Core Information Model (CoreModel)

TR-512.1

Overview

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Disclaimer

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Important note

This Technical Recommendations has been approved by the Project TST, but has not been approved by the ONF board. This Technical Recommendation is an update to a previously released TR specification, but it has been approved under the ONF publishing guidelines for 'Informational' publications that allow Project technical steering teams (TSTs) to authorize publication of Informational documents. The designation of '-info' at the end of the document ID also reflects that the project team (not the ONF board) approved this TR.

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Document History

Version	Date	Description of Change
1.0	March 30, 2015	Initial version of the base document of the "Core Information Model" fragment of the ONF Common Information Model (ONF-CIM).
1.1	November 24, 2015	Version 1.1
1.2	September 20, 2016	Version 1.2 [Note Version 1.1 was a single document whereas 1.2 is broken into a number of separate parts]
1.3	September 2017	Version 1.3 [Published via wiki only]
1.3.1	January 2018	Addition of text related to approval status.
1.4	November 2018	Modifications to accommodate 1.4 enhancements. Addition of a simplified introductory section of the key object classes of the Core model.
1.5	September 2021	Enhancements to model structure

1 Introduction to the document suite

1.1 General introduction to the model

This ONF Technical Recommendation (TR) focuses on the Core Information Model (CoreModel) of the ONF Common Information Model (ONF-CIM). An information model describes the things in a domain in terms of objects, their properties (represented as attributes), and their relationships.

The ONF-CIM is expressed in a formal language called Unified Modeling Language (UML). UML defines a number of basic model elements, called UML artifacts. In order to assure consistent modeling, only a subset of these artifacts was used in the development of the ONF-CIM according to guidelines for creating an information model expressed in UML (documented in [ONF TR-514]).

The ONF-CIM is formed from a number of pieces and is focused on the CoreModel. At its heart, the CoreModel provides a representation of network forwarding resources[1] from a management-control perspective. The CoreModel is independent of:

- Specific forwarding technology, i.e. the CoreModel is forwarding technology neutral.
- Specific management-control interface protocol, i.e. the CoreModel is management-control interface protocol neutral (as described in [ONF TR-513]).

The ONF-CIM supports forwarding technology specific properties via application of the specification model (see 2.1.6 Specification Model (TR-512.7) on page 16) enabling reuse of existing technology specific standards definitions (e.g., from [ITU-T G.875]), pruned and refactored as appropriate (see [ONF TR-513]). The technology specific content, acquired in a runtime solution via "filled in" cases of specification, augment the CoreModel to provide a forwarding technology specific representation.

From an interfacing perspective, considering the SDN architecture [ONF TR-521] as an example, a controller may expose a view of the network in terms of ONF-CIM entities to client SDN controllers or applications to meet the needs of that client. The interface may expose the information in a client specific form where that form can be deterministically mapped to the ONF-CIM[2]. Tooling is used to generate an interface specific form from the UML[3] model[4].

[1] It is focused on representation of the functions/resources that have the primary purpose of supporting information forwarding (transfer and transform functions), that form a network that realizes virtual adjacency, for the purpose of control of those functions/resources. Those resources are referred to as network forwarding resources. The information model is not intended to cover functional resources that have a primary purpose of supporting storage or compute solutions.
[2] The Transport API (TAPI) provides an interface-oriented representation (in UML) derived from the CoreModel using the “Pruning & Refactoring” process [ONF TR-513] supported by tooling.
[3] UML is not an interface protocol language.
[4] For example, TAPI [ONF-TAPI] uses IISOMI tooling [ONF-IISOMI] to generate interface specific form (Yang, JSON etc).

