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References

- [1] Standardization Template
AUTOSAR_FO_TPS_StandardizationTemplate

1 Introduction

1.1 Document Conventions

The representation of requirements in AUTOSAR documents follows the table specified in [TPS_STDT_00078], see Standardization Template, chapter Support for Traceability ([1]).

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 ([1]).

1.2 Requirements Tracing

The following table references the uses cases specified in *this document* and links to the fulfillments of these.

Requirement	Description	Satisfied by
[UC_FMDT_00001]	Overall Workflow	[RS_FMDT_00001] [RS_FMDT_00002] [RS_FMDT_00013]
[UC_FMDT_00002]	Exchange of Feature Models	[RS_FMDT_00001] [RS_FMDT_00002] [RS_FMDT_00013]
[UC_FMDT_00003]	Characteristics of Features	[RS_FMDT_00005] [RS_FMDT_00006]
[UC_FMDT_00004]	Restrictions for Features	[RS_FMDT_00008]
[UC_FMDT_00005]	Complex Restrictions for Features	[RS_FMDT_00008]
[UC_FMDT_00006]	Relations among Features	[RS_FMDT_00008]
[UC_FMDT_00007]	Attributes for Features	[RS_FMDT_00009]
[UC_FMDT_00008]	Distributed development of Feature Models	[RS_FMDT_00011] [RS_FMDT_00012]
[UC_FMDT_00009]	Feature Models are optional	[RS_FMDT_00014]
[UC_FMDT_00010]	Define a Feature Configuration for a concrete product	[RS_FMDT_00003]
[UC_FMDT_00011]	Exchange of Feature Configurations	[RS_FMDT_00003]
[UC_FMDT_00012]	Documentation for Features	[RS_FMDT_00004]
[UC_FMDT_00013]	Multiplicity of Features	[RS_FMDT_00007]
[UC_FMDT_00014]	Link Feature Modeling and Variant Handling	[RS_FMDT_00010]
[UC_FMDT_00015]	Cooperative Feature Model Development	[RS_FMDT_00011] [RS_FMDT_00012]
[UC_FMDT_00016]	BindingTimes for Features	[RS_FMDT_00015] [RS_FMDT_00016]

Table 1.1: Requirements Tracing

2 Use Cases

[UC_FMDT_00001] Overall Workflow [An OEM develops an AUTOSAR model and a feature model with toolset *A*. Then both models are passed to the supplier for completion. The supplier then enhances the work with toolset *B* and passes it back to the OEM. The OEM then re-imports the AUTOSAR model. This may happen several times during development cycles.]

Different engineering domains use different feature modeling tools for variant management because specific tools better cover the individual needs; hence toolsets *A* and *B* are expected to be different.

At several synchronization points during development, not only the solutions but also the feature descriptions need to be integrated.]

[UC_FMDT_00002] Exchange of Feature Models [An OEM develops an AUTOSAR model and a feature model. The feature model is actually maintained in an external tool. This may be because the OEMs toolchain does not include a variant management tool that directly supports the AUTOSAR feature model, or because corporate standards call for a specific tool that does not have native support for the AUTOSAR feature model format.]

Note: the feature model is not changed by the supplier in this use case.]

[UC_FMDT_00003] Characteristics of Features [A Feature Model developer wants to express certain characteristics of features:

- For clarity, feature models have a hierarchical structure¹, which is interpreted as follows: a feature may only be included into a product if its parent feature is also included in the product.
- A feature is mandatory for a product. For example, a car must have a steering wheel. It should be noted that (in accordance with the hierarchical structure) this does not mean that the feature is present in every product. A mandatory feature is only (but then, always) included in a product if its parent feature is included there. For example, if a car has a radio, speakers are also mandatory.
- A feature is optional, that is, it may or may not be present in a product. For example, a radio or a sunroof is an optional feature.
- Two or more features are marked as alternative: exactly one of them must be present in a product. For example, a car may have either a diesel or a gasoline engine.

¹The hierarchy in question is actually a tree structure, meaning that each element (except the topmost one) has exactly one parent.

- Two or more features are marked as *multipleFeatures*: at least one of them must be present (the lower limit is not zero because this is already covered by optional features). It is possible to select several features.

]

[UC_FMDT_00004] Restrictions for Features [Sometimes, a hierarchy is not sufficient to express all constraints on a feature model.

For example, there are features that are country specific, such as the location of the steering wheel or the default setting of the speedometer. However, it is not desirable to make “country x” a high level feature and arrange all other features below that feature, because this would lead to unnecessary repetition.

