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Guidelines for Translation of UML Information Model to YANG Data Model

draft-mansfield-netmod-uml-to-yang-02

Abstract

This document defines guidelines for translation of data modeled with UML to YANG including mapping of object classes, attributes, data types, associations, interfaces, operations and operation parameters, notifications, and lifecycle.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

As discussed in draft-lam-teas-usage-info-model-net-topology [7] a Data Model (DM) may be derived from an Information Model (IM). However, in order to assure a consistent and valid data modelling language representation that enables maximum interoperability, translation guidelines are required. A set of translation rules also assists in development of automated tooling.

This draft defines guidelines for translation of data modelled with UML [8] (as constrained by the ONF's UML Modeling Guidelines [9]) to YANG (defined in RFC6020 [1] and YANG Update [5]) including mapping of object classes, attributes, data types, associations, interfaces, operations and operation parameters, notifications, and lifecycle.

2. Terminology

The following terms are defined in RFC6020 [1]

- anydata
- anyxml
- augment
- container
- data node
- identity
- instance identifier
- leaf
- leaf-list
- list
- module
- submodule

The following terms are defined in UML 2.4 [8]

- association
- attribute
- data type
- interface
- object class
- operation
- parameter
- signal (used to model notifications)

3. Overview

This document defines translation rules for all constructs used in a UML based IM to a data model using YANG.

While some mapping rules are straightforward, an IM in UML uses some constructs that cannot be mapped directly to a DM using YANG and conventions are described to make the translation predictable. Additionally, in some cases multiple mapping approaches are possible and selection among these is also necessary to assure interoperability.

Mapping guidelines for these constructs are provided in the following sections.

4. Mapping Guidelines

4.1 Mapping Guideline Considerations

Where "??" is inserted in the table, it means that the specific mapping is for further study as it is either as yet unclear how to map the construct or that there are multiple ways of doing the mapping and a single one needs to be selected.

A table will be included summarizing constructs in UML that do not directly map to YANG and where in this draft the associated guidelines for mapping these constructs will be provided.

4.2 Mapping of Object Classes

Object Class		
- Real object classes having/inheriting at least one attribute identified as "identifier" will be mapped to a "list" statement - Real object classes not having/inheriting any attribute identified as "identifier" will be mapped to a "container" statement - Abstract object classes used for inheritance will be mapped to a "grouping" statement		
UML Artifact	YANG Artifact	Comment
documentation "Applied comments" (carried in XMI as "ownedComment")	"description" substatement	Multiple "applied comments" defined in UML, need to be collapsed into a single "description" substatement.
superclass(es)	"grouping" statement	Concrete superclasses are then mapped to container/list which uses these groupings.
abstract	"grouping" statement	It is possible that the superclass or abstract class contains the key attribute for the instantiated subclass, this requires the creation of the grouping but later when the subclass is instantiated the key value must be identified from within the grouping.
object identifier Note: Attributes used as object identifier are defined in UML by the attribute property "partOfObjectKey".	list::"key" substatement	It is possible that the super-class or abstract class contains the key attribute for the instantiated subclass.
object identifier list Does not appear in the UML when mapping to YANG.		The splitting of a list attribute (marked as key) into a single key attribute and an additional list attribute will be done in UML during Pruning and Refactoring. i.e. The mapping tool will never get a list attribute which is part of the object identifier.
objectCreationNotification [YES/NO/NA]	"notification" statement	Goes beyond the simple "a notification has to be sent": a tool can construct the signature of the notification by reading the created object.
objectDeletionNotification [YES/NO/NA]	"notification" statement	Goes beyond the simple "a notification has to be sent": a tool can construct the signature of the notification by reading the deleted object. (i.e. not necessary to provide the attributes of the deleted object).

support condition	"if-feature" substatement	Support and condition belong together. If the "support" is conditional, then the "condition" explains the conditions under which the class has to be supported.
operation	"action" substatement	YANG 1.0 supports only rpc -> add prefix to the rpc name; i.e. objectClass::rpc; "action" requires YANG 1.1
XOR	"choice" substatement	
muliplicity on association	list::"min-elements" "max-elements" substatements	min-elements default = 0 max-elements default=unbounded mandatory default=false
Conditional PACs	container::presence" substatement	
hyperlink??	"reference" substatement	Papyrus doesn't support hyperlinks
lifecycle stereotypes	"status" substatement	UML: <<Example>>, <<Experimental>>, <<Faulty>>, <<LikelyToChange>>, <<Deprecated>>, <<Obsolete>>, <<Preliminary>> YANG: "current", "deprecated", "obsolete", default="current"
constraint property	list::"unique" substatement	UML is not able to define a group of attributes to be unique as YANG can do using the "unique" substatement.
abstract superclass/ inheritance complex attribute	"uses" substatement	use of a complex data type as the type of the attribute; e.g., date and time, object creation data It is possible that the superclass or abstract class contains the key attribute for the instantiated subclass.
{<constraint>}	"when" substatement	

Figure 1: Mapping of Object Classes

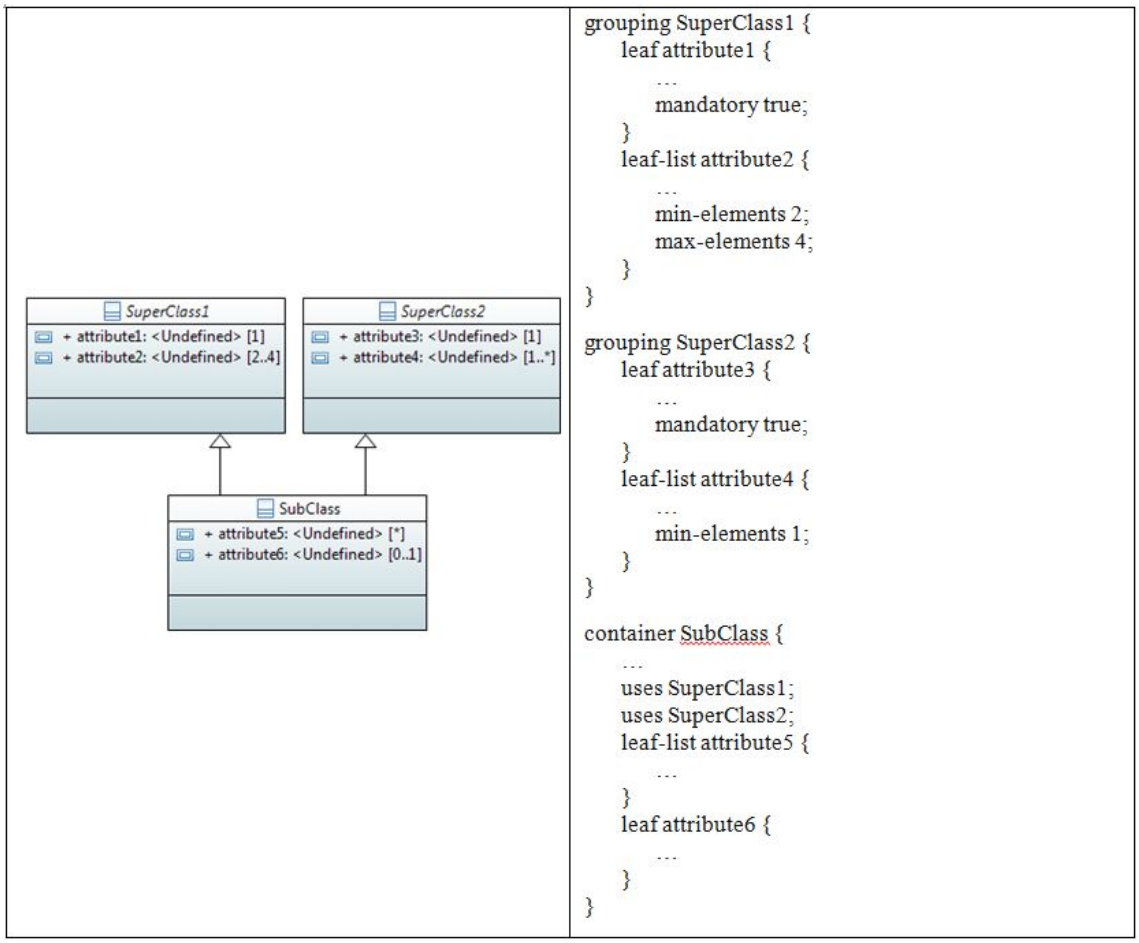


Figure 2: Example of Abstract Object Class Mapping (Available in PDF or HTML versions)