1.2 Introduction to this document

This document acts as a guide to the set of documents that describe the CoreModel of the ONF-CIM, providing:

- An introduction to the CoreModel of the ONF-CIM in the form of a brief overview of the model with links to the other documents in the set (see section 2.1 Model Document Structure on page 9 and section 2.2 Supporting documents on page 26 including a reference to the data dictionary (see section 2.2.2 Data Dictionary (TR-512.DD) on page 27)).
- A brief explanation of how to introduce attributes and structure related to a specific network technology (see section 2.1.6 Specification Model (TR-512.7) on page 16).
- A terminology translation table (see section 2.2.3 Terminology mapping (TR-512.TM) on page 27)
- An explanation of supporting guidelines with references to the guideline documents (see section 2.3 Supporting Guidelines on page 28).
- A summary of the main changes from the previous versions (see section 3 Summary of changes on page 35).
- A list of references used in the document set (see section 4 References 40).
- A list of definitions used in the document set (see section 5 Definitions on page 43)
- A list of abbreviations used in the document set (see section 5.3 Abbreviations and acronyms on page 43).
- Some conventions used in the document set including key stereotypes and keys to the diagram symbol sets (see section 6 Conventions on page 49).
- A summary of future work (see section 7 Future CoreModel work areas on page 51)

In addition, a number of appendix documents, that provide examples and further explanatory details, are included with the deliverables. These are summarized in TR-512.A.1.

Separate work activities are taking the CoreModel and deriving interface models (see [ONF-TAPI]).

1.3 Tool versions

In addition to the documentation referenced above and throughout this document, the TR-512 delivery package includes the CoreModel in Papyrus UML (see OnfModel folder). The ongoing intention is to publish using the environment versions as stated in the guidelines [ONF TR-515]. The precise versions are stated below. The OpenModelProfile is the latest available from GitHub at the time of publication:

Table 1: Tooling and Profile Versions

	[ONF TR-515] Version	GitHub Version	Version used for [ONF TR-512]	Comments
Eclipse	4.13.0 (2019-09)		4.13.0.v20190916-1323	
Papyrus	4.5.0		4.5.0.201909110925	
Gendoc	0.7.2		0.7.2.201909241003	

	[ONF TR-515] Version	GitHub Version	Version used for [ONF TR-512]	Comments
OpenModelProfile		0.2.14	0.2.14	

In addition, an Experimental profile has been used for some of the Experimental model. This profile will be integrated into the formal profile structure in a later release.

1.4 Viewing UML diagrams

Some of the UML diagrams in figures are very dense. To view them either zoom (sometimes to 400%) or open the associated image file (and zoom appropriately) or open the corresponding UML diagram via Papyrus (for each figure with a UML diagram the UML model diagram name is provided under the figure or within the figure).

The UML diagram convention is provided in [ONF TR-514]. There are some key aspects of the diagrams that need to be emphasized.

- Association end attribute (the name of which always starts with "_") highlighted in the diagrams by the navigable end of the association (arrow head) is an attribute of the class at the non-navigable end of the association. It is the convention not to show the attribute in the class in the diagrams. The attributes for non-navigable ends (owned by the association) are not shown in the diagram (so in the figure there is no attribute name by the black diamond).
- On some occasions, other properties of the association end attribute are also shown.

In the diagram above, the text at the arrow head end _lp… is an attribute of the Logical Termination Point.

This attribute is shown in the fragment of abbreviated data dictionary below for LogicalTerminationPoint.

Table 2: Attributes for LogicalTerminationPoint

Attribute Name	Lifecycle Stereotype (empty = Mature)	Description
_lp		Ordered list of LayerProtocols that this LTP is comprised of where the first entry in the list is the lowest server layer (e.g. physical).

This sort of table is used in each of the documents on a section of the model and only provides summary information. For full information the reader should refer to the data dictionary (see section 2.2.2 Data Dictionary (TR-512.DD) on page 27) or the model itself (see OnfModel folder).

2 Model Overview

This section provides an overview of the ONF Core Information Model (CoreModel) and of the structure of the model description documentation. Each document described has a hyperlink that will take you to the document in your system[5]. The documents referenced in this section are all in the "ModelDescriptions" folder and are covered by two subsections:

- The documents referred to in Section 2.1 describe the core model artifacts progressing through the model from the basics of forwarding and termination through to a description of the augmentation mechanism of the specification model.
- The documents referred to in Section 2.2 provide additional supporting material including the Data Dictionary.

