keyword needs to be related to the interpolation routine which needs to be invoked. **Tags:** xml.sequenceOffset=250
swIsVirtual	Boolean	0..1	attr	This element distinguishes virtual objects. Virtual objects do not appear in the memory, their derivation is much more dependent on other objects and hence they shall have a swDataDependency . **Tags:** xml.sequenceOffset=260
swPointerTargetProps	SwPointerTargetProps	0..1	aggr	Specifies that the containing data object is a pointer to another data object. **Tags:** xml.sequenceOffset=280
swRecordLayout	SwRecordLayout	0..1	ref	Record layout for this data object. **Tags:** xml.sequenceOffset=290
swRefreshTiming	MultidimensionalTime	0..1	aggr	This element specifies the frequency in which the object involved shall be or is called or calculated. This timing can be collected from the task in which write access processes to the variable run. But this cannot be done by the MCD system. So this attribute can be used in an early phase to express the desired refresh timing and later on to specify the real refresh timing. **Tags:** xml.sequenceOffset=300

swTextProps	SwTextProps	0..1	aggr	the specific properties if the data object is a text object. **Tags:** xml.sequenceOffset=120
swValueBlockSize	Numerical	0..1	attr	This represents the size of a Value Block **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=preCompileTime xml.sequenceOffset=80
unit	Unit	0..1	ref	Physical unit associated with the semantics of this data object. This attribute applies if no compuMethod is specified. If both units (this as well as via compuMethod) are specified the units shall be compatible. **Tags:** xml.sequenceOffset=350
valueAxisDataType	ApplicationPrimitiveDataType	0..1	ref	The referenced ApplicationPrimitiveDataType represents the primitive data type of the value axis within a compound primitive (e.g. curve, map). It supersedes CompuMethod, Unit, and BaseType. **Tags:** xml.sequenceOffset=355

Table E.65: SwDataDefProps

Class	**SwSystemconstantValueSet**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class represents the ability to specify a set of system constant values. **Tags:** atp.recommendedPackage=SwSystemconstantValueSets			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
swSystemconstantValue	SwSystemconstValue	*	aggr	This is one particular value of a system constant.

Table E.66: SwSystemconstantValueSet

Class	**SwSystemconstantValueSet**			
Package	M2::AUTOSARTemplates::GenericStructure::VariantHandling			
Note	This meta-class represents the ability to specify a set of system constant values. **Tags:** atp.recommendedPackage=SwSystemconstantValueSets			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
swSystemconstantValue	SwSystemconstValue	*	aggr	This is one particular value of a system constant.

Table E.67: SwSystemconstantValueSet

Class	**System**			
Package	M2::AUTOSARTemplates::SystemTemplate			
Note	The top level element of the System Description. The System description defines five major elements: Topology, Software, Communication, Mapping and Mapping Constraints. The System element directly aggregates the elements describing the Software, Mapping and Mapping Constraints; it contains a reference to an ASAM FIBEX description specifying Communication and Topology. **Tags:** atp.recommendedPackage=Systems			
Base	ARElement, ARObject, AtpClassifier, AtpFeature, AtpStructureElement, Collectable Element, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
clientIdDefinitionSet	ClientIdDefinitionSet	*	ref	Set of Client Identifiers that are used for inter-ECU client-server communication in the System.
containerIPduHeaderByteOrder	ByteOrderEnum	0..1	attr	Defines the byteOrder of the header in ContainerIPdus.
ecuExtractVersion	RevisionLabelString	0..1	attr	Version number of the Ecu Extract.
fibexElement	FibexElement	*	ref	Reference to ASAM FIBEX elements specifying Communication and Topology. All Fibex Elements used within a System Description shall be referenced from the System Element. atpVariation: In order to describe a product-line, all FibexElements can be optional. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild
j1939SharedAddressCluster	J1939SharedAddressCluster	*	aggr	Collection of J1939Clusters that share a common address space for the routing of messages. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild