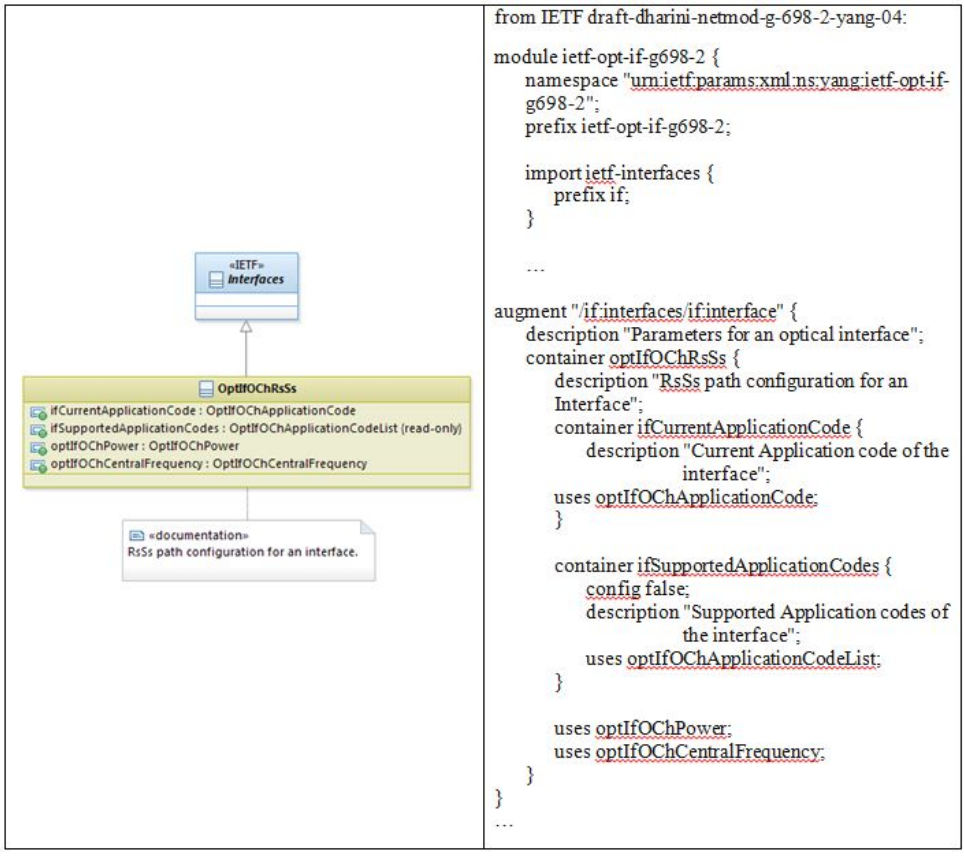


Figure 3: Example of Non-Abstract Object Class Mapping (Available in PDF or HTML versions)

4.3 Mapping of Attributes

Attribute --> "leaf" (single) or "leaf list" (multiple) statement		
UML Artifact	YANG Artifact	Comment
documentation "Applied comments" (carried in XMI as "ownedComment")	"description" substatement	Multiple "applied comments" defined in UML, need to be collapsed into a single "description" substatement.
type	"type" substatement (built-in or derived)	
readOnly	"config" substatement (false)	config default = true
isOrdered	"ordered-by" substatement ("system" or "user")	ordered-by default = system
multiplicity	"mandatory" or "min-elements" and "max-elements" substatements [0..1]=>no mapping needed; is default substatement=false [1]=>mandatory substatement=true [0..x]=> no mapping needed; is default [1..x]=> min-elements substatement = 1 [0..3]=> max-elements substatement = 3	min-elements default = 0 max-elements default=unbounded mandatory default=false
defaultValue	"default" substatement	If a default value exists and it is the desired value, the parameter does not have to be explicitly configured by the user.
isInvariant	"extension" substatement -> ompExt:isInvariant	
valueRange	"pattern", "range", or "length" substatement of "type" substatement	
passedByReference	if passedByReference = true -> type leafref {path "/<object>/<objectidentifier>"} if passedByReference = false -> either "list" statement (key property, multiple instances) or "container" statement(single instance)	Relevant only to attributes that have an object class defined as their type.
partOfObjectKey > 0	list::"key" substatement	It is possible that the (abstract) superclass contains the key attribute for the instantiated subclass.
unit	"units" substatement	Need to discuss with the YANG community about a standard way to express units (e.g. kilobitspersecond, kbit/s, kilobits/second, kbit/sec). Current description of the new "unit" property in OpenModelProfile v0.2.1 is: "This optional property contains a textual definition

		of the unit associated with the attribute value. The spelling of the unit, including the ones beyond SI scope, shall be in accordance to the NIST Publication 811 "Guide for the Use of the International System of Units (SI)" (http://www.nist.gov/pml/pubs/sp811/index.cfm), section 9 "Rules and Style Conventions for Spelling Unit Names"."
support	For conditional support only:	Support and condition belong together. If the "support" is conditional, then the "condition" explains the conditions under which the class has to be supported.
condition	"if-feature" substatement "when" substatement if condition can be formalized as XPath expression (i.e., it is conditioned by the value of another attribute)	
error notfication??	"must" substatement	
hyperlink??	"reference" substatement	Papyrus doesn't support hyperlinks
lifecycle stereotypes	"status" substatement	"current" "deprecated" "obsolete" default="current"
{<constraint>}	"when" substatement	

Figure 4: Mapping of Attributes

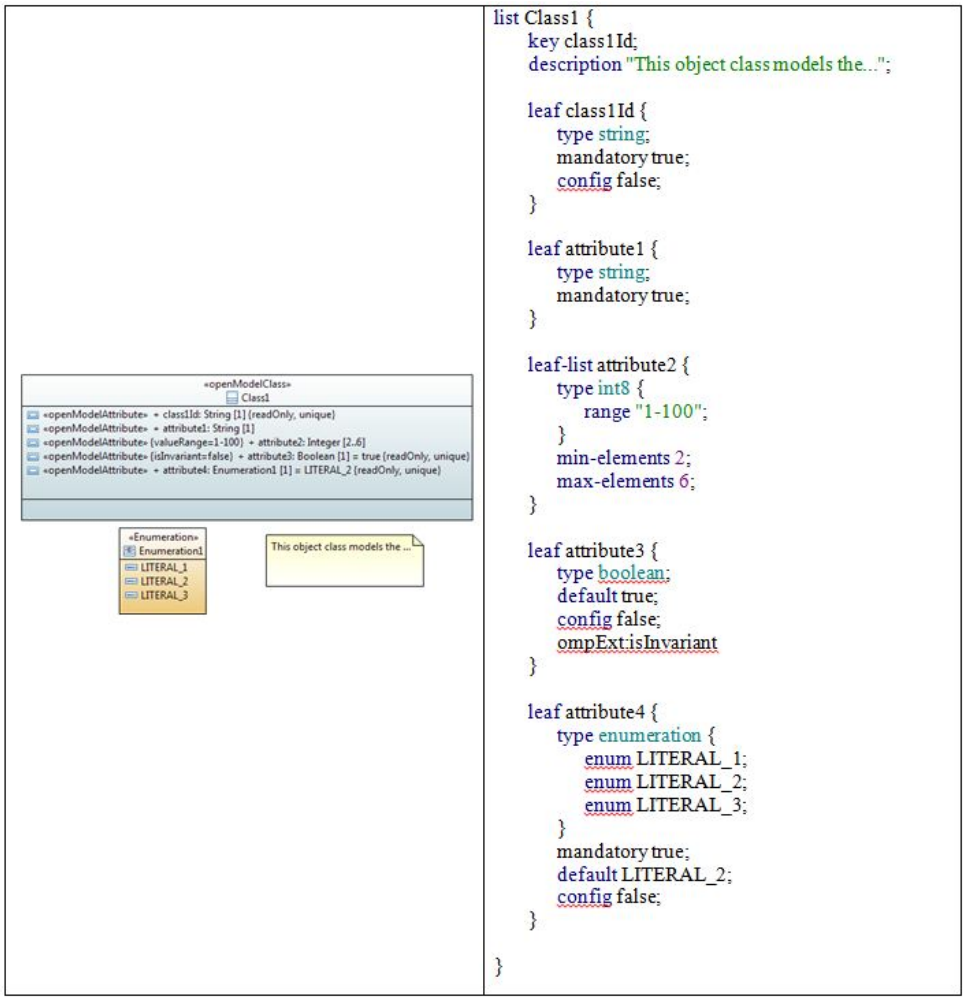


Figure 5: Example of Attribute Mapping (Available in PDF or HTML versions)

4.4 Mapping of Types

Types		
UML Artifact	YANG Artifact	Comment
Primitive Type	Built-In Type if defined; otherwise ??	e.g., Integer new built-in type??
Enumeration	"enum" statement	
Basic Data Type	"typeDef" statement	e.g., MAC address, IPv4 Address
Complex Data Type	"grouping" statement	e.g., date-time object creation data

Figure 6: Mapping of Types

4.4.1 Mapping of Primitive Types

Primitive Type -> new built-in type??		
UML Artifact	YANG Artifact	Comment
documentation (carried in XMI as "ownedComment")	Description field	
Integer	int64	
Boolean	boolean	
String	string	
Real	??	

