



Network Functions Virtualisation (NFV) Release 3; Information Modeling; UML Modeling Guidelines

Disclaimer

The present document has been produced and approved by the Network Functions Virtualisation (NFV) ETSI Industry Specification Group (ISG) and represents the views of those members who participated in this ISG.
It does not necessarily represent the views of the entire ETSI membership.

Reference

RGR/NFV-IFA017ed341

Keywords

information model, NFV, UML

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:

<http://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status.

Information on the current status of this and other ETSI documents is available at

<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:

<https://portal.etsi.org/People/CommiteeSupportStaff.aspx>

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2020.

All rights reserved.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members.

3GPP™ and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

oneM2M™ logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners.

GSM® and the GSM logo are trademarks registered and owned by the GSM Association.

Contents

| | |
|---|----|
| Intellectual Property Rights | 5 |
| Foreword..... | 5 |
| Modal verbs terminology..... | 5 |
| 1 Scope | 6 |
| 2 References | 6 |
| 2.1 Normative references | 6 |
| 2.2 Informative references..... | 6 |
| 3 Definition of terms, symbols and abbreviations..... | 6 |
| 3.1 Terms..... | 6 |
| 3.2 Symbols..... | 6 |
| 3.3 Abbreviations | 7 |
| 4 Overview | 7 |
| 5 UML artefact descriptions..... | 7 |
| 5.1 Classes..... | 7 |
| 5.1.1 Description..... | 7 |
| 5.1.2 Class notation..... | 7 |
| 5.1.3 Class properties..... | 8 |
| 5.2 Attributes in classes..... | 9 |
| 5.2.1 Description..... | 9 |
| 5.2.2 Attribute notation..... | 10 |
| 5.2.3 Attribute properties | 10 |
| 5.3 Relationships | 12 |
| 5.3.1 Description..... | 12 |
| 5.3.2 Relationship notation | 13 |
| 5.3.2.1 Association notation..... | 13 |
| 5.3.2.2 Generalization notation | 14 |
| 5.3.2.3 Dependency notation..... | 15 |
| 5.3.3 Relationship properties | 15 |
| 5.4 Interfaces | 18 |
| 5.5 Interface operations | 18 |
| 5.6 Operation parameters | 18 |
| 5.7 Notifications | 18 |
| 5.7.1 Description..... | 18 |
| 5.7.2 Notification notation | 18 |
| 5.7.3 Notification properties | 19 |
| 5.8 Data Types..... | 20 |
| 5.8.1 Description..... | 20 |
| 5.8.2 Type notation | 20 |
| 5.8.3 Type properties | 21 |
| 5.8.4 UML Primitive Types..... | 22 |
| 5.8.5 Pre-defined Data Types | 22 |
| 5.9 Qualifiers and conditions..... | 22 |
| 5.10 Use cases | 23 |
| 5.11 Activities | 23 |
| 5.12 State machines..... | 23 |
| 6 UML profile definitions | 23 |
| 6.1 UML Profile Structure..... | 23 |
| 6.2 Additional Properties for individual UML artefacts..... | 23 |
| 6.3 Additional Properties for all UML artefacts..... | 27 |
| 6.3.1 LifecycleState Property..... | 27 |
| 6.3.2 Reference property..... | 30 |
| 6.3.3 Example property..... | 31 |

| | | |
|-----------------|-------------------------------------|-----------|
| 7 | Recommended Modeling Patterns..... | 31 |
| 7.1 | Model Structure..... | 31 |
| 7.2 | Use of XOR/Choice/Proxy class | 32 |
| 7.2.1 | Xor constraint | 32 |
| 7.2.1.1 | Description..... | 32 |
| 7.2.1.2 | Example | 32 |
| 7.2.1.3 | Name style..... | 32 |
| 7.2.2 | "Choice"..... | 33 |
| 7.2.3 | Proxy class Modeling..... | 33 |
| 7.3 | UML diagram guidelines..... | 33 |
| 7.3.1 | Recommendations..... | 33 |
| 7.3.2 | Using colours | 33 |
| 7.3.3 | Style sheets | 33 |
| Annex A: | Change History | 34 |
| History | | 35 |

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<https://ipr.etsi.org/>).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Network Functions Virtualisation (NFV).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document defines the guidelines that have to be taken into account during the creation of a protocol-neutral UML (Unified Modeling Language) information model.

These guidelines are informative for the general reader, but need to be followed when designing models for the ETSI NFV Information Model.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Papyrus Eclipse UML Modeling Tool.

NOTE: Available at <https://www.eclipse.org/papyrus/>.

[i.2] Unified Modeling Language™ (UML®).

NOTE: Available at <http://www.uml.org/>.

[i.3] OMG Unified Modeling Language (OMG UML), Version 2.5.

NOTE: Available at <http://www.omg.org/spec/UML/2.5/>.

[i.4] Open Networking Foundation UML Modeling Guidelines V1.2, September 2016 (ONF TR-514).

[i.5] ETSI GR NFV-IFA 015: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Report on NFV Information Model".

[i.6] ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GS NFV 003 [i.6] apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS NFV 003 [i.6] and the following apply:

| | |
|-----|---------------------------|
| MAC | Media Access Control |
| UCC | Upper Camel Case |
| UML | Unified Modeling Language |

4 Overview

UML defines a large number of basic model elements (UML artefacts). In order to assure consistent and harmonious information models, only a selected subset of these artefacts are used in the UML model guidelines in the present document. The semantic of the selected artefacts is defined in [i.2].

The guidelines of each basic model artefact are divided into three parts:

- 1) Short description.
- 2) Graphical notation examples.
- 3) Properties.

The guidelines have been developed using the Papyrus open source UML tool [i.1].

The ONF UML Modeling Guidelines [i.4] have been used as a basis for these guidelines. The present document only uses a subset of the guidelines defined in the ONF UML Modeling Guidelines [i.4]. The parts not used are indicated clearly in each clause.

NOTE: The OpenInterfaceModel Profile and its stereotypes are not used by the ETSI NFV Information Model.

5 UML artefact descriptions

5.1 Classes

5.1.1 Description

Classes are used to convey a structural (often called static) representation of an entity, including properties and attributes.

5.1.2 Class notation

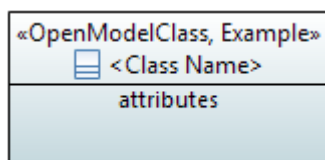


Figure 5.1.2-1: Graphical Notation for classes

As highlighted in figure 5.1.2-1, a class is represented with a name compartment and an attributes compartment. It is recommended that the name compartment contains also the assigned lifecycle stereotypes. The attributes compartment can be set in a diagram to not expose the attributes or to expose some or all of the attributes.

In some diagrams the attributes are hidden to reduce clutter, in others only a subset of the attributes is exposed to focus attention on those attributes. It is also possible to hide the attribute compartment of a class in the class diagrams where a large number of classes need to be shown, as depicted in figure 5.1.2-2.

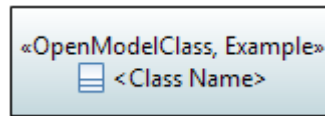


Figure 5.1.2-2: Graphical Notation for Classes without Attributes Compartment

It is recommended that the name compartment also show stereotypes for the class where relevant. When showing stereotypes, the compartment may include the stereotype "OpenModelClass" (as all classes in the model have this stereotype by default) and may also include other stereotypes.

In the general UML definition a class may have name, attribute and operation compartments, as shown in figure 5.1.2-3, but since the structural part and the behavioural part of the model are decoupled, the operation compartment, is not used and always hidden.

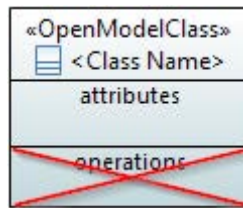


Figure 5.1.2-3: Graphical Notation for Classes with Attributes and Deprecated Operations Compartment

5.1.3 Class properties

A class has the following properties:

- Name:
 - Follows Upper Camel Case (UCC) convention. Each class in the model has a unique name. An example of Upper Camel Case: NetworkService.
- Documentation:
 - Contains a short definition. The documentation is carried in the "Applied comments" field in Papyrus as shown on figure 5.1.3-1; i.e. the "Owned comments" field is not used. The complete documentation should be written in a single comment; i.e. at most one "Applied comment".

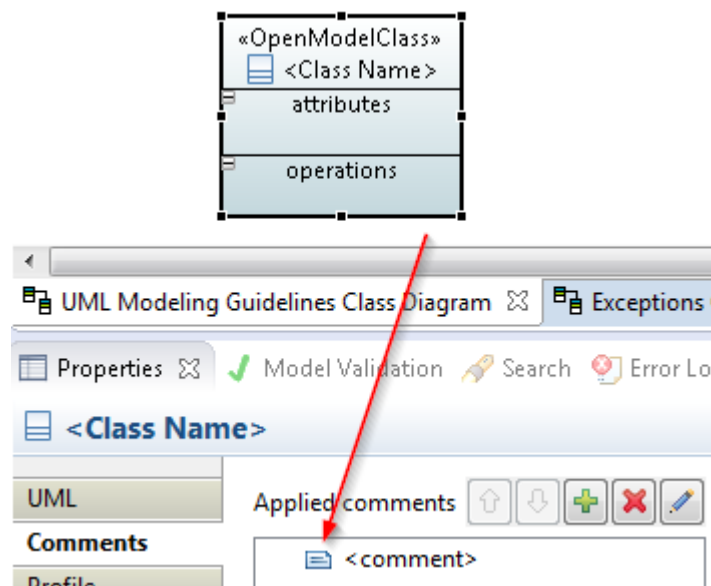


Figure 5.1.3-1: Entering documentation

- Superclass:
 - Inheritance may be used to deal with shared properties. Multiple inheritance is not supported in ETSI NFV Information Model.
- Abstract:
 - Indicates if the object class can be instantiated or is just used for inheritance; i.e. abstract classes will not be instantiated.
- Additional properties are defined in the "OpenModelClass" stereotype which extends by default (required) the "metaclass" Class as shown on figure 5.1.3-2.