Instead, it is easier to position the feature “country x” at an appropriate place in the feature tree, and refer to that feature from any location in the feature tree.]

An example for a feature model with country-specific restrictions is shown in Figure 2.1.

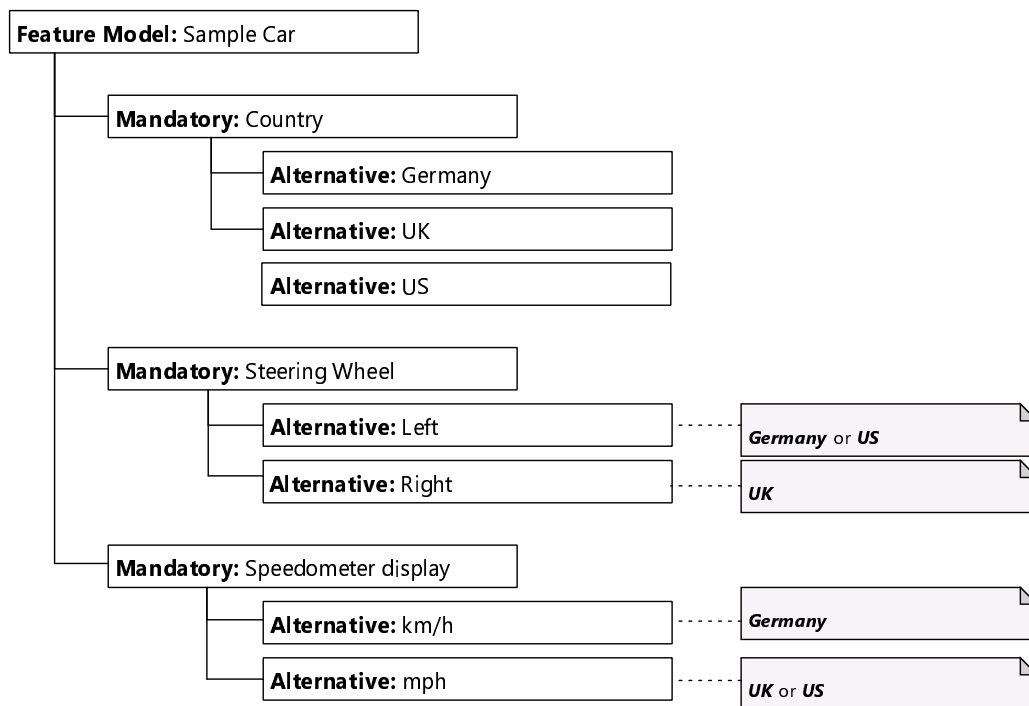


Figure 2.1: Example for Restrictions

[UC_FMDT_00005] Complex Restrictions for Features [A feature may be dependent on several other features. That is, it is only included in a product if all those other features are also included in the product. This cannot be expressed with the hierarchy proposed in Use Case [UC_FMDT_00003].

More complex types of restrictions may also apply.]

For example, Use Case [UC_FMDT_00004] could use more complex formulas of the form

(Germany or US) and not UK
UK and not (Germany or US)

(UK or US) and not Germany
Germany or not (UK or US)

[UC_FMDT_00006] Relations among Features [Similar to Use Cases [UC_FMDT_00004] and [UC_FMDT_00005], a feature model needs to express relations between feature where feature *A* requires or excludes the feature *B*.

This could also be expressed by putting a restriction (see Use Cases [UC_FMDT_00004] and [UC_FMDT_00005]) to feature *B*, but sometimes it is not possible to make such a change to feature *B* because its feature model cannot be changed. This may be because feature *B* is “owned” by a different party.

Furthermore, relations are often easier to understand or use than restrictions because they are simple keywords with a list of features, and not formulas.

Hence, feature *A* must be able to express its relationship with feature *B*.]

Figure 2.2 shows a feature model that follows the example in Figure 2.1 in Use Case [UC_FMDT_00004], but uses relations instead of restrictions. Note that the relations start at the country related features (*Germany*, *UK*, *US*), while the restrictions in the previous model are located at the *Steering Wheel* and *Speedometer* default features.