Figure 7: Mapping of Primitive Types

4.4.2 Mapping of Enumeration Types

Enumeration Type -> "enum" statement typedef for reusable (indirect usage) enumerations identity statement?		
UML Artifact	**YANG Artifact**	**Comment**
documentation "Applied comments" (carried in XMI as "ownedComment")	"description" substatement	Multiple "applied comments" defined in UML, need to be collapsed into a single "description" substatement.
literal integer	"value" substatement	
hyperlink??	"reference" substatement	Papyrus doesn't support hyperlinks
lifecycle stereotypes	"status" substatement	"current", "deprecated", "obsolete" default=current
??	"if-feature" statement	

Figure 8: Mapping of Enumeration Types

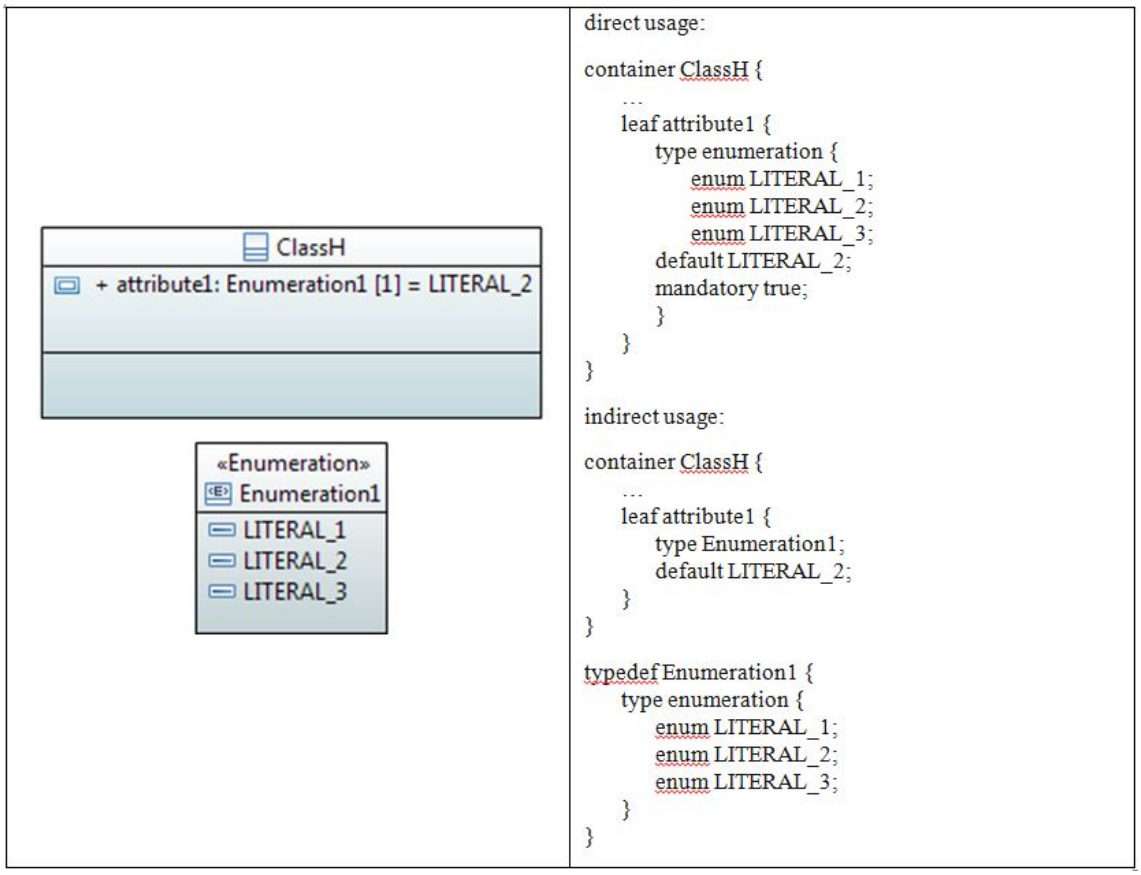


Figure 9: Example of Enumeration Type Mapping (Available in PDF or HTML versions)

4.4.3 Mapping of Basic Data Types

Basic Data Type -> "typeDef" statement		
UML Artifact	YANG Artifact	Comment
documentation "Applied comments" (carried in XMI as "ownedComment")	"description" substatement	Multiple "applied comments" defined in UML, need to be collapsed into a single "description" substatement.
type	"type" substatement (built-in type)	
defaultValue	"default" substatement	If a default value exists and it is the desired value, the parameter does not have to be explicitly config-ured by the user.
hyperlink??	"reference" substatement	Papyrus doesn't support hyperlinks
lifecycle stereotypes	"status" substatement	"current", "deprecated", "obsolete" default=current
unit	"units" statement	

Figure 10: Mapping of Basic Data Types

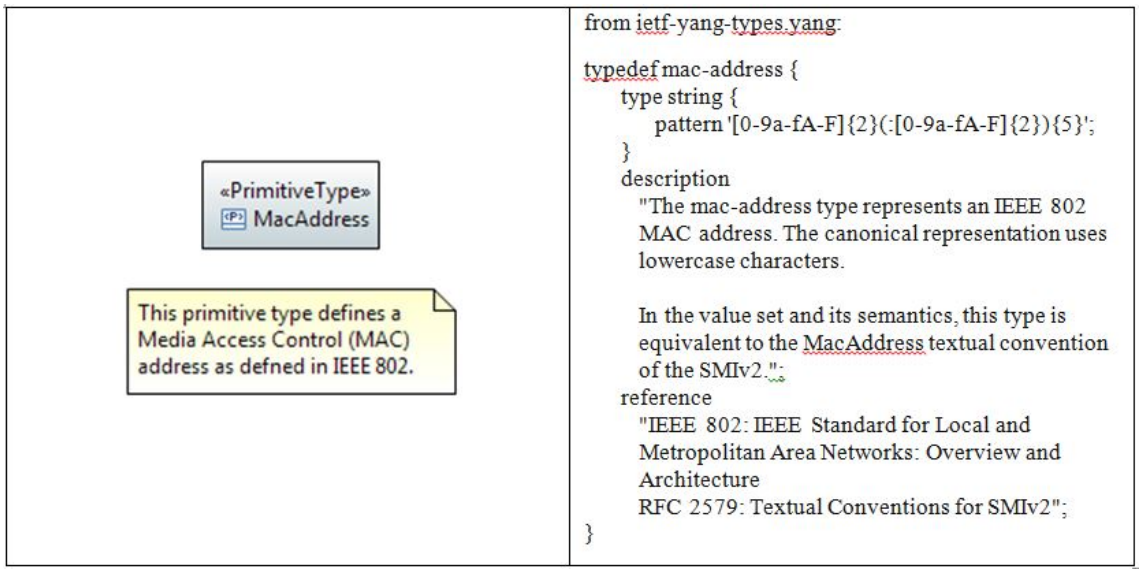


Figure 11: Example of Basic Data Type Mapping (Available in PDF or HTML versions)

4.4.4 Mapping of Complex Data Types

Complex Data Type -> "grouping" statement		
UML Artifact	YANG Artifact	Comment
documentation "Applied comments" (carried in XMI as "ownedComment")	"description" substatement	Multiple "applied comments" defined in UML, need to be collapsed into a single "description" substatement.
not used	"action" substatement	
XOR	"choice" substatement	
hyperlink??	"reference" substatement	Papyrus doesn't support hyperlinks
lifecycle stereotypes	"status" substatement	"current", "deprecated", "obsolete" default=current
complex attribute	"uses" statement	

Figure 12: Mapping of Complex Data Types

Leaf and leaf-list can only use built-in types, typeDef types or enumerations in their type substatement; i.e., not groupings. Complex data types with more than one item (e.g., name value pair) can only be defined using groupings. Groupings can only be used by grouping, container and list statements.

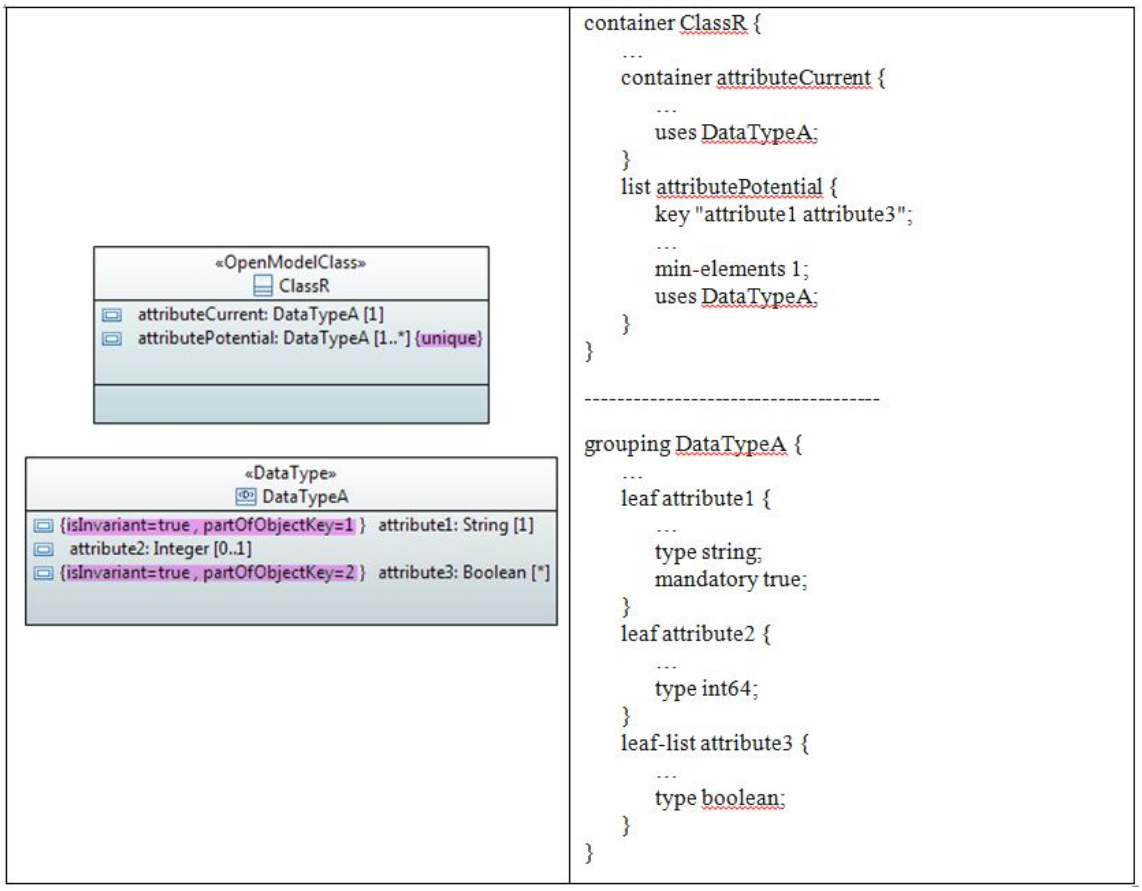


Figure 13: Example of Complex Data Type Mapping (Available in PDF or HTML versions)

4.5 Mapping of Associations

Associations		
UML Artifact	YANG Artifact	Comment
Inheritance	abstract superclass: "grouping" statement concrete superclass: "augment" statement	Multiple inheritance can also be mapped using "groupings" Need to define when augment is used. Note: Augmentation can be conditional.
Composition with (aggregation= 'composite') "passed by value"	"container" statement containing "list" statement(s) (multiple contained instances) or "container" statement(s) (single contained instances)	How to map "passed by reference"??
Aggregation with (aggregation='shared') "passed by reference"	"leafref" statement	How to map "passed by value"??