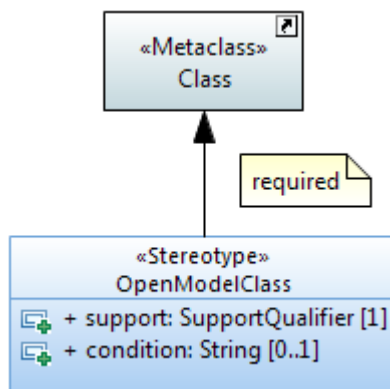


Figure 5.1.3-2: "OpenModelClass" Stereotype

- Support:
 - This property qualifies the support of the object class at the management interface. See definition in clause 5.9.
- Condition:
 - This property contains the condition for the condition-related support qualifiers.

The following class stereotype is not used for ETSI NFV Information Model:

- Choice.

The following UML defined class properties are not used:

- Is leaf (default = false).
- Is active (default = false).
- Visibility (default = public).

5.2 Attributes in classes

5.2.1 Description

Attributes contain the properties of an object class. Note that the roles of navigable association ends become an attribute at the other associated end when this association end is owned by the classifier; see also "Role Type" property in clause 5.3.3.

NOTE: The association end can also be owned by the association itself in which case it does not become an attribute.

5.2.2 Attribute notation

The notation, shown in figure 5.2.2-1, is:

- `"<list of stereotypes>"<visibility> <attribute name> : <attribute type> [<multiplicity>] = <default value>.`

NOTE: When no default is relevant or no default is defined, the "=" is not shown.

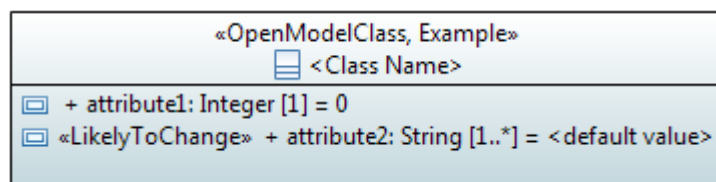


Figure 5.2.2-1: Graphical Notation for object class with attributes

5.2.3 Attribute properties

An attribute has the following properties:

- Name:
 - Follows Lower Camel Case (LCC) and is unique across all attribute names in the inheritance tree. An example of Lower Camel Case: virtualMemSize.
 - It is recommended that all Boolean typed attribute names start with 'is' (e.g. 'isAbstract'), or a verb such as 'has' and the whole attribute name should be composed in a way that it is possible to answer it by 'true' or 'false'.
- Documentation:
 - Contains a short definition. The documentation is carried in the "Applied comments" field in Papyrus; i.e. the "Owned comments" field is not used. The complete documentation should be written in a single comment; i.e. at most one "Applied comment".
- Type:
 - Refers to a datatype or a basic UML type. See clause 5.5.
 - If it is needed to reference another information model element (i.e. class), then an association is used (see clause 5.3).
- Default Value:
 - Provides the value that the attribute has to start with in case the value is not provided during creation, or already defined because of a system state.
- Multiplicity (*, 1, 1..*, 0..1, ...):
 - Defines the number of values the attribute can simultaneously have:
 - * is a list attribute with 0, one or multiple values;
 - 1 attribute has always one value;
 - 1..* is a list attribute with at least one value;
 - 0..1 attribute may have no or at most one value;
 - Default value is 1;
 - Other values are possible; e.g. "2..17".

- Additional properties are defined in the "OpenModelAttribute" stereotype which extends by default (required) the "metaclass" Property, as shown on figure 5.2.3-1.

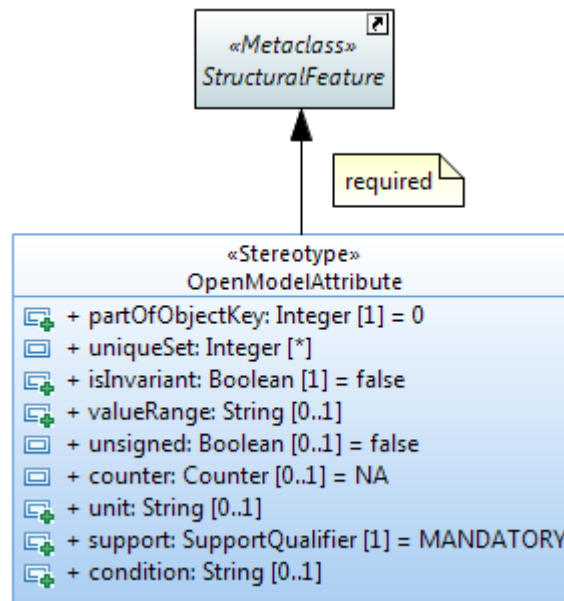


Figure 5.2.3-1: "OpenModelAttribute" Stereotype

- isInvariant:
 - This property identifies if the value of the attribute can be changed after it has been created.
- Support:
 - This property qualifies the support of the object class at the management interface. See definition in clause 5.9.
- Condition:
 - This property contains the condition for the condition-related support qualifiers.
- Other properties:
 - PassedByReference:
 - This property is only applied to attributes that have an object class defined as their type; i.e. association member ends owned by the class which became attributes. The stereotype is applied on a case by case basis. Figure 5.2.3-2 is showing this stereotype.
 - The property defines that the attribute contains only the reference (e.g. name, identifier, address) of the referred object instance(s) when being transferred across the interface. Otherwise the attribute contains the complete information of the object instance(s) when being transferred across the interface.

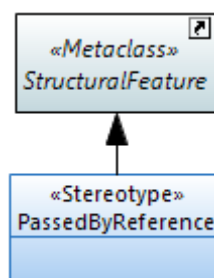


Figure 5.2.3-2: "PassedByReference" Stereotype

The following properties of the OpenModelAttribute stereotype are not used:

- partOfObjectKey.
- uniqueSet.
- valueRange.
- unsigned.
- counter.
- unit.

The following UML defined attribute properties are not used:

- Ordered (default = false).
- Unique (default = true).
- Read Only (default = false).
- Is derived (default = false).
- Is derived union (default = false).
- Is leaf (default = false).
- Is static (default = false).
- Visibility (default = public).

5.3 Relationships

5.3.1 Description

Relationships are defined between classes. Relationships have relationship-ends. A relationship end specifies the role that the class at that end performs.

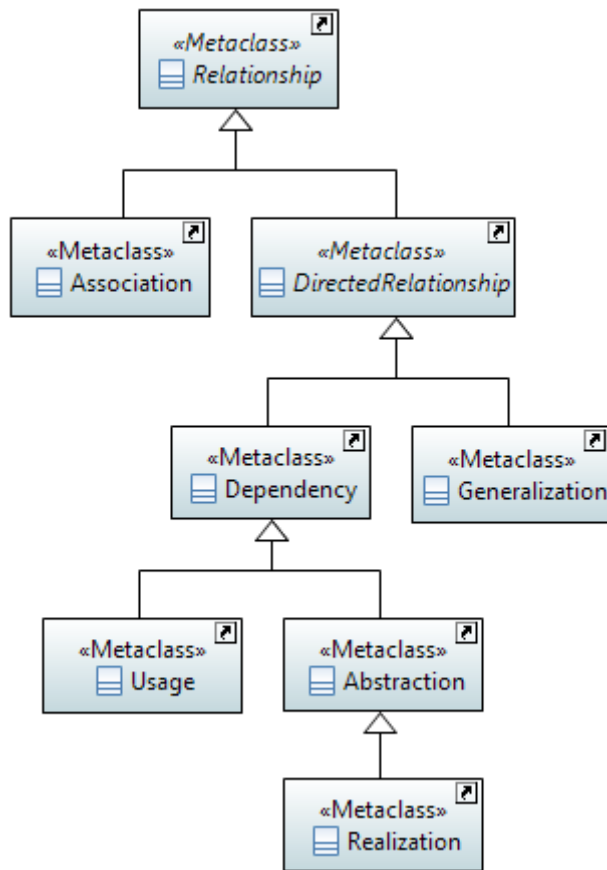


Figure 5.3.1-1: Metaclass Diagram of used Relationships

Usage relationships are not used in ETSI NFV Information Model.

5.3.2 Relationship notation

5.3.2.1 Association notation

The following examples show the different kinds of associations that are to be used in the model.

Figure 5.3.2.1-1 shows a bi-directional navigable association where each object class has a pointer to the other. The association end role name becomes the name of the corresponding attribute. I.e. in the example: ClassA will have an attribute named "_classB" pointing to ClassB and vice versa.

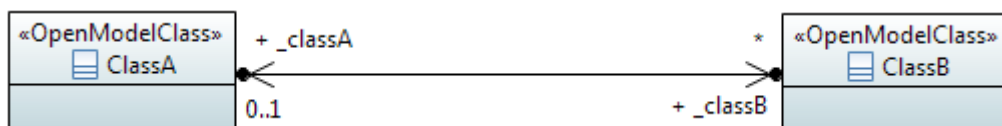


Figure 5.3.2.1-1: Bidirectional Association Relationship Notation

Figure 5.3.2.1-2 shows a unidirectional association (shown with an open arrow at the target class) where only the source class has a pointer to the target class and not vice-versa.