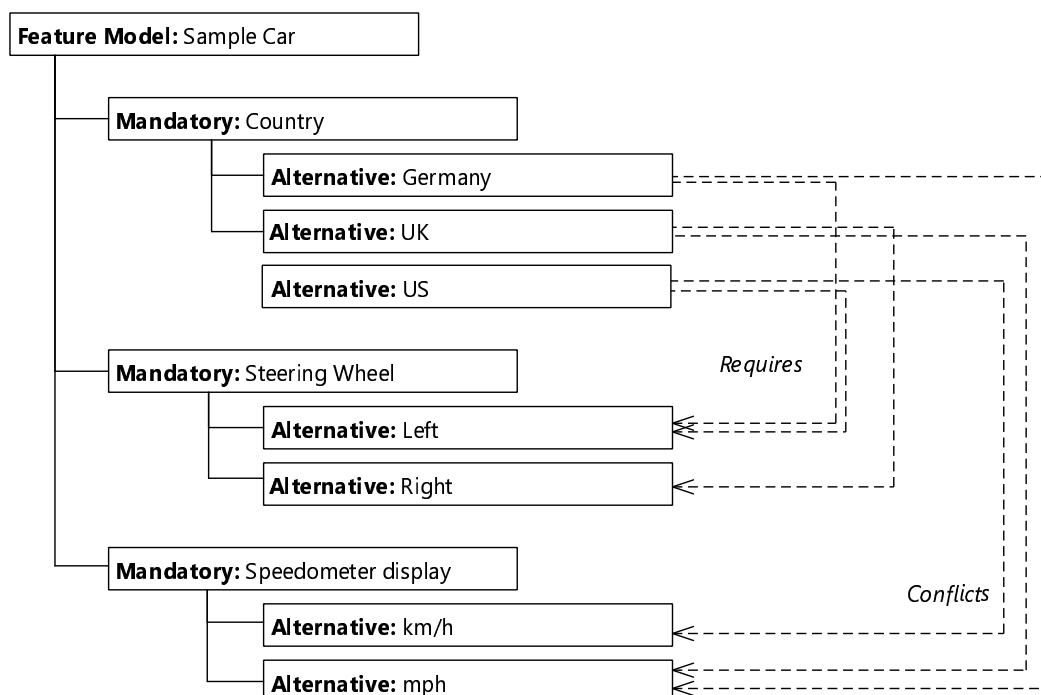


Figure 2.2: Example for Relations

Other examples for relations are *recommended for*, *discouraged for* and *impacts*.

[UC_FMDT_00007] Attributes for Features [A feature modeler wants to supply additional information to a feature, for example the maximum amount of bandwidth that the corresponding device may use.

Such information is useful if there are several options (*multipleFeatures* as in Use Case [UC_FMDT_00003]) where each feature corresponds to a separate device, but the total bandwidth that is available for these devices is limited by the characteristics of the bus. This would yield the restriction

$$(child1.bandwidth + child2.bandwidth + child3.bandwidth) < maximumBandwidth$$

]

[UC_FMDT_00008] Distributed development of Feature Models [A feature model is developed by different entities. These entities may be different departments within the same company, or different companies altogether.

For example, an AUTOSAR software model (created by an OEM) that already has a feature model is integrated with another software model (created by a supplier) that comes with its own feature model.

As another example, consider two independent AUTOSAR software components, each of which comes with its own feature model. They must be integrated into a large AUTOSAR model which describes the whole system, and also contains its own feature model.

These examples are handled best if every party is able to edit and write their own file. The overall feature model is distributed over several files, or split into several different feature models that work together.]

[UC_FMDT_00009] Feature Models are optional [OEM *A* develops an AUTOSAR model with the help of feature models, and wants to include software components that are supplied by supplier *B*. However, *B* does not use feature modeling (or uses feature modeling but does not share its feature model for IP or contract reasons).

This does not preclude the use of AUTOSAR variant handling, which has been developed independent of feature modeling.]

[UC_FMDT_00010] Define a Feature Configuration for a concrete product [A feature model describes the features a product line and their interdependencies. Some of these features may be selectable. In contrast, a concrete product is described by a set of selected features. This set of selected features must satisfy the various constraints defined by the feature model.

To define the features of a concrete product, an OEM (or supplier) selects the subset of the features of the feature model. Furthermore, it must be checked that the feature selection adheres to the various constraints (see especially Use Cases [UC_FMDT_00003], [UC_FMDT_00004], [UC_FMDT_00005] and [UC_FMDT_00006]) as defined in the feature model.

This is repeated for every applicable product within the product line. That is, there can be multiple feature configurations.]