Figure 14: Mapping of Associations

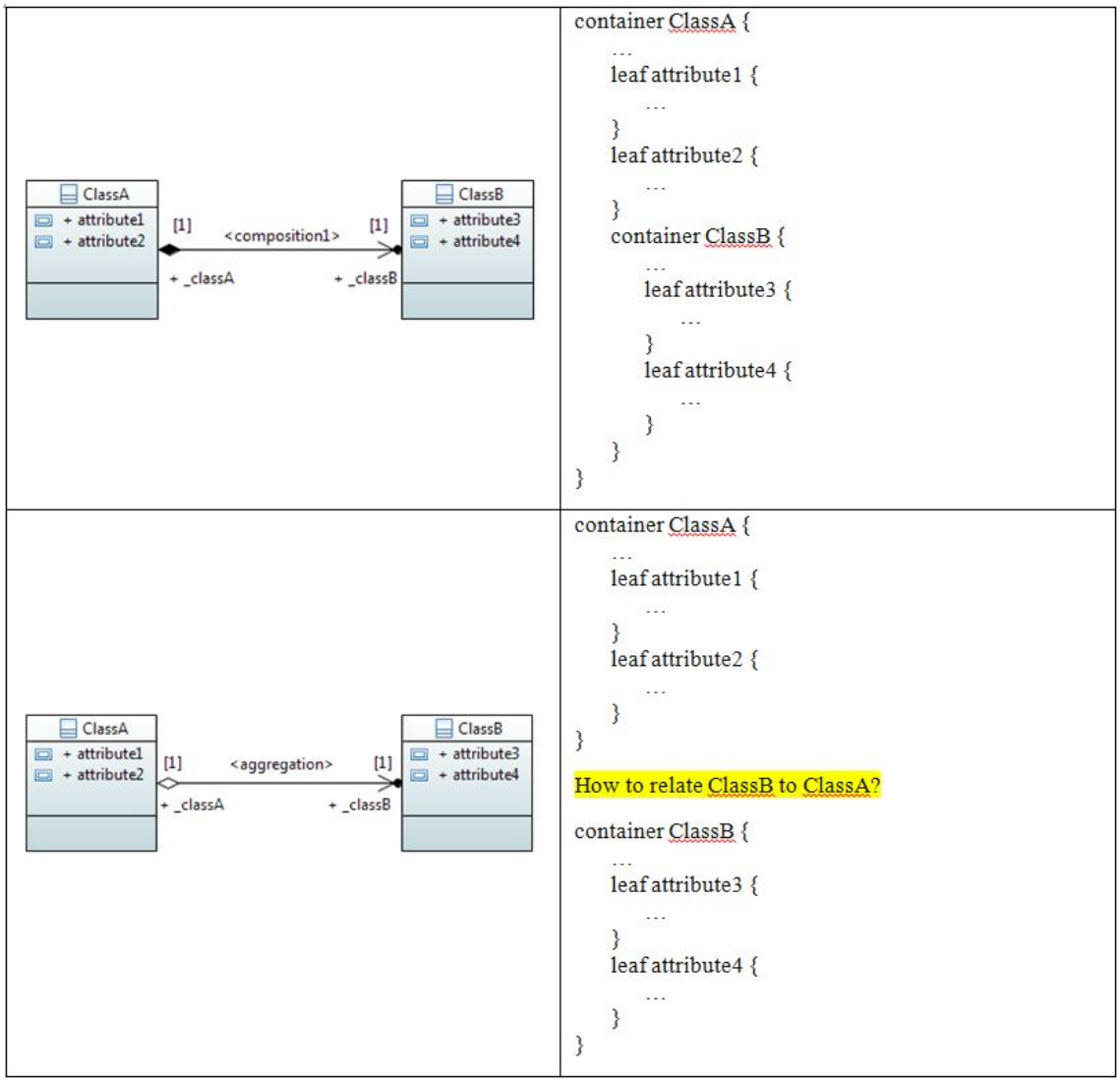
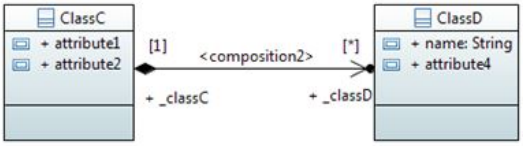
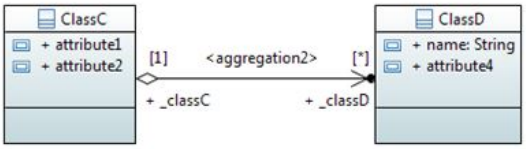


Figure 15: Association Mapping Example 1 (Available in PDF or HTML versions)




```
container ClassC {
    ...
    leaf attribute1 {
        ...
    }
    leaf attribute2 {
        ...
    }
    list ClassD {
        key "name";
        leaf name {
            type string;
        }
        leaf attribute4 {
            ...
        }
    }
}
```

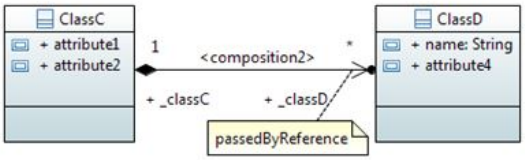



```
container ClassC {
    ...
    leaf attribute1 {
        ...
    }
    leaf attribute2 {
        ...
    }
}
```

How to relate ClassD to ClassC?

```
list ClassD {
    key "name";
    leaf name {
        type string;
    }
    leaf attribute4 {
        ...
    }
}
```

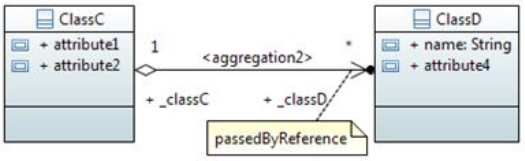
Figure 16: Association Mapping Example 2 (Available in PDF or HTML versions)




```
container ClassC {
    ...
    leaf attribute1 {
        ...
    }
    leaf attribute2 {
        ...
    }
    leaf-list classD {
        type leafref {
            path "/ClassD/name";
        }
    }
}

list ClassD {
    key "name";
    leaf name {
        type string;
    }
    leaf attribute4 {
        ...
    }
}
```

Note: Lifecycle dependency is not considered in the YANG mapping!




```
container ClassC {
    ...
    leaf attribute1 {
        ...
    }
    leaf attribute2 {
        ...
    }
    leaf-list _classD {
    type leafref {
        path "/ClassD/name";
    }
}

list ClassD {
    key "name";
    leaf name {
        type string;
    }
    leaf attribute4 {
        ...
    }
}
```

Figure 17: Association Mapping Example 3 (Available in PDF or HTML versions)

	UML		
	containment	association	inheritance
YANG	nesting	X	
	grouping		X (abstract superclasses)
	augment		X (concrete superclasses)
	leafref	X	