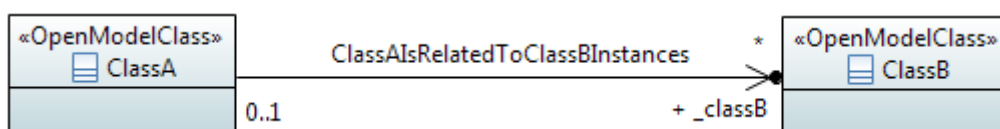


Figure 5.3.2.1-2: Unidirectional Association Relationship Notation

Figure 5.3.2.1-3 shows a non-navigable association where none of the classes have a pointer to the other; i.e. such associations are just for illustration purposes. Non-navigable associations should have a name.

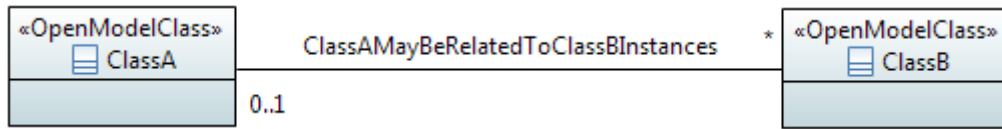


Figure 5.3.2.1-3: Non-navigable Association Relationship Notation

An shared aggregation is a special type of association in which objects are assembled or configured together to create a more complex object. Aggregation protects the integrity of an assembly of objects by defining a single point of control called aggregate, in the object that represents the assembly. Figure 5.3.2.1-4 shows an aggregation association.

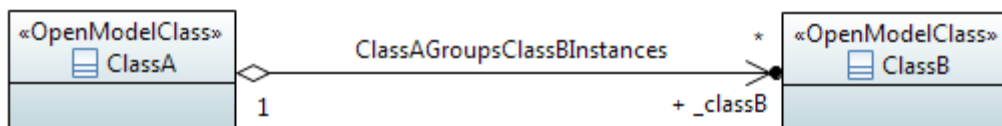


Figure 5.3.2.1-4: Aggregation Association Relationship Notation

A composite aggregation association is a strong form of aggregation that requires a part instance be included in at most one composite at a time. If a composite is deleted, all of its parts are deleted as well; i.e. the lifecycle of all instances of ClassB is tied to the lifecycle of the ClassA instance. Figure 5.3.2.1-5 shows a composite aggregation association.

NOTE: In the example below, ClassA names ClassB instances; defined by the "Names" stereotype that is not used in ETSI NFV Information Model.

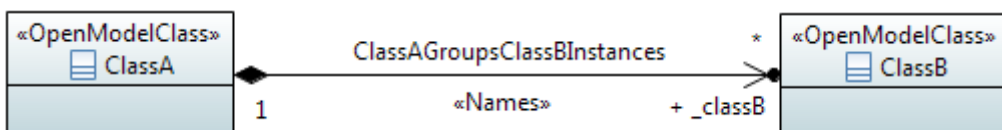


Figure 5.3.2.1-5: Composite Aggregation Association Relationship Notation

The "Lifecycle Aggregate" and "Extended Composite" aggregations are not used in ETSI NFV Information Model.

5.3.2.2 Generalization notation

A generalization association indicates a relationship in which one class (the child) inherits from another class (the parent). A generalization relationship may be conditional, identified by the "Cond" stereotype. Figure 5.3.2.2-1 shows the 2 types of generalization relationship, as well as an example.

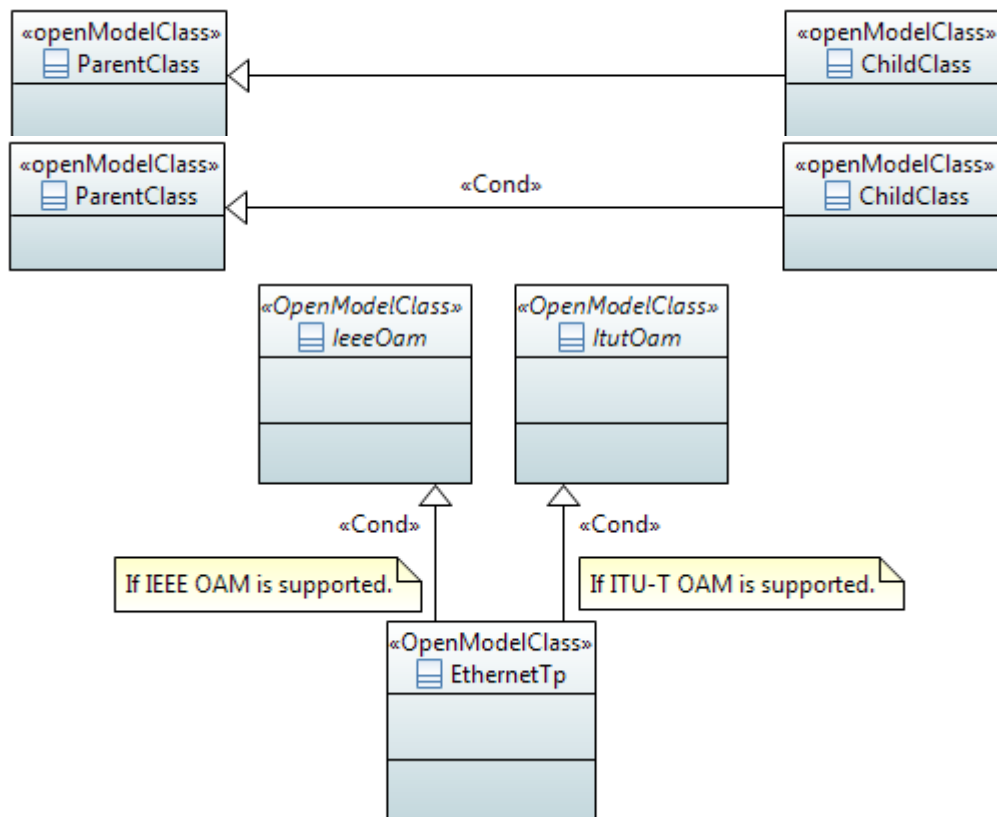


Figure 5.3.2.2-1: Generalization Relationship Notation (normal, conditional and example)

5.3.2.3 Dependency notation

"A dependency is a relationship that signifies that a single or a set of model elements requires other model elements for their specification or implementation. This means that the complete semantics of the depending elements is either semantically or structurally dependent on the definition of the supplier element(s)...", an extract from [i.2].

The realization relationship along with the "PruneAndRefactor" stereotype indicates the association between a Core Model class or relationship and the cloned Purpose Specific Model class or relationship. Figure 5.3.2.3-1 shows a realization relationship.

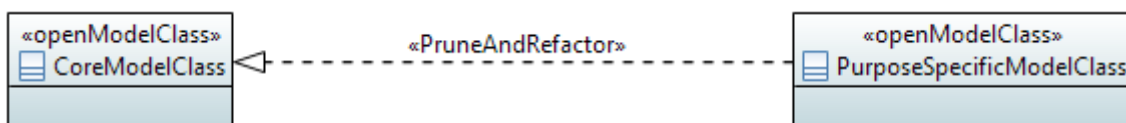


Figure 5.3.2.3-1: Realization Relationship Notation

The usage and abstraction dependency relationships are not used in ETSI NFV Information Model.

5.3.3 Relationship properties

An association has the following properties:

- Name:
 - Follows Upper Camel Case (UCC) and is unique across all association names defined in the whole model.
 - The format is "<Class1Name><VerbPhrase><Class2Name>" where the verb phrase creates a sequence that is readable and meaningful. In case of a long class name, it is also allowed to use a short form of the name.

- Documentation:
 - Contains a short definition. The documentation is carried in the "Applied Comments" field in Papyrus, i.e. the "Owned comments" field is not used. The complete documentation should be written in a single comment; i.e. at most one "Applied comment".
- Abstract:
 - Associations which are just for explanation to the reader of the model are defined as "abstract". Their ends are not navigable and have no role names. Abstract associations should not be taken into account in a protocol specific implementation.
- Type:
 - The following types are used:
 - inheritance;
 - simple association (aggregation = none);
 - composition (aggregation = composite);
 - aggregation (aggregation = shared);
 - generalization;
 - dependency;
 - realization dependency.
- Role Name (only for associations):
 - Follows Lower Camel Case (LCC) and identifies the role that the object plays at this end (Member End) of the association. Prefixing the role name with an underscore "_" is not needed in ETSI NFV Information Model.
 - Only navigable Member Ends have role names and follow the definitions made for attributes in clause 5.2.
- Role Type (only for associations):
 - The type of the role is fixed to the class attached to the association end. Therefore it is important to define the type as passedByReference or passedByValue. The "PassedByReference" stereotype identifies that the role (becoming an attribute) that has the stereotype associated, contains only the reference (name, identifier, address) to the referred instance(s) when being transferred across the interface. Otherwise the role (becoming an attribute) contains the complete information of the instance(s) when being transferred across the interface.

NOTE: The Owner of a navigable Member End has to be the Classifier to become an attribute in the class, as shown in figure 5.3.3-1.

| Member End | |
|------------|---|
| Name | <input type="text" value="_classB"/> |
| Owner | <input type="text" value="Classifier"/> |
| Navigable | <input checked="" type="radio"/> true <input type="radio"/> false |

Figure 5.3.3-1: Owner of a navigable Member End

- Role Multiplicity:
 - Identifies the number of object instances that can participate in an instance of the association.