mapping	SystemMapping	*	aggr	Aggregation of all mapping aspects (mapping of SW components to ECUs, mapping of data elements to signals, and mapping constraints). In order to support OEM / Tier 1 interaction and shared development for one common System this aggregation is atpSplitable and atpVariation. The content of SystemMapping can be provided by several parties using different names for the SystemMapping. This element is not required when the System description is used for a network-only use-case. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variation Point.shortLabel vh.latestBindingTime=postBuild
pncVector Length	PositiveInteger	0..1	attr	Length of the partial networking request release information vector (in bytes).
pncVector Offset	PositiveInteger	0..1	attr	Absolute offset (with respect to the NM-PDU) of the partial networking request release information vector that is defined in bytes as an index starting with 0.
rootSoftwa reComposi tion	RootSwCompos itionPrototype	0..1	aggr	Aggregation of the root software composition, containing all software components in the System in a hierarchical structure. This element is not required when the System description is used for a network-only use-case. atpVariation: The RootSwCompositionPrototype can vary. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variation Point.shortLabel vh.latestBindingTime=systemDesignTime
systemDoc umentation	Chapter	*	aggr	Possibility to provide additional documentation while defining the System. The System documentation can be composed of several chapters. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variation Point.shortLabel vh.latestBindingTime=systemDesignTime xml.sequenceOffset=-10
systemVer sion	RevisionLabelSt ring	1	attr	Version number of the System Description.

Table E.68: System

Class	**TimingExtension (abstract)**			
Package	M2::AUTOSARTemplates::CommonStructure::Timing			
Note	The abstract parent class of the different template specific timing extensions. Depending on the specific timing extension (VfbTiming, SwcTiming, SystemTiming, BswModuleTiming, EcuTiming) the timing descriptions and timing constraints, that can be used to specify the timing behavior, are restricted.			
Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	**Type**	**Mul.**	**Kind**	**Note**
timingCondition	TimingCondition	*	aggr	The timing condition specifies a specific condition. **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild
timingDescription	TimingDescription	*	aggr	The timing descriptions that belong to a specific timing specification. In order to support different timing description variants within a timing specification, the aggregation is marked with the stereotype "atpVariation". **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild
timingGuarantee	TimingConstraint	*	aggr	The timing constraints that belong to a specific timing specification in the role of a timing guarantee. In order to support different timing constraint variants within a timing specification, the aggregation is marked with the stereotype "atpVariation". **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild
timingRequirement	TimingConstraint	*	aggr	The timing constraints that belong to a specific timing specification in the role of a timing requirement. In order to support different timing constraint variants within a timing specification, the aggregation is marked with the stereotype "atpVariation". **Stereotypes:** atpSplitable; atpVariation **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel vh.latestBindingTime=postBuild

timingResource	TimingExtensionResource	0..1	aggr	The timing resource contains all instance references referred from within a timing condition formula of a timing view. **Stereotypes:** atpSplitable **Tags:** atp.Splitkey=shortName, variationPoint.shortLabel

Table E.69: TimingExtension

Class	≪**atpMixed**≫ **TopicContent**			
Package	M2::MSR::Documentation::Chapters			
Note	This meta-class represents the content of a topic. It is mainly a documentation block, but can also be a table.			
Base	ARObject			
Attribute	***Type***	***Mul.***	***Kind***	***Note***
blockLevelContent	DocumentationBlock	1	aggr	This is that part of the content which may also occur in a table cell. **Tags:** xml.roleElement=false
table	Table	0..1	aggr	Ths represents a table within a topic. **Stereotypes:** atpVariation **Tags:** vh.latestBindingTime=postBuild

Table E.70: TopicContent

Class	**Unit**			
Package	M2::MSR::AsamHdo::Units			

Note	This is a physical measurement unit. All units that might be defined should stem from SI units. In order to convert one unit into another factor and offset are defined.
	