The remaining subsections provide:

- Related guidelines for model generation and usage (section 2.3)
- Key references (section 2.4)
- A brief overview of the Papyrus files (section 2.5)
- A simplified introduction of the key object classes across multiple model parts (section 2.7).

2.1 Model Document Structure

The CoreModel of the ONF-CIM consists of model artifacts that are intended for use by multiple applications and/or forwarding technologies. For navigability, the CoreModel is further sub-structured into Core Network Model (CNM), Core Foundation Model, Core Physical Model, and the Core Specification Model.

The Core Network Model (CNM) consists of artifacts that model the essential network aspects that are neutral to the forwarding technology of the network. The CNM currently encompasses Forwarding, Termination, Timing, Topology, and Resilience aspects (subsets of the CNM).

This section provides a list of all associated documents that describe the model. Each of the following sub-sections provides some brief highlights from the associated document and a link to that associated document.

The model documentation is broken down into a number of key parts which relate to but do not exactly match the model breakdown:

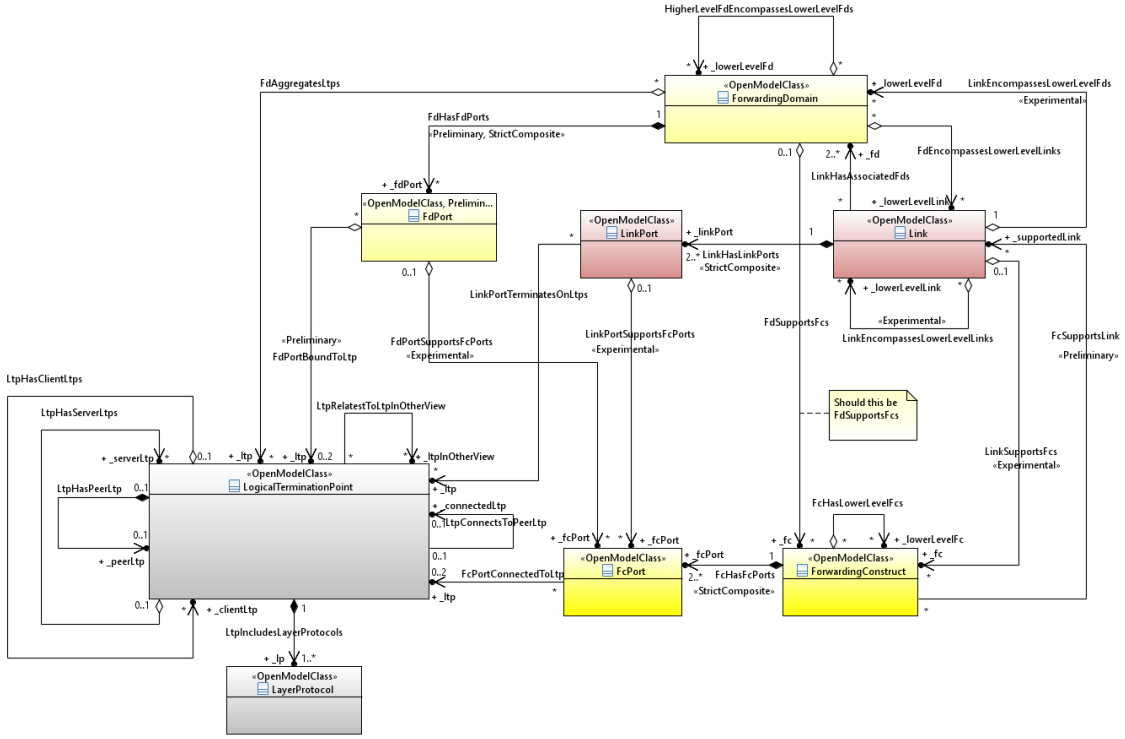
- CoreNetworkModel:
  - Forwarding and Termination (see section 2.1.1)
  - Topology (see section 2.1.3)
  - Resilience (see section 2.1.4)
  - Timing (see section 2.1.1)
- CoreFoundationModel (see section 2.1.2)
- CorePhysicalModel (see section 2.1.5)
- CoreSpecificationModel (see section 2.1.6)

[5] The link will only work if you have unzipped the whole package as one.