- Additional properties:
 - "Cond":
 - The "Cond" stereotype identifies that the association is conditional. The condition is also provided.
 - "StrictComposite":
 - The "StrictComposite" stereotype can only be applied to associations with a composite end (i.e. composite aggregation association). It means that the content of the composed classes is part of the parent class and has no opportunity for independent lifecycle. The composed classes are essentially carrying attributes of the parent class where the composite is used to provide grouping of similar properties. The composed classes just provide groups of attributes for the parent class; i.e. they are abstract and cannot be instantiated.
 - Whereas in an association with a composite end that is not StrictComposite the composed class is a part that has a restricted independent lifecycle. In this case an instance of the composed class can be created and deleted in the context of the parent class and should be represented as a separate instance from the parent in an implementation. This is especially true where there is a recursive composition. It is possible that in some cases the composed instance could move from one parent to another so long as it exists with one parent only at all points of the transaction. This move is not meaningful for a class associated via a StrictComposite association.
 - "PruneAndRefactor":
 - This "PruneAndRefactor" stereotype identifies that a realization association is used to identify pruning and refactoring.

Figure 5.3.3-2 shows all the potential annotations for associations.

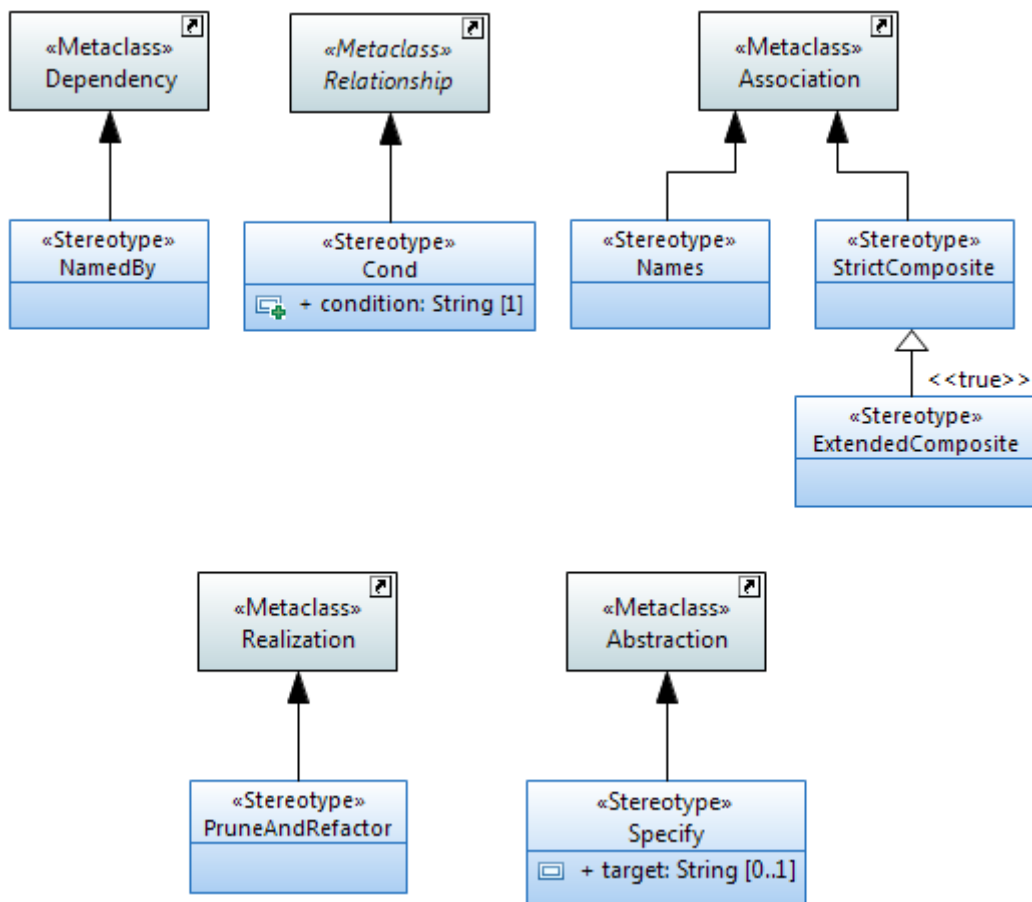


Figure 5.3.3-2: Potential Annotations for Associations

The following stereotypes applicable to associations are not used:

- "Names";
- "NamedBy";
- "ExtendedComposite";
- "LifecycleAggregate";
- "Specify".

The following UML defined attribute properties are not used:

- Visibility (default = public).

5.4 Interfaces

An "Interface" is used to group operations, i.e. models the dynamic part of the model. Groupings of operations can be used to modularize the functionalities of the specification.

Interfaces are not used in ETSI NFV Information Model.

5.5 Interface operations

Operations can be defined within an "Interface". An "Interface" has at least one operation.

Operations are not used in ETSI NFV Information Model.

5.6 Operation parameters

Parameters define the input and output signals of an operation.

Parameters are not used in ETSI NFV Information Model.

5.7 Notifications

5.7.1 Description

The UML "Signal" is used to define the content of a notification. The information is defined in the attributes of the "Signal".

5.7.2 Notification notation

Figure 5.7.2-1 shows the graphical notation for notification.

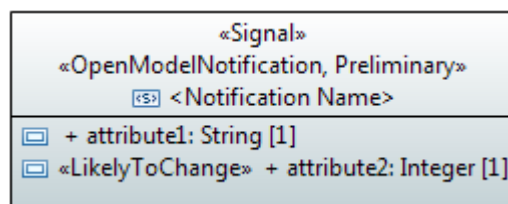


Figure 5.7.2-1: Graphical Notation for notification

5.7.3 Notification properties

A notification/signal has the following properties:

- Name:
 - Follows Upper Camel Case (UCC) convention. Each notification/signal in the model has a unique name. An example of Upper Camel Case: CapacityChangeNotification.
- Documentation:
 - Contains a short definition. The documentation is carried in the "Applied Comments" field in Papyrus; i.e. the "Owned comments" field is not used. The complete documentation should be written in a single comment; i.e. at most one "Applied comment".
- Superclass(es):
 - Inheritance may be used to deal with shared properties. Multiple inheritance is not supported in ETSI NFV Information Model.
- Abstract:
 - Indicates if the notification/signal can be instantiated or is just used for inheritance.
- Additional properties are defined in the "OpenModelNotification" stereotype which extents by default (required) the "metaclass" Signal, as shown on figure 5.7.3-1.

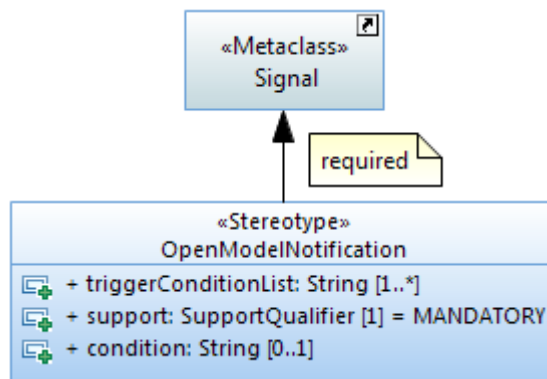


Figure 5.7.3-1: "OpenModelNotification" Stereotype

- triggerConditionList:
 - This property contains the list of conditions that causes the notification. Create one element in the trigger condition list per trigger as shown on figure 5.7.3-2.

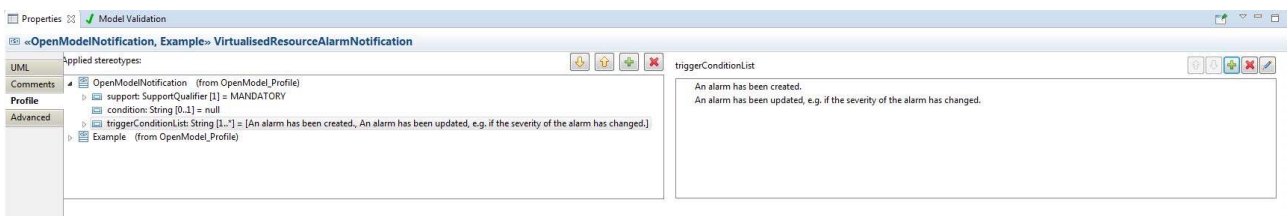


Figure 5.7.3-2: Notification trigger condition list

- Use the green + button to create a new element in the list as shown on figure 5.7.3-3.

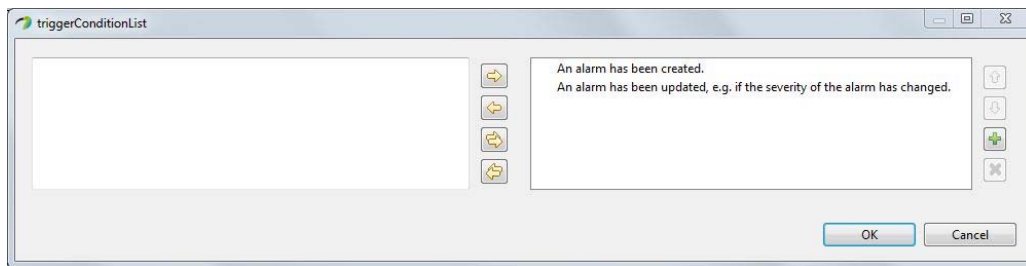


Figure 5.7.3-3: Trigger condition list pop-up

- Support:
 - This property qualifies the support of the notification/signal at the management interface. See definition in clause 5.9.
- Condition:
 - This property contains the condition for the condition-related support qualifiers.