	For the calculation from SI-unit to the defined unit the factor (factorSiToUnit) and the offset (offsetSiToUnit) are applied as follows:
	`x [{unit}] := y * [{siUnit}] * factorSiToUnit [[unit]/{siUnit}] + offsetSiToUnit [{unit}]`
	
	For the calculation from a unit to SI-unit the reciprocal of the factor (factorSiToUnit) and the negation of the offset (offsetSiToUnit) are applied.
	`y {siUnit} := (x*{unit} - offsetSiToUnit [{unit}]) / (factorSiToUnit [[unit]/{siUnit}]`
	
	Tags: atp.recommendedPackage=Units			

Base	ARElement, ARObject, CollectableElement, Identifiable, MultilanguageReferrable, PackageableElement, Referrable			
Attribute	***Type***	***Mul.***	***Kind***	***Note***

displayName	SingleLanguageUnitNames	0..1	aggr	This specifies how the unit shall be displayed in documents or in user interfaces of tools.The displayName corresponds to the Unit.Display in an ASAM MCD-2MC file. **Tags:** xml.sequenceOffset=20
factorSiToUnit	Float	0..1	attr	This is the factor for the conversion from SI Units to units. The inverse is used for conversion from units to SI Units. **Tags:** xml.sequenceOffset=30
offsetSiToUnit	Float	0..1	attr	This is the offset for the conversion from and to siUnits. **Tags:** xml.sequenceOffset=40
physicalDimension	PhysicalDimension	0..1	ref	This association represents the physical dimension to which the unit belongs to. Note that only values with units of the same physical dimensions might be converted. **Tags:** xml.sequenceOffset=50

Table E.71: Unit

F Examples

This chapter contains more detailed information for examples which were shown inside the preceding chapters of the specification.

F.1 ShortLabels in VariationPoints

F.1.1 Identifiables with identical shortNames

The following ARXML files illustrate the use of shortLabels in case of identical shortNames and distribution in two partial models. The listing F.1 contains the identical shortNames as in the listing F.2 but both exist in separate partial models. Both have the atp.splitkey lb_MySWC/VP1 and the shortLabel (VP1). The listing F.3 has the atp.splitkey lb_MySWC/VP2 and the shortLabel (VP2). All three partial models can build a merged model with these two VariationPoints.

Listing F.1: Example for identical shortNames in partial model 1

```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0␣AUTOSAR_4-1-3.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Demo</SHORT-NAME>
      <AR-PACKAGES>
        <AR-PACKAGE>
          <SHORT-NAME>SwComponentTypes</SHORT-NAME>
          <ELEMENTS>
            <APPLICATION-SW-COMPONENT-TYPE>
              <SHORT-NAME>MySWC</SHORT-NAME>
              <INTERNAL-BEHAVIORS>
                <SWC-INTERNAL-BEHAVIOR>
                  <SHORT-NAME>Ib_MySWC</SHORT-NAME>
                  <RUNNABLES>
                    <RUNNABLE-ENTITY>
                      <SHORT-NAME>Run1</SHORT-NAME>
                    </RUNNABLE-ENTITY>
                  </RUNNABLES>
                  <VARIATION-POINT>
                    <SHORT-LABEL>VP1</SHORT-LABEL>
                    <SW-SYSCOND BINDING-TIME="CODE-GENERATION-TIME">
                      <SYSC-REF DEST="SW-SYSTEMCONST">/Demo/SystemConstants
                          /SY_TURBO</SYSC-REF>== 0</SW-SYSCOND>
                  </VARIATION-POINT>
                </SWC-INTERNAL-BEHAVIOR>
              </INTERNAL-BEHAVIORS>
            </APPLICATION-SW-COMPONENT-TYPE>
          </ELEMENTS>
        </AR-PACKAGE>
    <AR-PACKAGE>
```

```
            <SHORT-NAME>SystemConstants</SHORT-NAME>
            <ELEMENTS>
              <SW-SYSTEMCONST>
                <SHORT-NAME>SY_TURBO</SHORT-NAME>
                <SW-DATA-DEF-PROPS>
                  <SW-DATA-DEF-PROPS-VARIANTS>
                    <SW-DATA-DEF-PROPS-CONDITIONAL>
                      <SW-CALIBRATION-ACCESS>NOT-ACCESSIBLE</SW-CALIBRATION-
                          ACCESS>
                    </SW-DATA-DEF-PROPS-CONDITIONAL>
                  </SW-DATA-DEF-PROPS-VARIANTS>
                </SW-DATA-DEF-PROPS>
              </SW-SYSTEMCONST>
        </ELEMENTS>
      </AR-PACKAGE>
        </AR-PACKAGES>
      </AR-PACKAGE>
    </AR-PACKAGES>
</AUTOSAR>
```