Figure 18: Association Mapping Summary

4.6 Mapping of Interfaces

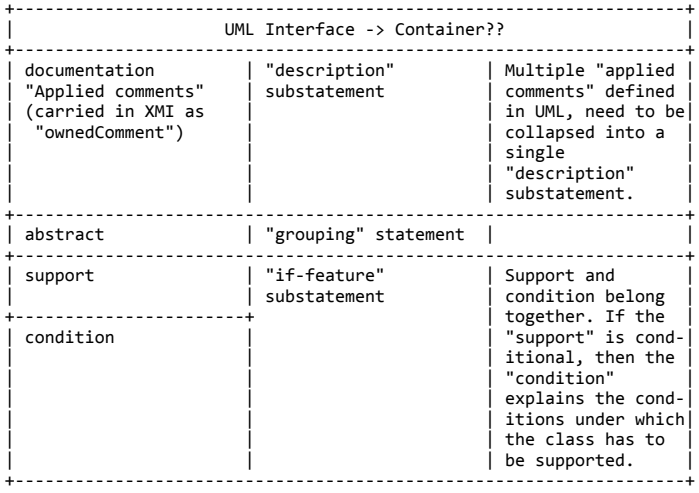


Figure 19: Mapping of Interfaces (grouping of operations

4.7 Mapping of Operations

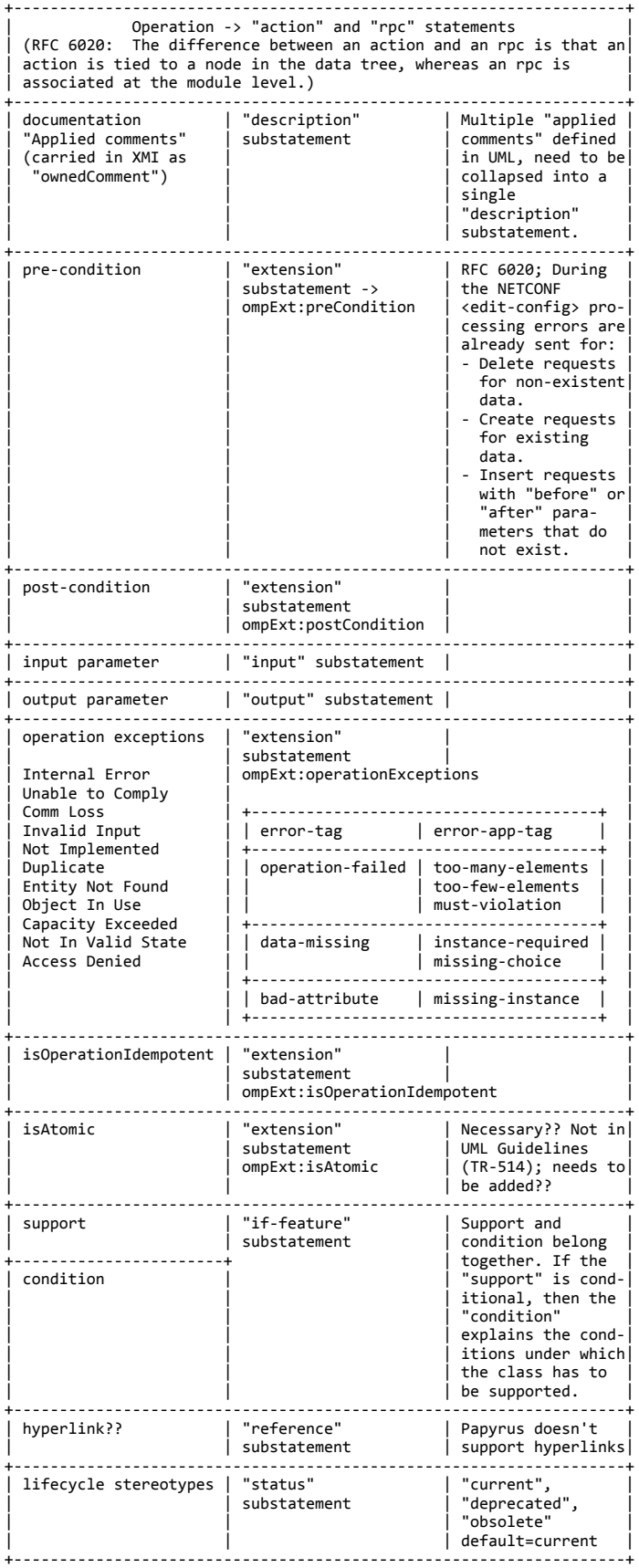


Figure 20: Mapping of Operations

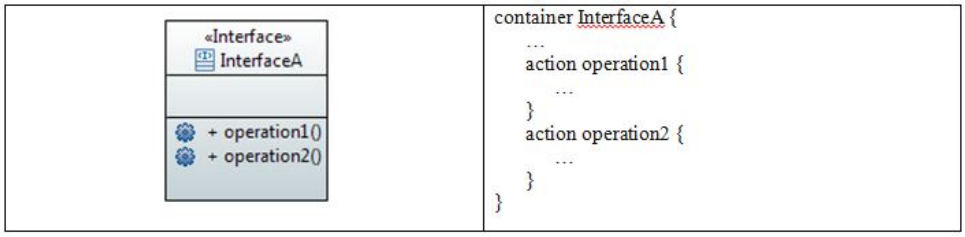


Figure 21: Operation Mapping Example (Available in PDF or HTML versions)

4.8 Mapping of Operation Parameters

Operation Parameters		
documentation "Applied comments" (carried in XMI as "ownedComment")	"description" substatement	Multiple "applied comments" defined in UML, need to be collapsed into a single "description" substatement.
direction	"input" or "output" substatement	
type	see mapping of attribute types (grouping, leaf, leaf-list, list, typedef, uses)	
isOrdered		
multiplicity		
defaultValue		
valueRange		
passedByReference	if passedByReference = true -> type leafref { path "/<object>/<objectidentifier>"} if passedByReference = false -> either "list" statement (key property, multiple instances) or "container" statement(single instance)	Relevant only to attributes that have an object class defined as their type.
support	"if-feature" substatement not defined for input and output substatements in YANG??	Support and condition belong together. If the "support" is cond-itional, then the "condition" explains the cond-itions under which the class has to be supported.
condition		
XOR	"choice" substatement	
error notification??	"must" substatement	
complex parameter	"uses" substatement	

Figure 22: Mapping of Operation Parameters

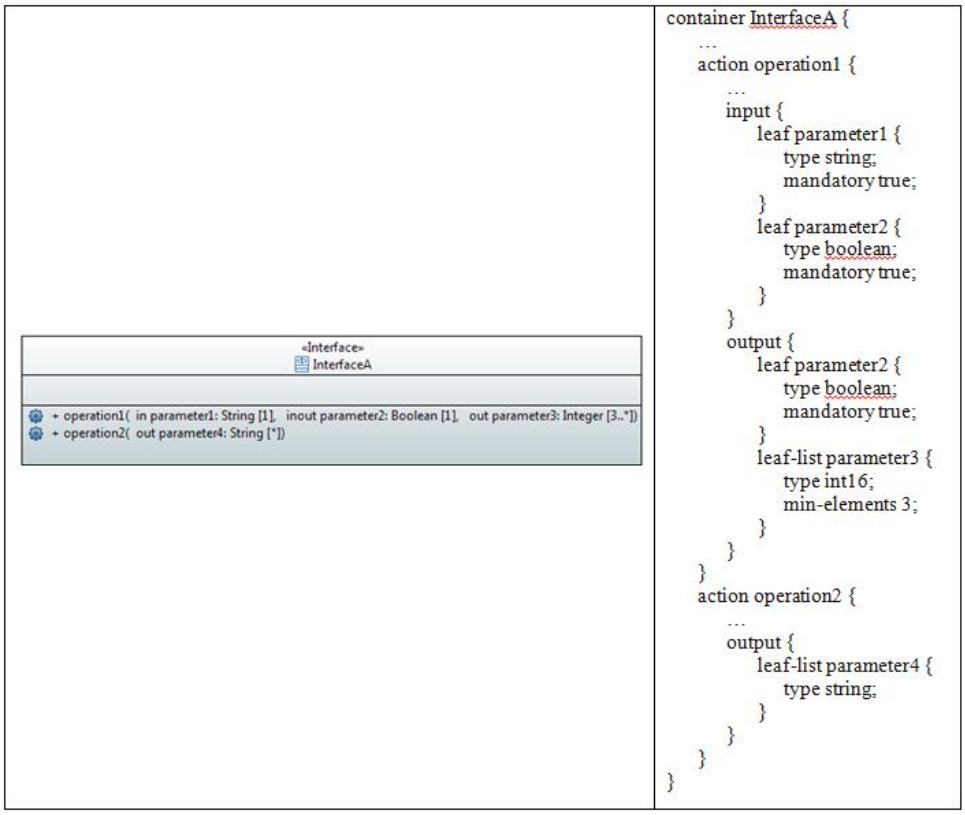


Figure 23: Parameter Mapping Example (Available in PDF or HTML versions)

4.9 Mapping of Notifications

Signal -> "notification" statement		
documentation "Applied comments" (carried in XMI as "ownedComment")	"description" substatement	Multiple "applied comments" defined in UML, need to be collapsed into a single "description" substatement.
support	"if-feature" substatement	Support and condition belong together. If the "support" is conditional, then the "condition" explains the conditions under which the class has to be supported.
condition		
XOR	"choice" substatement	
error notification??	"must" substatement	
hyperlink??	"reference" substatement	Papyrus doesn't support hyperlinks
lifecycle stereotypes	"status" substatement	"current", "deprecated", "obsolete" default=current
attributes	see mapping of attribute types (grouping, leaf, leaf-list, container, list, typedef, uses)	
complex attribute	"uses" substatement	

Figure 24: Mapping of Notifications

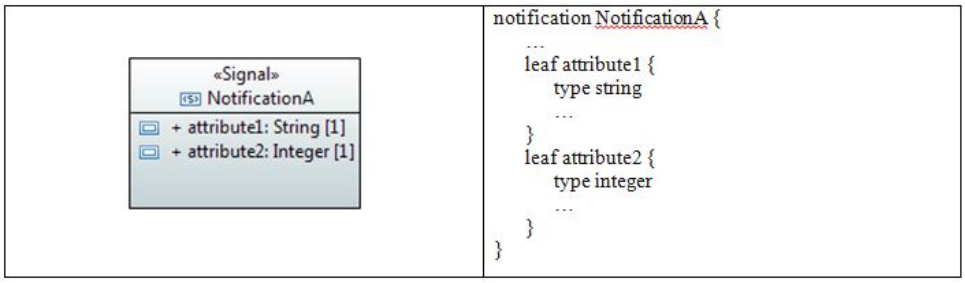


Figure 25: Notification Mapping Example (Available in PDF or HTML versions)

4.10 Mapping of Lifecycle

UML Lifecycle			
lifecycle stereotypes	"status" substatement	YANG: "current", "deprecated", "obsolete" default=current	
		UML: <<Example>>, <<Experimental>>, <<Faulty>>, <<Preliminary>>, <<Obsolete>>, <<LikelyToChange>>	
		How to map or enhance??	