The following UML defined signal properties are not used:

- Is leaf (default = false).
- Visibility (default = public).

5.8 Data Types

5.8.1 Description

Types are used as type definitions of attributes and parameters.

Data Types are divided into 3 categories:

- (complex) DataTypes (further structured; e.g. Host which combines ipAddress and domainName).
- Primitive Types (not further structured; e.g. Integer, MAC address).
- Enumerations.

5.8.2 Type notation

The various graphical notations are shown on the figure 5.8.2-1 for datatype, figure 5.8.2-2 for enumeration and figure 5.8.2-3 for primitive type.

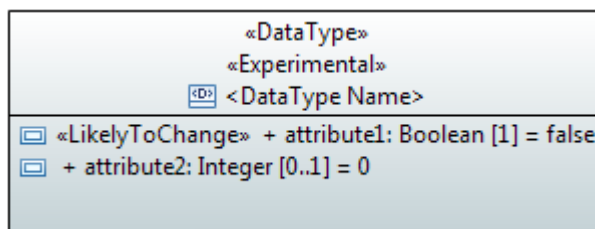


Figure 5.8.2-1: Graphical notation for "DataType"

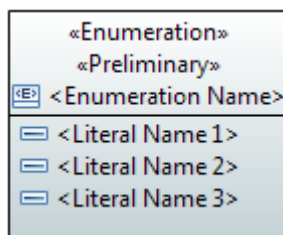


Figure 5.8.2-2: Graphical notation for "Enumeration"

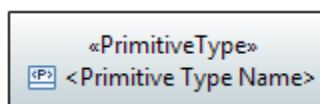


Figure 5.8.2-3: Graphical notation for "PrimitiveType"

5.8.3 Type properties

A type has the following properties:

- Category:
 - Three categories are used in the model:
 - dataType;
 - enumeration;
 - primitive.
- Name:
 - Follows Upper Camel Case (UCC) convention. Each datatype in the model has a unique name.
- Documentation:
 - Contains a short definition. The documentation is carried in the in Papyrus; i.e. the "Owned comments" field is not used. The complete documentation should be written in a single comment; i.e. at most one "Applied comment".
- Datatype attributes (only for dataTypes):
 - Follow the definitions made for attributes in clause 5.2 with the following exceptions:
 - the isInvariant property can be ignored and is fixed to "true";
 - the notification property can be ignored and is fixed to "NA".
- Enumeration literals (only for enumerations):
 - The name contains only upper case characters where the words are separated by "_". Example: "CHANGED_DATA".

The following stereotypes applicable to data types are not used:

- Choice.
- Exception.

The following UML/Papyrus defined attribute properties that are not used:

- Is abstract (default = false).
- Is leaf (default = false).

5.8.4 UML Primitive Types

Papyrus already provides the following UML primitive types, as shown on figure 5.8.4-1.

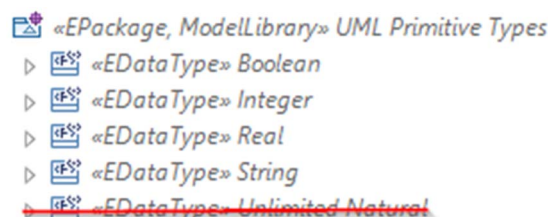


Figure 5.8.4-1: Primitive Types provided by Papyrus

The datatype UnlimitedNatural is not used in the ETSI NFV Information Model.

NOTE: Papyrus also exposes the internal Eclipse eCore primitives which are not to be used in models.

The annotations used to further restrict the UML Primitive Types are not supported in the ETSI NFV Information Model. These annotations are described by the following properties contained in the OpenModelAttribute stereotype:

- bitLength;
- unsigned;
- encoding;
- counter.

5.8.5 Pre-defined Data Types

No separate model library defining additional common data types is used in ETSI NFV Information Model.

Additional primitive types should be defined in the CommonTypesModule (NfvInformationModel::NFVCoreModel::NFVCommonDomain::CommonTypesModule).

5.9 Qualifiers and conditions

This clause defines the qualifiers applicable for model elements specified in the present document, e.g. the "OpenModelClass" (see clause 5.1.2), the "OpenModelAttribute" (see clause 5.2.2) and the <<OpenModelNotification>> (see clause 5.3.2). The qualifications are M, O, CM and CO. Their meanings are specified in this clause. This type of qualifier is called Support Qualifier:

- Definition of M (Mandatory) qualification:
 - The model element needs to be supported.
- Definition of O (Optional) qualification:
 - The model element may, but needs not to, be supported.
- Definition of CM (Conditional-Mandatory) qualification:
 - The model element needs to be supported under certain conditions. If the specified conditions are met then the model element needs to be supported.
- Definition of CO (Conditional-Optional) qualification:
 - The model element may, but needs not to, be supported under certain conditions. If the specified conditions are met then the model element may, but needs not to, be supported. If the specified conditions are not met then the model element needs to be supported.

The qualification C (Conditional) is not supported by the ETSI NFV Information Model.

The condition property contains the condition for the condition-related support qualifiers (CM, CO).

The use of conditional classes to group conditions is not supported by the ETSI NFV Information Model.

5.10 Use cases

Use case diagrams define actors in a system and the defined behaviour over a specific interface.

Use case diagrams are not used in ETSI NFV Information Model.

5.11 Activities

Activities defined in UML are used for business process modeling.

Activities are not used in ETSI NFV Information Model.

5.12 State machines

State machines define state transitions and triggers that are needed for the transitions to take place.

State machines are not used in ETSI NFV Information Model.

6 UML profile definitions

6.1 UML Profile Structure

The additional properties for the UML Model artifacts and UML Profile artifacts are defined in UML Profiles. The structure is defined in the figure 6.1-1.

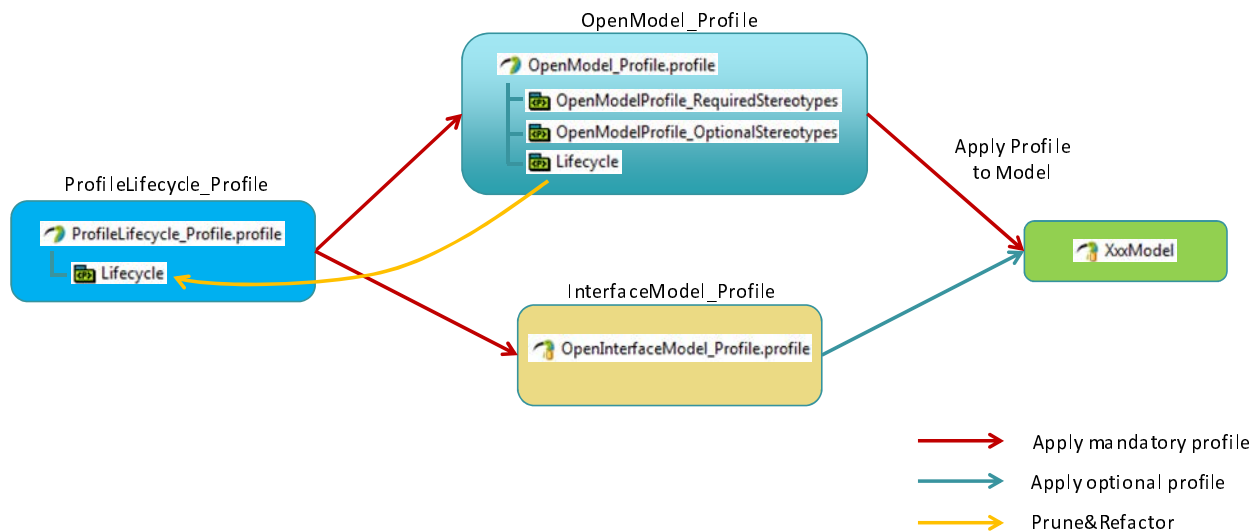


Figure 6.1-1: UML Profile Structure

6.2 Additional Properties for individual UML artefacts

Clause 5 has already described the additional properties for each UML artefact. All defined stereotypes are shown as an overview in figures 6.2-1 and 6.2-2 and table 6.2-1.