[UC_FMDT_00011] Exchange of Feature Configurations [An OEM defines a feature model for a product line, and then selects a number of feature configurations that define individual products as outlined in Use Case [UC_FMDT_00010]. Together with the feature model, these feature configurations are handed to a supplier to ensure that the concrete software works for the intended products (i.e., feature configurations).]

[UC_FMDT_00012] Documentation for Features [Experience has shown that it is a time consuming process to define the structure of a feature model (that is, which features are there, what is their hierarchical structure, what are their characteristics), establish relations between features and define which features are implemented by which system constants.

This is especially true if a feature model is created for a software product line which already exists. Typically, several people from different departments are involved in such a task.

Hence, the decisions that helped shaping the final version – the why? – of the feature model need to be documented.]

[UC_FMDT_00013] Multiplicity of Features [Features that are characterized as *multipleFeatures* in Use Case [UC_FMDT_00003] may supply a multiplicity constraint. This constraint restricts the number of features that may be included in a feature configuration.

For example, there may be 5 *multipleFeatures* features, but any feature configuration must include at least 2 and at most 4 such features. For example, a control panel may contain a number of switches, but there is space for at most four switches.]

[UC_FMDT_00014] Link Feature Modeling and Variant Handling [After creating a feature model, the developer needs to establish a link between the feature model and the variation points in the corresponding AUTOSAR model.

The relationship between features and variation points is not a one-to-one relationship. For example, one feature may influence several variation points, or one variation point may be influenced by more than one feature.]

[UC_FMDT_00015] Cooperative Feature Model Development [An OEM creates a feature model, exports it to an AUTOSAR feature model and transfers this model to a

supplier. The supplier changes this model and hands it back to the OEM. The OEM then imports this model.]

[UC_FMDT_00016] BindingTimes for Features [A developer restricts the possible binding times for the implementation of a feature, for example to define that a feature should at least be implemented as *PreCompileTime*. This is described in the feature model.

Furthermore, there are two feature selections that are targeted at different customers: one customers wants a *PreCompileTime* implementation, and the other customer wants a *PostBuild* solution. This is described in the feature selection.]

3 Requirements

[RS_FMDT_00001] Support Product Lines

Upstream requirements: [UC_FMDT_00001](#), [UC_FMDT_00002](#)

[

Description:	A <i>Feature Model Exchange Format</i> should be able to express the basic functionality of a product line in terms of a set of related products which could have identical or shared features.
Rationale:	–
Use Case:	[UC_FMDT_00001] , [UC_FMDT_00002]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00002] Features

Upstream requirements: [UC_FMDT_00001](#), [UC_FMDT_00002](#)

[

Description:	A <i>Feature Model Exchange Format</i> should be able to express the basic functionality of a product in terms of features.
Rationale:	–
Use Case:	[UC_FMDT_00001] , [UC_FMDT_00002]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00003] Feature Selection

Upstream requirements: [UC_FMDT_00010](#), [UC_FMDT_00011](#)

[

Description:	A <i>Feature Model Exchange Format</i> should provide a feature selection mechanism that defines the feature set of a concrete product.
Rationale:	–
Use Case:	[UC_FMDT_00010] , [UC_FMDT_00011]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00004] Features should have names

Upstream requirements: [UC_FMDT_00012](#)

[

Description:	A Feature Model Exchange Format should be able to name and describe a feature.
Rationale:	–
Use Case:	[UC_FMDT_00012]
Dependencies:	[RS_FMDT_00003]
Supporting Material:	–

]

[RS_FMDT_00005] Feature Decomposition

Upstream requirements: [UC_FMDT_00003](#)

[

Description:	A Feature Model Exchange Format should be able to decompose a feature into subfeatures.
Rationale:	–
Use Case:	[UC_FMDT_00003]
Dependencies:	[RS_FMDT_00003]
Supporting Material:	–

]

[RS_FMDT_00006] Characteristics of Subfeatures

Upstream requirements: [UC_FMDT_00003](#)

[

Description:	Subfeatures should have different characteristics, for example “Mandatory”, “Optional”, and “Alternative”.
Rationale:	–
Use Case:	[UC_FMDT_00003]
Dependencies:	[RS_FMDT_00002] , [RS_FMDT_00005]
Supporting Material:	–

]

[RS_FMDT_00007] Multiplicity of Features

Upstream requirements: [UC_FMDT_00013](#)