- GeneralControllerModel (see section 2.1.7)
- CoreOperationsModel (see section 2.1.9)
- ProcessingConstructModel (see section 2.1.10)
- Software (see section 2.1.11)
- Party (see section 2.1.12)
- Location (see section 2.1.13

2.1.1 Core Network Model – Forwarding and Termination Model (TR-512.2)

The Forwarding and Termination document provides a high-level overview of the Termination and Forwarding aspects of the CoreNetworkModel. This model is essentially a canonical model of networking from a management-control perspective. The figure below is a skeleton class diagram illustrating the interrelationships between key object classes defined in the CoreNetworkModel of the CoreModel. The classes are colored to help recognize key groupings in the model. The colors are chosen to match the key entity colors in Figure 6-1 Network diagram symbol set (with the Link in the alternative color for clarity). This color scheme for class diagrams is used in some of the figures in the associated documents.



CoreModel diagram: Forwarding-LtpInterLayerSkeletonOverview

Figure 2-1 Skeleton Class Diagram of key object classes

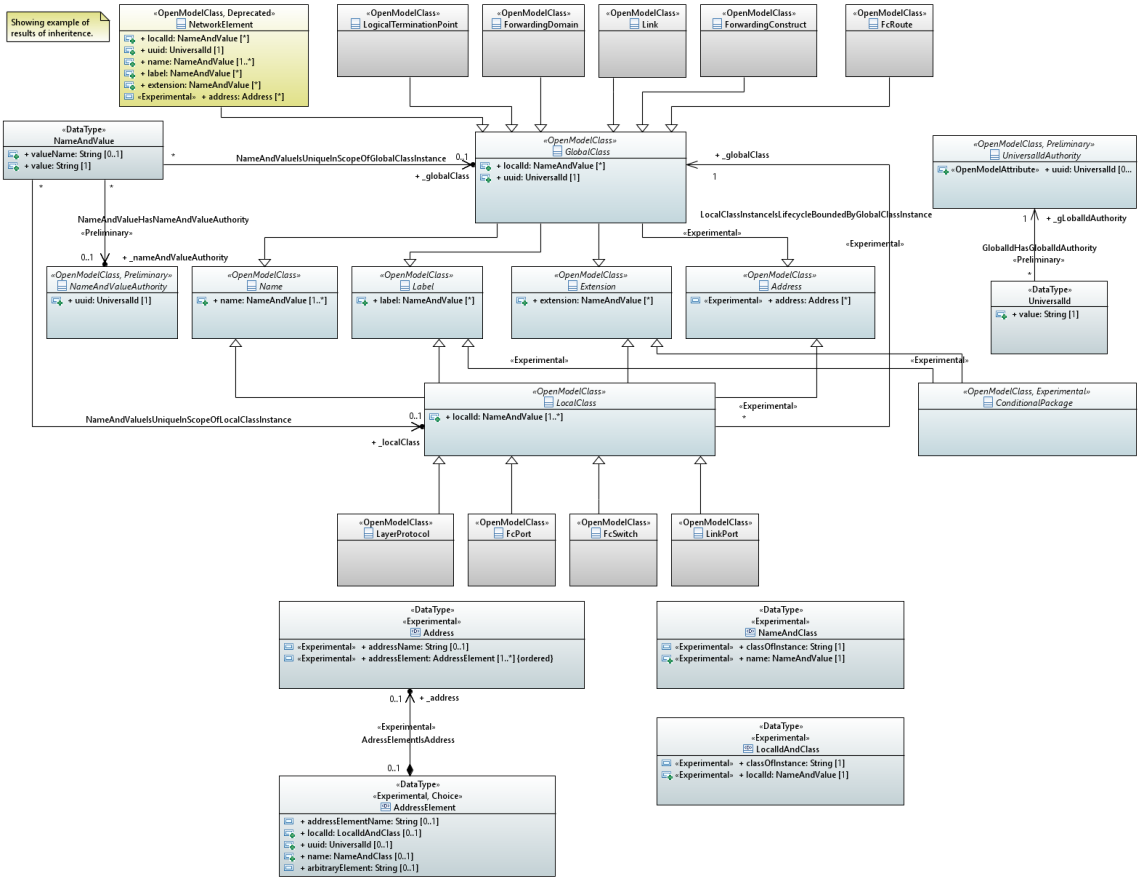
Examples of applying the Core Network Model for modeling timing and synchronization are provided in TR-512.A.8.