Figure 26: Mapping of Lifecycle

4.11 Other Mappings

UML Lifecycle		
Conditional Package	"container" statement with "presence" substatement	
Package??	Submodule	

Figure 27: Other Mappings

5. Mapping Issues

5.1 Using types defined in YANG?

Many common types (primitive and complex) are already defined in YANG. E.g., ietf-inet-types, ietf-yang-types (others to be investigated):

```
+ ietf-inet-type
   + domain name and URI types
      - DomainName
      - Uri
      - <<Union>> Host
   + types related to
      IP addresses and hostnames
      - Ipv4Address
      - Ipv4AddressNoZone
      - Ipv4Prefix
      - Ipv6Address
      - Ipv6AddressNoZone
      - Ipv6Prefix
      - <<Union>> IpAddress
      - <<Union>> IpAddressNoZone
      - <<Union>> IpPrefix
   + types related to protocol fields
      - IpVersion
      - DSCP
      - IpV6FlowLabel
      - PortNumber
```

```
+ ietf-yang-types
   - Counter32
   - Counter64
   - DateAndTime
   - DottedQuad
   - Gauge32
   - Gauge64
   - HexString
   - MacAddress
   - ObjectIdentifier
   - ObjectIdentifier128
   - PhysAddress
   - Timestamp
   - Timeticks
   - Uuid
   - Xpath1.0
   - YangIdentifier
   - ZeroBasedCounter32
   - ZeroBasedCounter64
```

Figure 28: Re-engineered Example

It is proposed to define for the commonly used YANG types corresponding UML primitive or complex data types respectively. These types will be available (by default) for use in all UML information models. This "re-engineering" needs to be done without making the UML models YANG-depended.

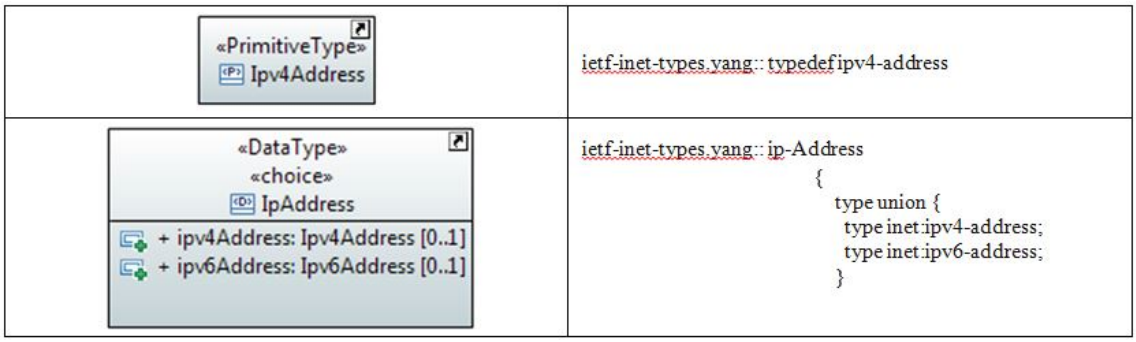


Figure 29: IP Address Mapping Example (Available in PDF or HTML versions)

5.2 YANG 1.0 or YANG 1.1

YANG 1.0 is approved and defined in RFC6020 [1].

YANG 1.1 is not currently approved and its definition is ongoing in draft-ietf-netmod-rfc6020bis [5]. Main enhancements are the action and anydata statements.

5.3 Mapping of UML Packages

Need to define mapping rules for UML package into YANG modules or the new draft YANG package statement (draft-bierman-netmod-yang-package [4])?

5.4 Combination of different Associations

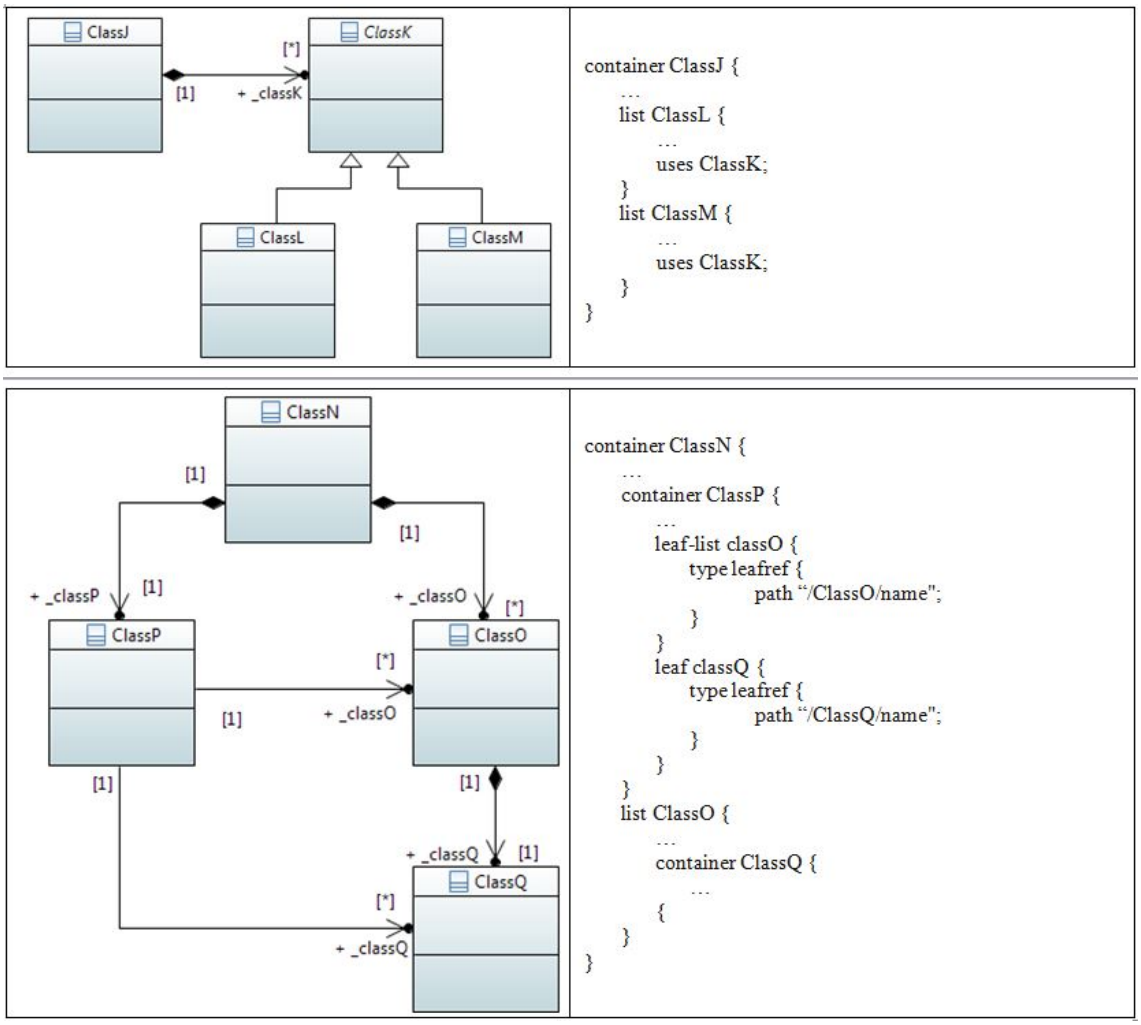


Figure 30: Combination of different Associations Example (Available in PDF or HTML versions)

6. Mapping Patterns

6.1 UML Recursion

As YANG defines hierarchical data store, any instances that need to store recursive containment will require translation. A mapping between object-oriented store and a hierarchical store is possible; however, there is more than one option:

- Reference Based Approach approach - have a flat list of objects, where the objects are linked into a hierarchy using references. An example of a two-way navigable approach is in RFC7223 [2].
- Assume some specific number of "recursions"; i.e., specify some default number of recursion levels, and define a configurable parameter to allow changing the number of levels.