Listing F.2: Example for identical `shortNames` in partial model 2

```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0␣AUTOSAR_4-1-3.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Demo</SHORT-NAME>
      <AR-PACKAGES>
        <AR-PACKAGE>
          <SHORT-NAME>SwComponentTypes</SHORT-NAME>
          <ELEMENTS>
            <APPLICATION-SW-COMPONENT-TYPE>
              <SHORT-NAME>MySWC</SHORT-NAME>
              <INTERNAL-BEHAVIORS>
                <SWC-INTERNAL-BEHAVIOR>
                  <SHORT-NAME>Ib_MySWC</SHORT-NAME>
                  <RUNNABLES>
                    <RUNNABLE-ENTITY>
                      <SHORT-NAME>Run2</SHORT-NAME>
                    </RUNNABLE-ENTITY>
                  </RUNNABLES>
                  <VARIATION-POINT>
                    <SHORT-LABEL>VP1</SHORT-LABEL>
                  </VARIATION-POINT>
                </SWC-INTERNAL-BEHAVIOR>
              </INTERNAL-BEHAVIORS>
            </APPLICATION-SW-COMPONENT-TYPE>
          </ELEMENTS>
        </AR-PACKAGE>
      </AR-PACKAGES>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

The following ARXML file contains the identical shortName as in the listing F.1 but a different shortLabel (VP2).

Listing F.3: Example for identical shortNames but different shortLabel

```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http:
    //autosar.org/schema/r4.0" xsi:schemaLocation="http://autosar.org/schema
    /r4.0␣AUTOSAR_4-1-3.xsd">
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>Demo</SHORT-NAME>
      <AR-PACKAGES>
        <AR-PACKAGE>
          <SHORT-NAME>SwComponentTypes</SHORT-NAME>
          <ELEMENTS>
            <APPLICATION-SW-COMPONENT-TYPE>
              <SHORT-NAME>MySWC</SHORT-NAME>
              <INTERNAL-BEHAVIORS>
                <SWC-INTERNAL-BEHAVIOR>
                  <SHORT-NAME>Ib_MySWC</SHORT-NAME>
                  <RUNNABLES>
                    <RUNNABLE-ENTITY>
                      <SHORT-NAME>Run1</SHORT-NAME>
                    </RUNNABLE-ENTITY>
                    <RUNNABLE-ENTITY>
                      <SHORT-NAME>Run3</SHORT-NAME>
                    </RUNNABLE-ENTITY>
                  </RUNNABLES>
                  <VARIATION-POINT>
                    <SHORT-LABEL>VP2</SHORT-LABEL>
                    <SW-SYSCOND BINDING-TIME="CODE-GENERATION-TIME">
                      <SYSC-REF DEST="SW-SYSTEMCONST">/Demo/SystemConstants
                          /SY_TURBO</SYSC-REF>== 1</SW-SYSCOND>
                  </VARIATION-POINT>
                </SWC-INTERNAL-BEHAVIOR>
              </INTERNAL-BEHAVIORS>
            </APPLICATION-SW-COMPONENT-TYPE>
          </ELEMENTS>
        </AR-PACKAGE>
      </AR-PACKAGES>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```