2.1.2 Core Foundation Model

The Foundation document provides a detailed view of all aspects of the CoreModel that are relevant to all other parts of the ONF-CIM. Currently this model includes coverage of naming and identifiers as well as states.

2.1.2.1 Naming and Identifiers (TR-512.3)

Rationalizing the approach to naming, identification and addressing of entities described in the ONF-CIM.

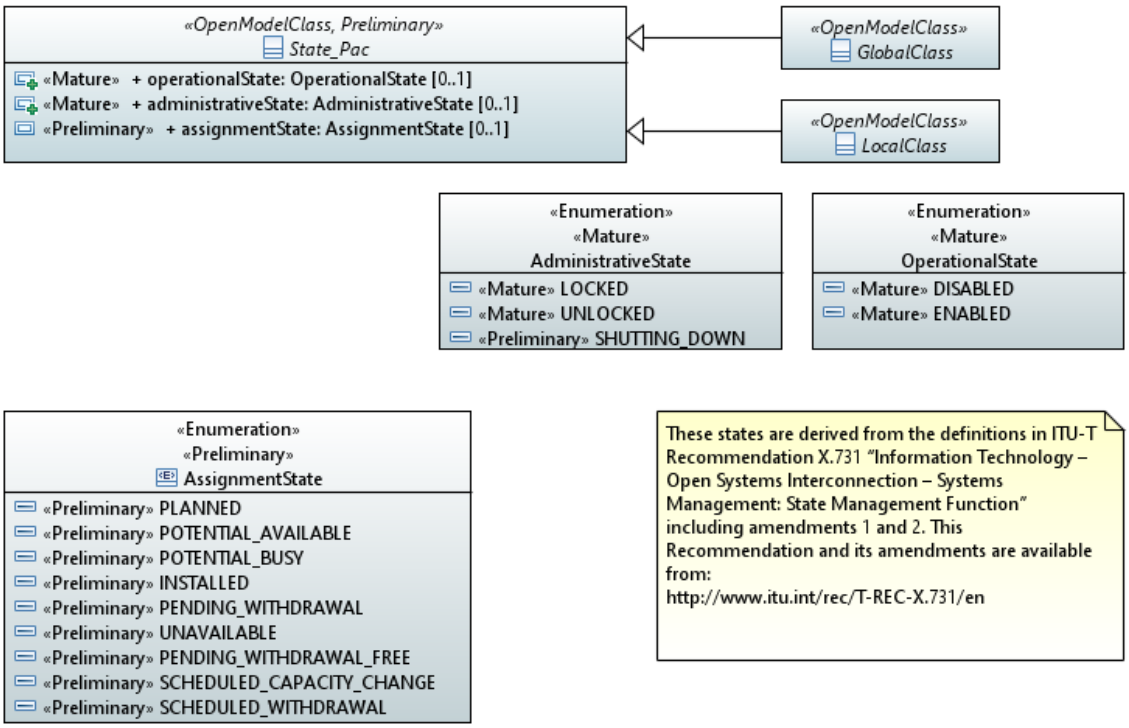


CoreModel diagram: Foundation-CommonPackagesNoNotes

Figure 2-2 Overview of Naming and Identifier of Objects

2.1.2.2 States (TR-512.17)

Basic states applicable to a majority of entities in the ONF-CIM.