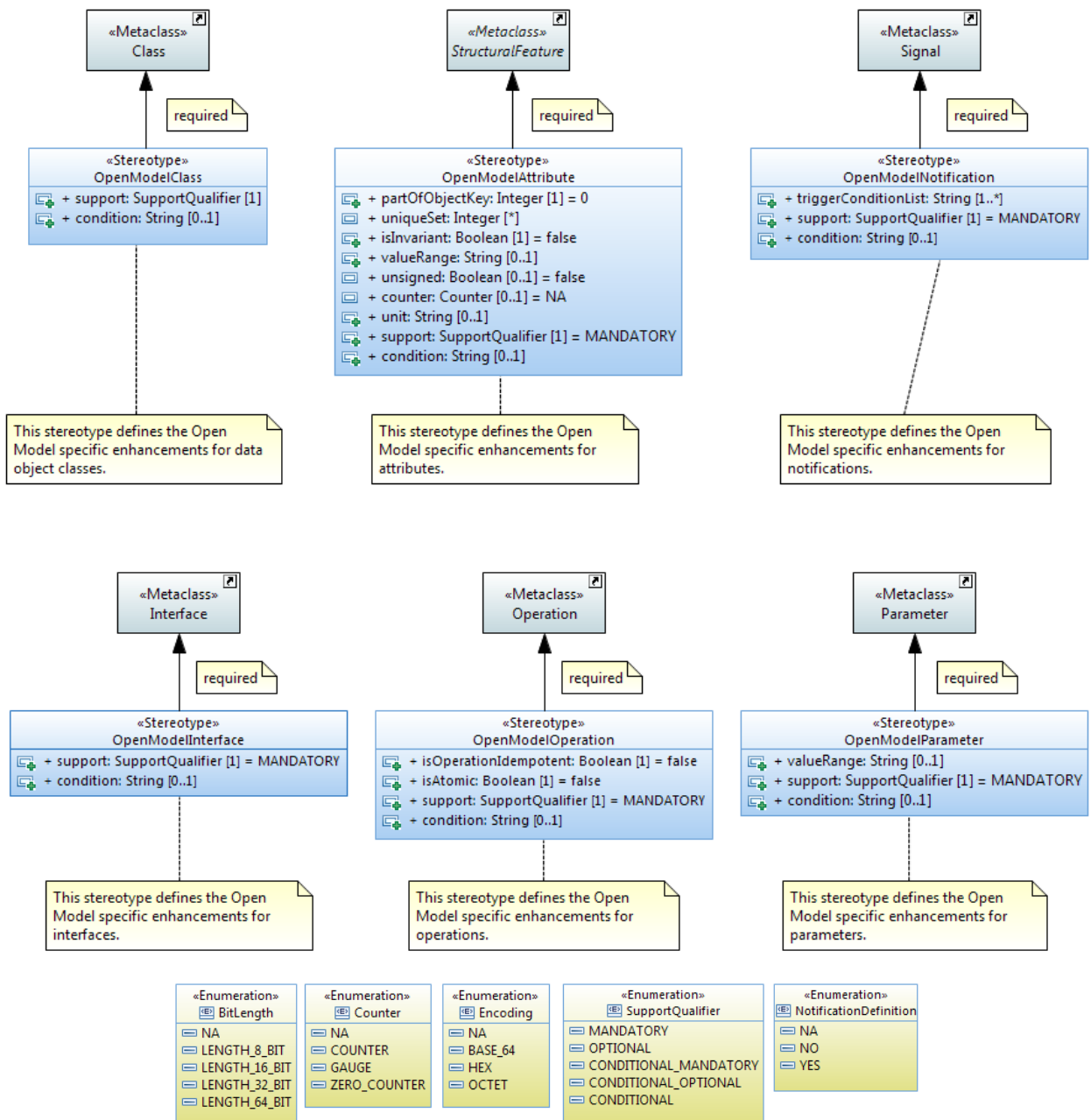


Figure 6.2-1: Required "Stereotypes"

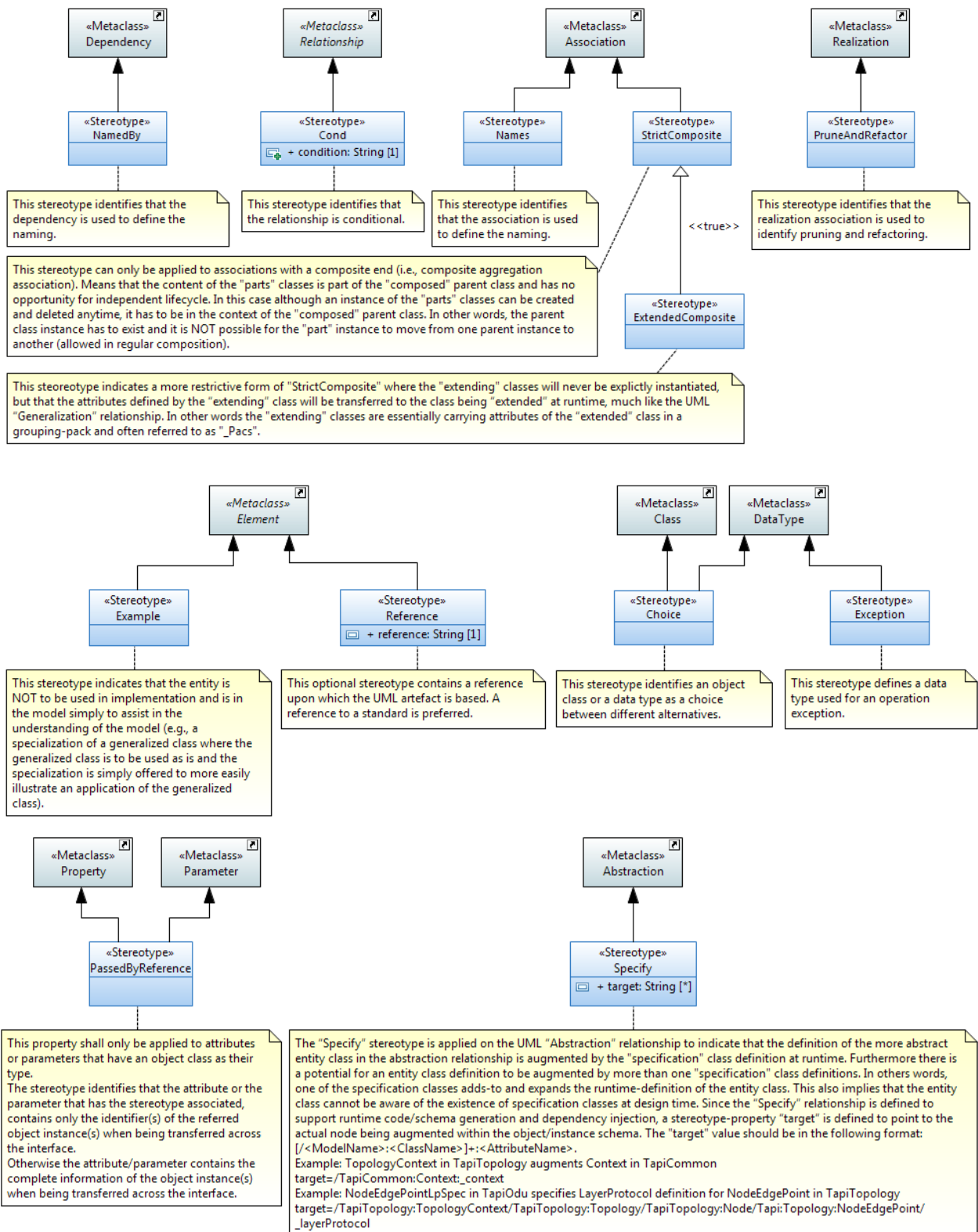


Figure 6.2-2: Optional "Stereotypes"

The NFV Information Model is only supporting a subset of the stereotypes and properties of the OpenModel profile. The stereotypes and properties not supported by the ETSI NFV Information Model are marked with an asterisk in table 6.2-1.

Table 6.2-1: UML Artefact Properties Defined in Complex "Stereotypes"

| Stereotype | Name of property | Type | Allowed values | Default value | Associated to metaclass |
|----------------------|--------------------------------------|-------------|---|---------------|-------------------------|
| OpenModelClass | support | enumeration | MANDATORY, OPTIONAL, CONDITIONAL_MANDATORY, CONDITIONAL_OPTIONAL, CONDITIONAL | MANDATORY | Class |
| | condition | string | | | |
| | partOfObjectKey * | Integer | 0, 1, 2, 3, etc. | 0 | |
| | attributeValue Change Notification * | enumeration | NO, YES, NA | NA | |
| OpenModelAttribute | isInvariant | Boolean | true/false | false | Property |
| | valueRange * | string | | NA | |
| | bitLength * | BitLength | NA, LENGTH_8_BIT, LENGTH_16_BIT, LENGTH_32_BIT, LENGTH_64_BIT | NA | |
| | unsigned * | Boolean | true/false | false | |
| | encoding * | Encoding | NA, BASE_64, HEX, OCTET, | NA | |
| | counter * | Counter | NA, COUNTER, GAUGE, ZERO_COUNTER, | NA | |
| | unit * | String | | | |
| | support | enumeration | MANDATORY, OPTIONAL, CONDITIONAL_MANDATORY, CONDITIONAL_OPTIONAL, CONDITIONAL * | MANDATORY | |
| | condition | string | | | |
| | support * | enumeration | MANDATORY, OPTIONAL, CONDITIONAL_MANDATORY, CONDITIONAL_OPTIONAL, CONDITIONAL | MANDATORY | |
| OpenModelInterface * | isOperationIdempotent * | Boolean | true/false | false | Interface |
| | isAtomic * | Boolean | true/false | false | |

| Stereotype | Name of property | Type | Allowed values | Default value | Associated to metaclass |
|-----------------------|----------------------|-------------|---|---------------|-------------------------|
| OpenModelOperation * | support * | enumeration | MANDATORY, OPTIONAL, CONDITIONAL_ MANDATORY, CONDITIONAL_ OPTIONAL, CONDITIONAL | MANDATORY | Operation |
| | condition * | string | | | |
| | valueRange * | string | | NA | |
| | support * | enumeration | MANDATORY, OPTIONAL, CONDITIONAL_ MANDATORY, CONDITIONAL_ OPTIONAL, CONDITIONAL | MANDATORY | |
| OpenModelParameter * | condition * | string | | | Parameter |
| | triggerConditionList | String | | | |
| | support | enumeration | MANDATORY, OPTIONAL, CONDITIONAL_ MANDATORY, CONDITIONAL_ OPTIONAL, CONDITIONAL | MANDATORY | |
| OpenModelNotification | condition | string | | | Signal |

6.3 Additional Properties for all UML artefacts

6.3.1 LifecycleState Property

All UML artefacts (packages, classes, attributes, interfaces, operations, parameters, datatypes, notifications, associations and generalizations) can be appended with one of the following lifecycle states, using the Lifecycle stereotypes shown in figure 6.3.1-1:

- **Deprecated:**
 - This stereotype indicates that the entity may become obsolete in the near future. It may still be used in new implementation.
 - The entity should be kept in this state for at least one further release. The team has to decide on a case by case basis when to move it to Obsolete.
- **Experimental:**
 - This stereotype indicates that the entity is at a very early stage of development and will almost certainly change. The entity is NOT mature enough to be used in implementation.
- **Faulty:**
 - This stereotype indicates that the entity should not be used in new implementation and that attempts should be made to remove it from existing implementation as there is a problem with the entity. An update to the model with corrections will be released.