6.1.1 Reference Based Approach

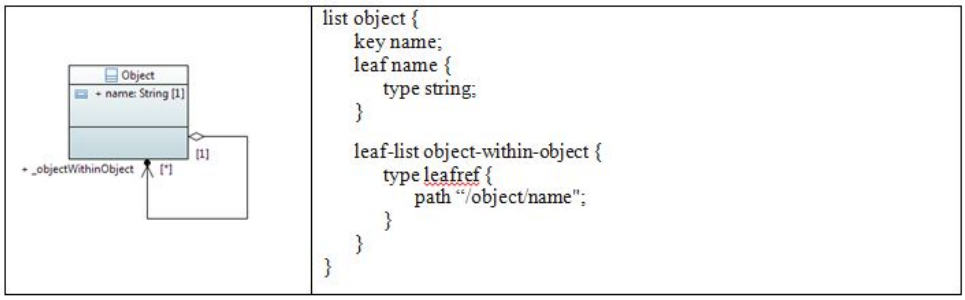


Figure 31: Recursion Mapping Example 1 (Available in PDF or HTML versions)

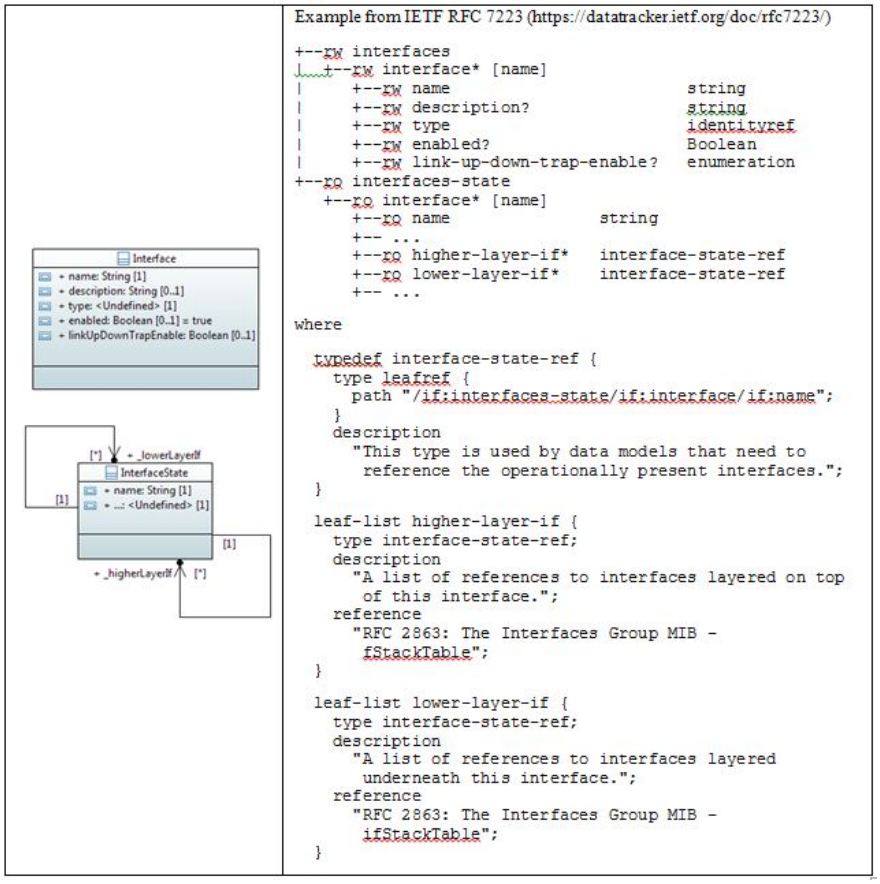


Figure 32: Recursion Mapping Example 2 (Available in PDF or HTML versions)

6.2 UML Conditional Pacs

Use the "presence" property of the container statement?

Note: An example of this usage is given in the "Data nodes for the operational state of IP on interfaces." within ietf-ip.yang RFC7277 [3].

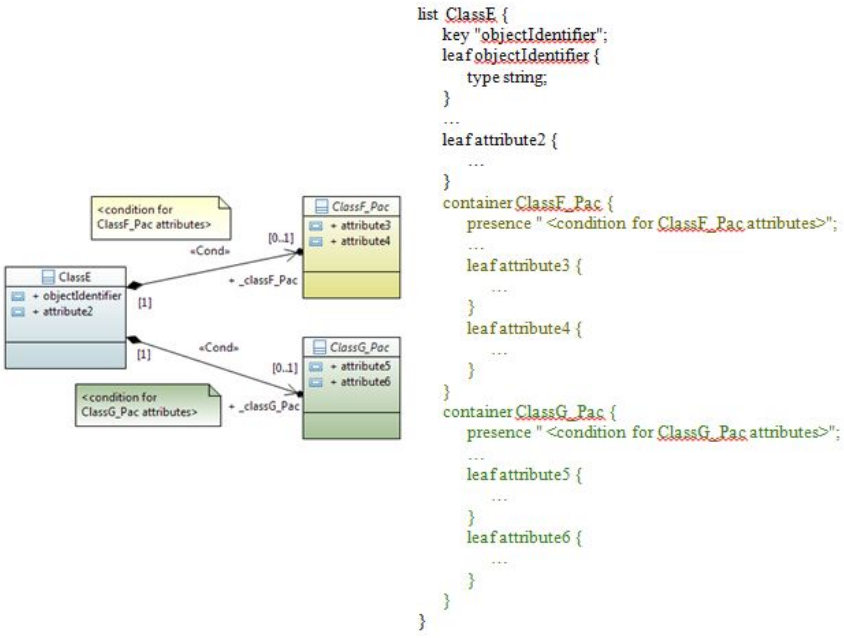


Figure 33: Mapping of Conditional Packages (Available in PDF or HTML versions)

6.3 XOR Relationship

Use the "choice" property of the container statement.

6.4 Mapping of UML Support and Condition

The UML Modeling Guidelines [9] define support and condition for all UML artifacts (M - Mandatory, O - Optional, C - Conditional, CM - Conditional-Mandatory, CO - Conditional-Optional). Support qualifies the support of the artifact at the management interface. Condition contains the condition for the condition-related support qualifiers.

M - Mandatory maps to the "mandatory" substatement in choice and leaf or to the "min-elements" substatement in leaf-list and list.

O - Optional need not be mapped since the per default the "mandatory" and "min-elements" substaments define optional.

All conditional UML support qualifiers are mapped to the "if-feature" substatement.

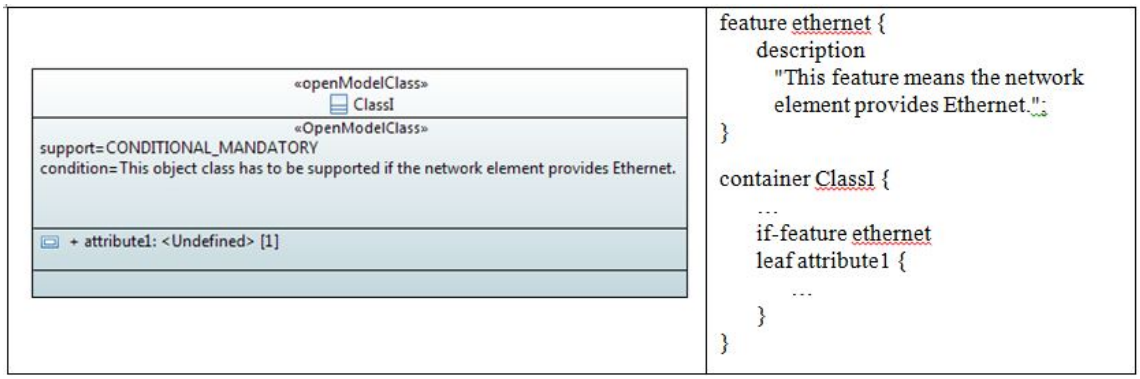


Figure 34: Support and Condition Mapping Example (Available in PDF or HTML versions)

7. Mapping Basics

7.1 UML-YANG or XMI-YANG

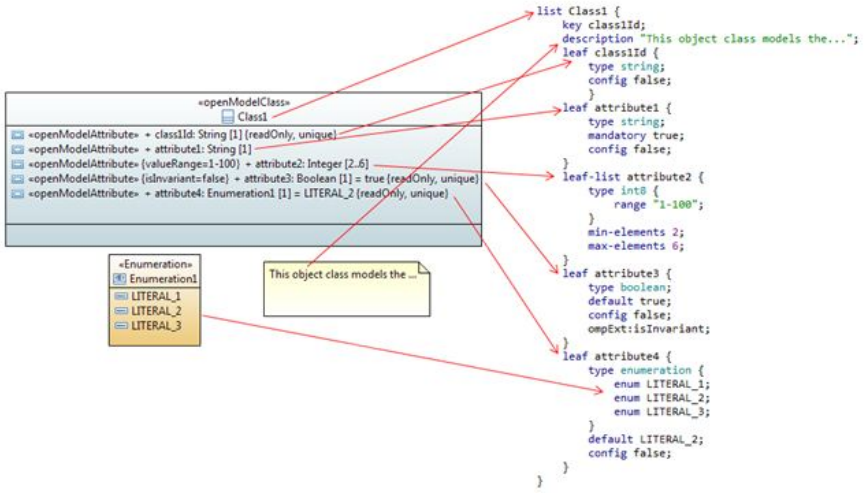


Figure 35: Example UML to YANG Mapping (Available in PDF or HTML versions)

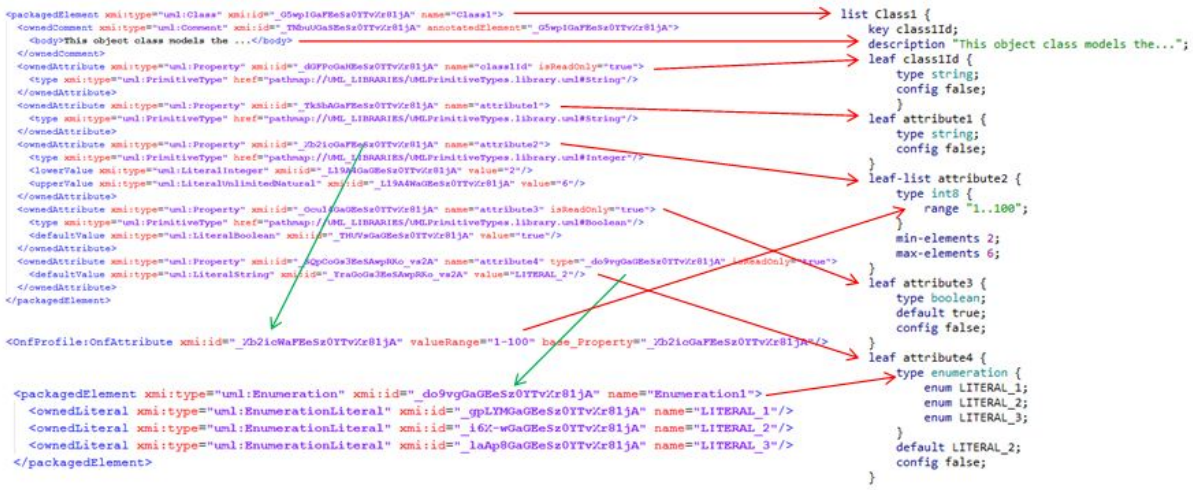


Figure 36: Example XMI (Papyrus) to YANG Mapping (Available in PDF or HTML versions)

8. Acknowledgements

9. IANA Considerations

This memo includes no request to IANA.