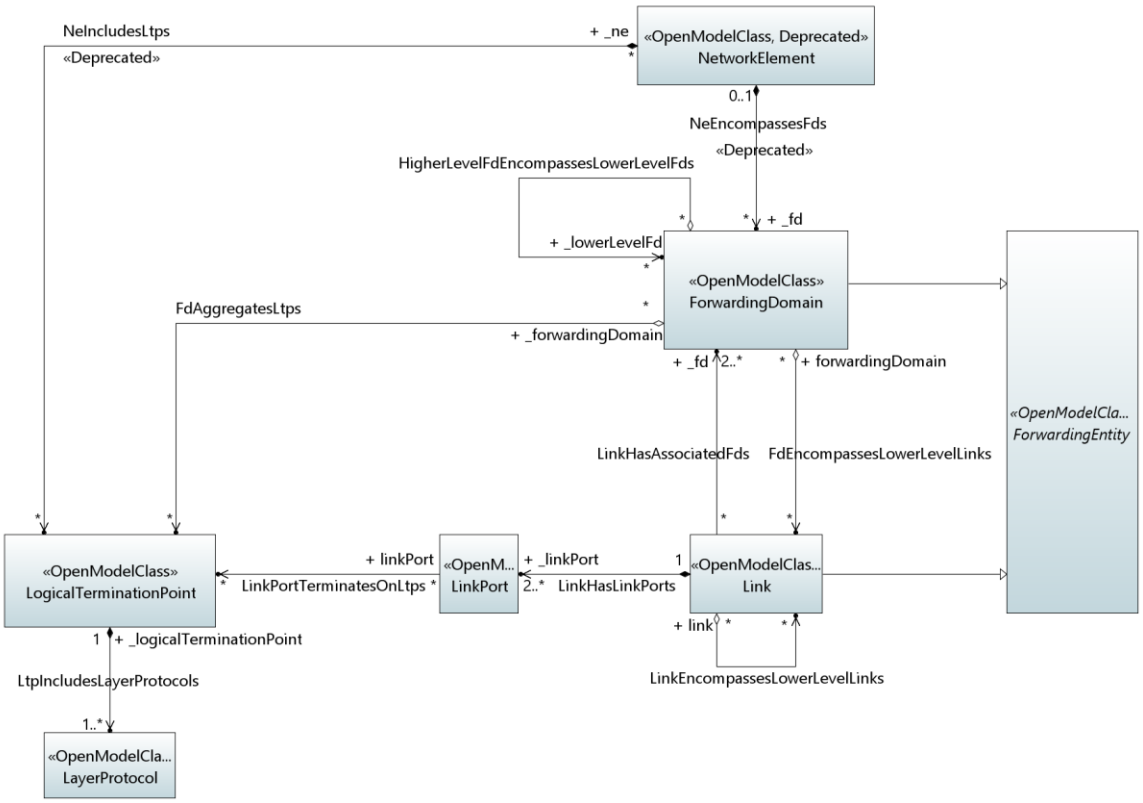


CoreModel diagram: State-FullModel

Figure 2-3 States for all Objects

2.1.3 Core Network Model – Topology Model (TR-512.4)

The topology document provides a detailed view of the topology model covering both the basic topology pattern with detailed attributes as well as multi-layered topology and topology views.