- LikelyToChange:
 - This stereotype indicates that although the entity may be mature, work in the area has indicated that change will be necessary (e.g. there are new insights in the area or there is now perceived benefit to be had from further rationalization). The entity can still be used in implementation but with caution.
- Mature:
 - This stereotype indicates that the entity is fully developed and can be used in implementations without any constraints.
- Obsolete:
 - This stereotype indicates that the entity should not be used in new implementation and that attempts should be made to remove it from existing implementation.
 - The entity should be kept in the model at least for one further release. The team has to decide on a case by case basis when to remove it from the model.
- Preliminary:
 - This state indicates that the entity is at a relatively early stage of development and is likely to change, but is mature enough to be used in implementation.

Rules:

One and only one lifecycle state has to be associated to every UML artefact.

It is recommended that every new UML artefact is initially annotated with the "Experimental" lifecycle stereotype.

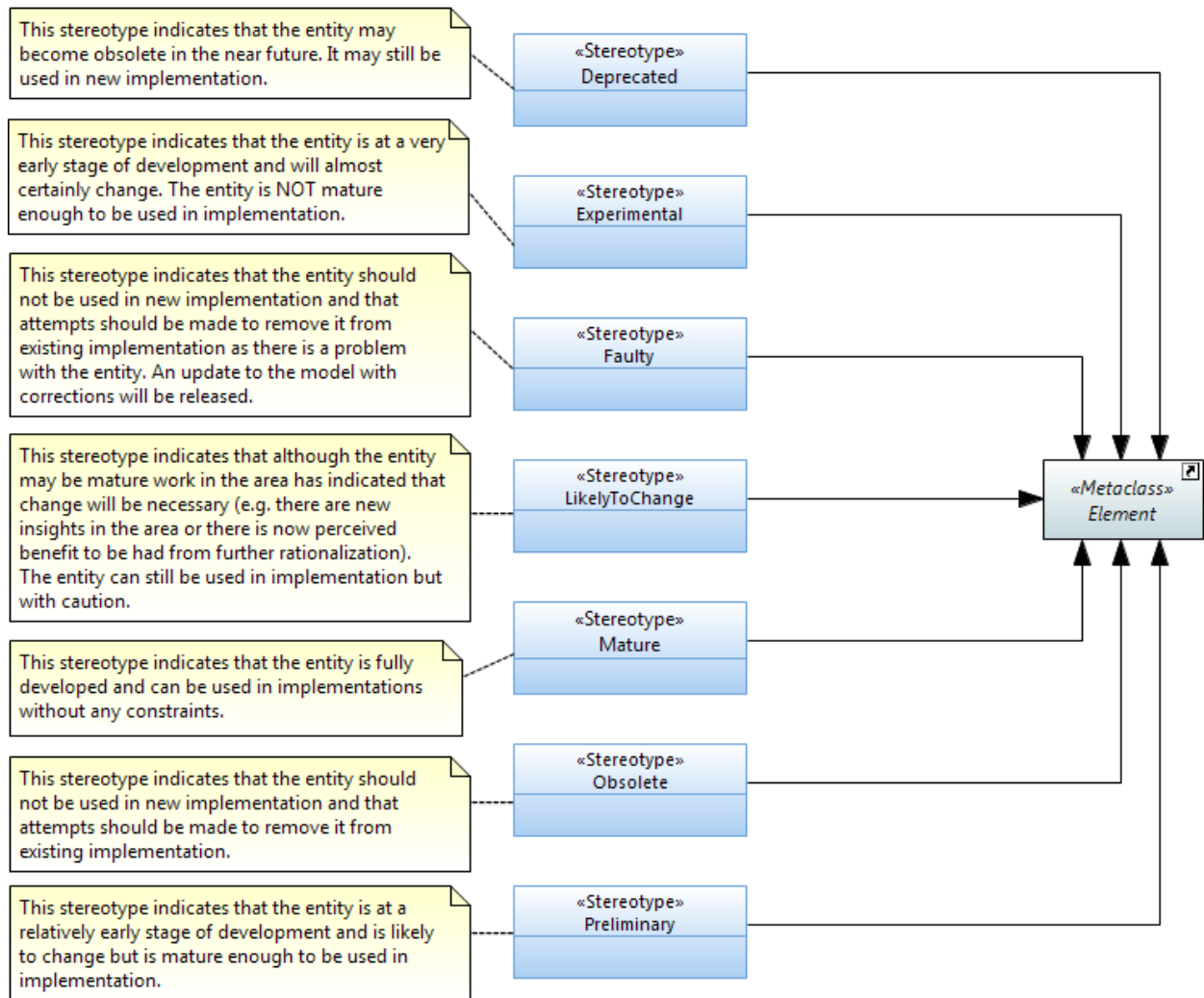


Figure 6.3.1-1: Lifecycle "Stereotypes"

The following state machine diagram, presented in figure 6.3.1-2, shows the defined state transitions.

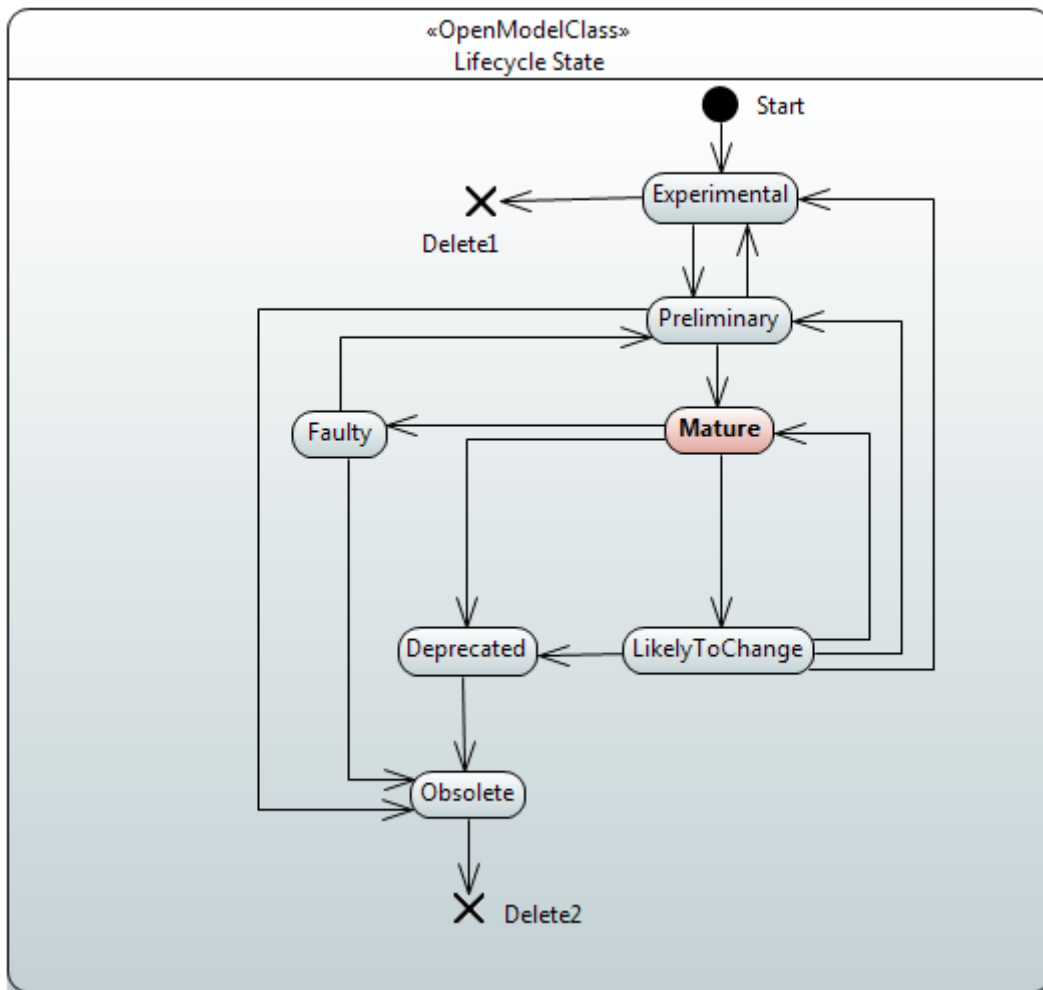


Figure 6.3.1-2: OpenModelProfile LifecycleState State Machine

6.3.2 Reference property

A reference can be defined for all UML artefacts. This is an optional property which contains a reference upon which the artefact is based. A reference to a standard is preferred.

The reference property is defined in the Reference stereotype and extend the Element Metaclass, as shown in figure 6.3.2-1.