10. Security Considerations

This document defines defines guidelines for translation of data modeled with UML to YANG. As such, it doesn't contribute any new security issues beyond those discussed in Sec. 16 of RFC6020 [1].

11. Informative References

[1] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <http://www.rfc-editor.org/info/rfc6020>.

[2] Bjorklund, M., "A YANG Data Model for Interface Management", RFC 7223, DOI 10.17487/RFC7223, May 2014, <http://www.rfc-editor.org/info/rfc7223>.

[3] Bjorklund, M., "A YANG Data Model for IP Management", RFC 7277, DOI 10.17487/RFC7277, June 2014, <http://www.rfc-editor.org/info/rfc7277>.

[4] Bierman, A., "The YANG Package Statement", Internet-Draft draft-bierman-netmod-yang-package-00 (work in progress), July 2015.

[5] Bjorklund, M., "The YANG 1.1 Data Modeling Language", Internet-Draft draft-ietf-netmod-rfc6020bis-11 (work in progress), February 2016.

[6] Galimberti, G., Kunze, R., Lam, H., Hiremagalur, D., Grammel, G., Fang, L., and G. Ratterree, "A YANG model to manage the optical interface parameters of "G.698.2 single channel" in DWDM applications", Internet-Draft draft-dharini-netmod-g-698-2-yang-04 (work in progress), July 2015.

[7] Lam, H., Varma, E., Doolan, P., Davis, N., Zeuner, B., Betts, M., Busi, I., Mansfield, S., Vilata, R., and V. Lopezalvarez, "Usage of IM for network topology to support TE Topology YANG Module Development", Internet-Draft draft-lam-teas-usage-info-model-net-topology-02 (work in progress), October 2015.

[8] OMG, "Unified Modeling Language (UML)", 2011, <http://www.omg.org/spec/UML/2.4/>.

[9] OMG, "ONF TR-514 v1.0 UML Modeling Guidelines", 2015, <https://www.opennetworking.org/images/stories/downloads/sdn-resources/technical-reports/UML_Modeling_Guidelines_V1.0.pdf>.

A. Example

The YANG data schema (in tree format) shown below was extracted from dharini-netmod-g-698-2-yang [6] and represents the same data as UML model appearing in Figure 39 after the tree format. Note: The color code used in the tree format corresponds to the color code used in the UML class diagram.

```
augment /if:interfaces/if:interface:
  +--rw optIfOChRsSs
     +--rw ifCurrentApplicationCode
     |  +--rw applicationCodeId?   uint8
     |  +--rw applicationCode?     string
     +--rw ifCurrentVendorTransceiverClass
     |  +--rw vendorTransceiverClassId?   uint8
     |  +--rw vendorTransceiverClass?     string
     +--ro ifSupportedApplicationCodes
     |  +--ro numberApplicationCodesSupported?   uint32
     |  +--ro applicationCodesList* [applicationCodeId]
     |     +--ro applicationCodeId   uint8
     |     +--ro applicationCode?    string
     +--ro ifSupportedVendorTransceiverClass
     |  +--ro numberVendorTransceiverClassSupported?   uint32
     |  +--ro vendorTransceiverClassList* [vendorTransceiverClassId]
     |     +--ro vendorTransceiverClassId   uint8
     |     +--ro vendorTransceiverClass?    string
     +--rw outputPower?                     int32
     +--ro inputPower?                      int32
     +--rw wavelengthn?                     uint32
```

Figure 37: Interfaces Tree (Available in PDF or HTML versions)

```
notifications:
  +---n optIfOChWavelengthChange
  |  +--ro if-name?      leafref
  |  +--ro wavelength
  |     +--ro wavelength?   uint32
  +---n optIfOChApplicationCodeChange
  |  +--ro if-name?              leafref
  |  +--ro newApplicationCode
  |     +--ro applicationCodeId?   uint8
  |     +--ro applicationCode?     string
  +---n optIfOChVendorTransceiverCodeChange
     +--ro if-name?                    leafref
     +--ro newVendorTransceiverClass
        +--ro vendorTransceiverClassId?   uint8
        +--ro vendorTransceiverClass?     string
```

Figure 38: Notifications Tree (Available in PDF or HTML versions)

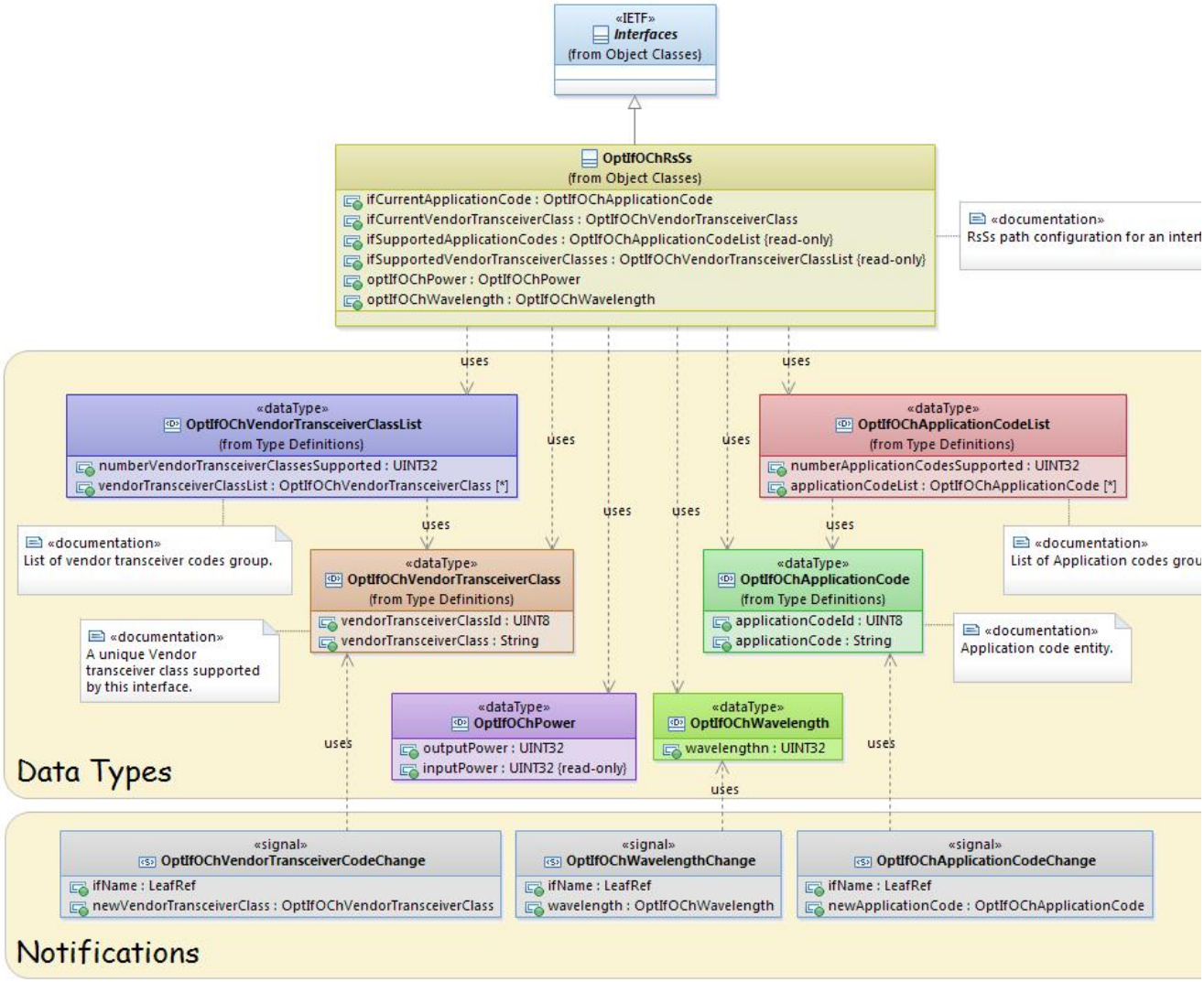


Figure 39: Interfaces UML Model (Available in PDF or HTML versions)

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