[

Description:	Features should be able to express a multiplicity. This is only relevant for the <i>multipleFeatures</i> type composition mentioned in Use Case [UC_FMDT_00013] . Mandatory, optional and alternative features do not have multiplicities.
Rationale:	–
Use Case:	[UC_FMDT_00013]
Dependencies:	[RS_FMDT_00002] , [RS_FMDT_00007]
Supporting Material:	–

]

[RS_FMDT_00008] Relationships between features

Upstream requirements: [UC_FMDT_00004](#), [UC_FMDT_00005](#), [UC_FMDT_00006](#)

[

Description:	Features should be able to express different relationship w.r.t. to other features, such as “required”, “excluded”, and “impacted”.
Rationale:	–
Use Case:	[UC_FMDT_00004] , [UC_FMDT_00005] , [UC_FMDT_00006]
Dependencies:	[RS_FMDT_00002] , [RS_FMDT_00005]
Supporting Material:	–

]

[RS_FMDT_00009] Attributes for features

Upstream requirements: [UC_FMDT_00007](#)

[

Description:	Feature should be able to have various attributes.
Rationale:	–
Use Case:	[UC_FMDT_00007]
Dependencies:	[RS_FMDT_00002]
Supporting Material:	–

]

[RS_FMDT_00010] Integration with AUTOSAR variant handling

Upstream requirements: [UC_FMDT_00014](#)

[

Description:	A <i>Feature Model Exchange Format</i> should be integrated with the existing AUTOSAR solution for variant handling.
Rationale:	–
Use Case:	[UC_FMDT_00014]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00011] Feature Model should be splitable

Upstream requirements: [UC_FMDT_00008](#), [UC_FMDT_00015](#)

[

Description:	A <i>Feature Model Exchange Format</i> should provide means to be able to be split the feature model into several different ARXML files.
Rationale:	–
Use Case:	[UC_FMDT_00008] , [UC_FMDT_00015]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00012] Distributed maintenance of Feature Models

Upstream requirements: [UC_FMDT_00008](#), [UC_FMDT_00015](#)

[

Description:	A <i>Feature Model Exchange Format</i> should provide means to distribute maintenance between different parties.
Rationale:	–
Use Case:	[UC_FMDT_00008] , [UC_FMDT_00015]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00013] Integration in AUTOSAR Methodology

Upstream requirements: [UC_FMDT_00001](#), [UC_FMDT_00002](#)

[

Description:	A <i>Feature Model Exchange Format</i> should be able to be integrated into the overall AUTOSAR Methodology.
Rationale:	–
Use Case:	[UC_FMDT_00001] , [UC_FMDT_00002]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00014] Feature Models are optional

Upstream requirements: [UC_FMDT_00009](#)

[

Description:	The usage of the <i>Feature Model Exchange Format</i> is optional in the scope of an AUTOSAR-compliant development cycle. This is similar to AUTOSAR variant handling; an AUTOSAR model that does not use variant handling is still a valid model.
Rationale:	–
Use Case:	[UC_FMDT_00009]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00015] Features may Specify Binding Times

Upstream requirements: [UC_FMDT_00016](#)

[

Description:	A feature may define an intended binding time that documents the binding time for the implementation of this feature. This attribute should be regarded as a hint.
Rationale:	–
Use Case:	[UC_FMDT_00016]
Dependencies:	–
Supporting Material:	–

]

[RS_FMDT_00016] Feature Selections may Specify Binding Times

Upstream requirements: [UC_FMDT_00016](#)

[

Description:	A feature selection may define a selected binding time that further refines the intended binding time from [RS_FMDT_00015] . This attribute should be regarded as a hint.
Rationale:	–
Use Case:	[UC_FMDT_00016]
Dependencies:	–
Supporting Material:	–

]

A Change History

Please note that the lists in this chapter also include constraints and specification items that have been removed from the specification in a later version. These constraints and specification items do not appear as hyperlinks in the document.

A.1 Change History of this document according to AUTOSAR Release R22-11

A.1.1 Added Requirements in R22-11

none

A.1.2 Changed Requirements in R22-11

none

A.1.3 Deleted Requirements in R22-11

none

A.2 Change History of this document according to AUTOSAR Release R23-11

A.2.1 Added Requirements in R23-11

none

A.2.2 Changed Requirements in R23-11

none

A.2.3 Deleted Requirements in R23-11

none

A.3 Change History of this document according to AUTOSAR Release R24-11

A.3.1 Added Requirements in R24-11

none

A.3.2 Changed Requirements in R24-11

none

A.3.3 Deleted Requirements in R24-11

none