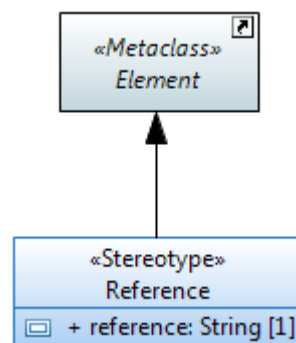


Figure 6.3.2-1: Reference "Stereotype"

6.3.3 Example property

This is an optional property which can be defined for all UML artefacts.

It is defined as a stereotype, as shown in figure 6.3.3-1, and indicates that the entity is NOT to be used in implementation and is in the model simply to assist in the understanding of the model (e.g. a specialization of a generalized class where the generalized class is to be used as is and the specialization is simply offered to more easily illustrate an application of the generalized class).

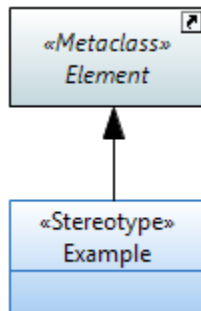


Figure 6.3.3-1: Example "Stereotype"

7 Recommended Modeling Patterns

7.1 Model Structure

The NFV Information Model, as shown in figure 7.1-1, is organized in a Core Model and extensions, extending the Core Model for specific needs.

One extension, Interface Information Model, is currently defined for containing information elements specific to interfaces.

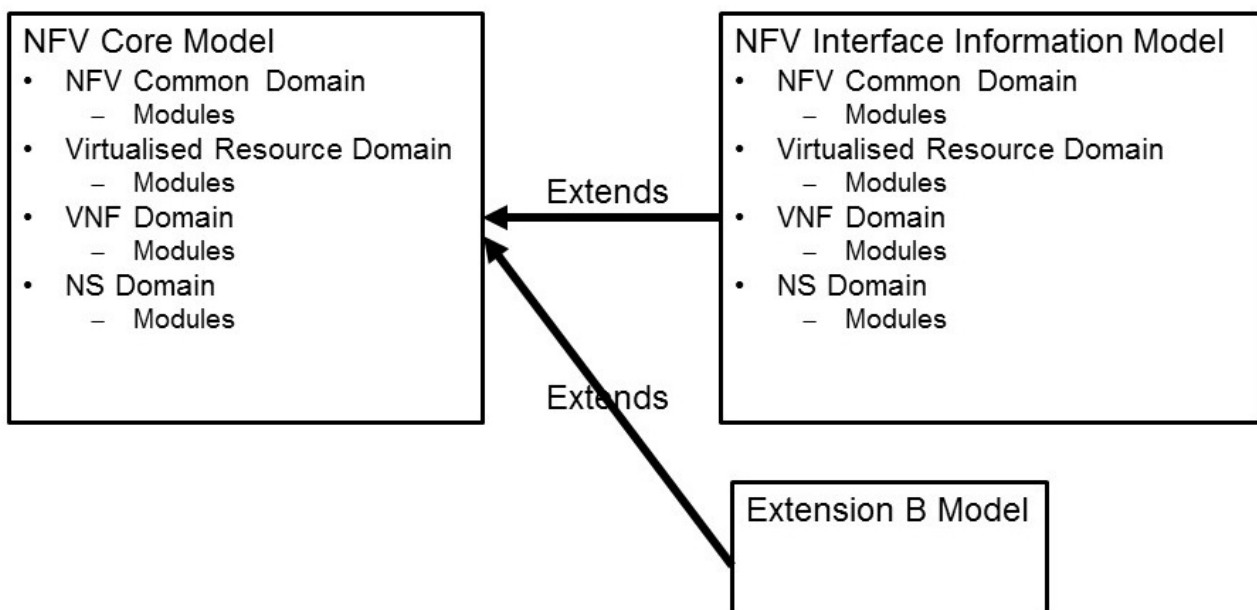


Figure 7.1-1: NFV Information Model structure

Each model is structured in Domains. Four domains are defined today:

- NFV Common Domain.
- Virtualised Resource Domain.
- VNF Domain.
- NS Domain.

Each domain can be structured in modules (represented by packages) and modules can be structured in sub-modules.

If a module is structured in sub-modules, it should only contain sub-modules and no other artefact (class, data type, etc.)

The ETSI NFV Information Model does not use pre-defined packages (i.e. by type of artefact) within the modules. Use of such pre-defined packages would break the generation of the model documentation using Gendoc.

7.2 Use of XOR/Choice/Proxy class

7.2.1 Xor constraint

7.2.1.1 Description

"A Constraint is an assertion that indicates a restriction that has to be satisfied by any valid realization of the model containing the Constraint. A Constraint is attached to a set of constrainedElements, and it represents additional semantic information about those Elements....", an extract from clause 7.6.1 Constraint of the OMG Unified Modeling Language (OMG UML) specification [i.3].

For a constraint that applies to two elements such as two associations, the constraint needs to be shown as a dashed line between the elements labelled by the constraint string (in braces). The constraint string, in this case, is xor.

7.2.1.2 Example

Figure 7.2.1.2-1 shows a ServerObjectClass instance that has relation(s) to multiple instances of a class from the choice of ClientObjectClass_Alternative1, ClientObjectClass_Alternative2 or ClientObjectClass_Alternative3.

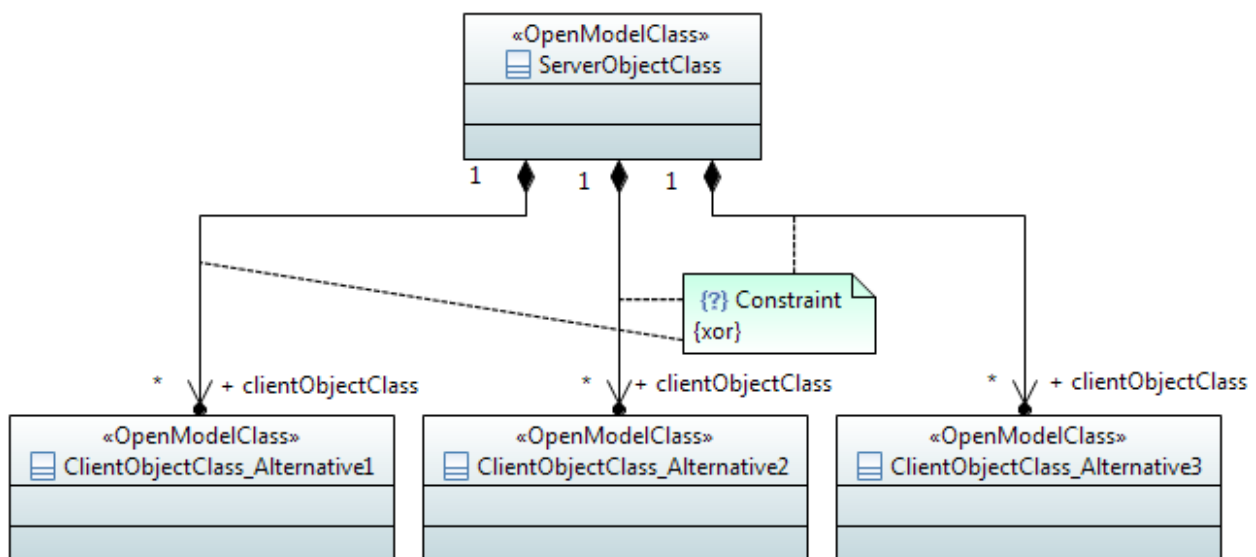


Figure 7.2.1.2-1: {xor} notation

7.2.1.3 Name style

It has no name so there is no name style.

7.2.2 "Choice"

The "Choice" stereotype represents one of a set of classes (when used as an information model element) or one of a set of data types (when used as an operations model element).

This stereotype is not supported in the ETSI NFV Information Model.

7.2.3 Proxy class Modeling

There are cases where an attribute or parameter may contain different kinds of classes. This would require an attribute/parameter per kind of class. In order to reduce the number of attributes/parameters it is recommended to define a proxy class and let a single attribute/parameter point to this class.

This modeling pattern is not supported in the ETSI NFV Information Model.

7.3 UML diagram guidelines

7.3.1 Recommendations

Classes and their relationships are presented in class diagrams.

It is recommended to create:

- An overview class diagram containing all classes related to a specific management area (e.g. module). - The class name compartment should contain the location of the class definition (e.g. "Qualified Name"). Depending on the complexity of the diagram, attributes and association roles might be shown or might be omitted in the overview diagram.
- A separate inheritance class diagram in case the overview diagram would be overloaded when showing the inheritance structure (Inheritance Class Diagram).
- A class diagram containing the user defined data types (Type Definitions Diagram).
- Additional class diagrams to show specific parts of the specification in detail as needed. Attributes and association roles can be shown on these diagrams.

7.3.2 Using colours

The colour conventions defined in clause 5.2 of ETSI GR NFV-IFA 015 [i.5] are applicable.

7.3.3 Style sheets

Classes in class diagrams should not show the "nestedclassifiers" and "operations" compartments.

Data Types in class diagrams should not show the "operations" compartment.

The use of the `CompartmentRestrictions.css` style sheet fulfils these requirements.

Attributes in class diagrams should only show name, type, multiplicity and default value.

Attributes in class diagrams should not show the stereotype "OpenModelAttribute".

The use of the `NoStereotypesDiagram.css` style sheet fulfils these requirements.

Annex A: Change History

| date | Version | Information about changes |
|-------------|----------------|---|
| June 2020 | V3.4.1 | Publication (unmodified with respect to version V3.1.1) |
| | | |
| | | |

History

| Document history | | |
|-------------------------|-------------|-------------|
| V3.1.1 | August 2018 | Publication |
| V3.4.1 | June 2020 | Publication |
| | | |
| | | |
| | | |