CoreModel diagram: Topology-HighLevelOverviewOfStructure-LargeText

Figure 2-4 Key classes that form the network topology

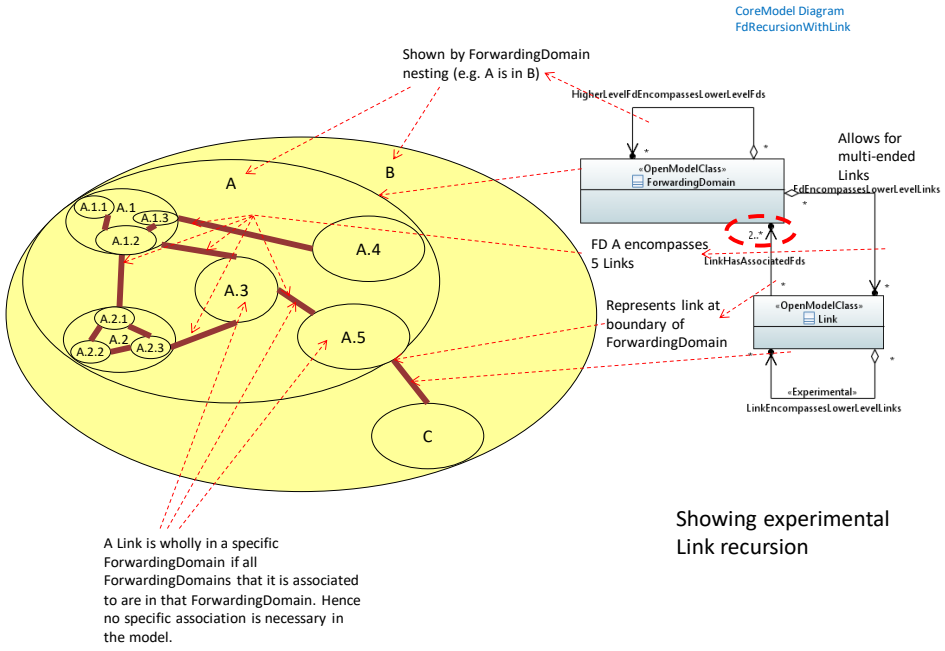


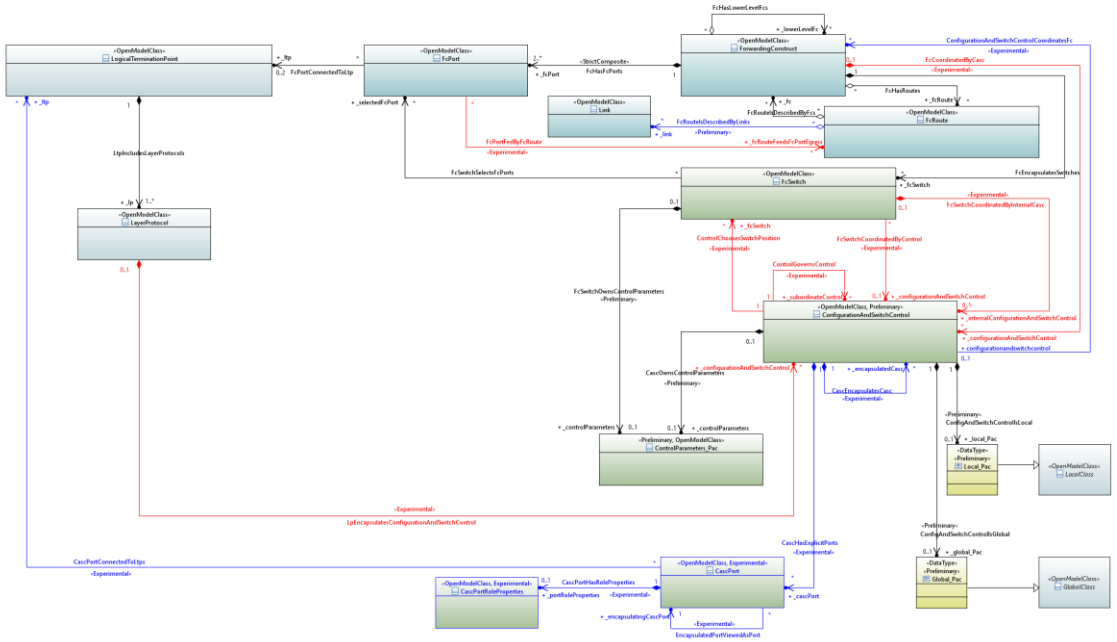
Figure 2-5 ForwardingDomain recursion with Link[6]

2.1.4 Core Network Model – Resilience Model (TR-512.5)

The Resilience document provides a view of the model for resilience (including protection and restoration) and encompasses:

- The basic resilience model structure
- The key attributes relevant to resilience
- The application of the resilience model to various cases

[6] The numbering of the FDs on the figure implies strict and fixed hierarchy. It should be noted that the association is aggregation and hence the hierarchy can change, and an FD may move from being encompassed by one FD to being encompassed by another. Consider the numbering as simply a view of the current structure.



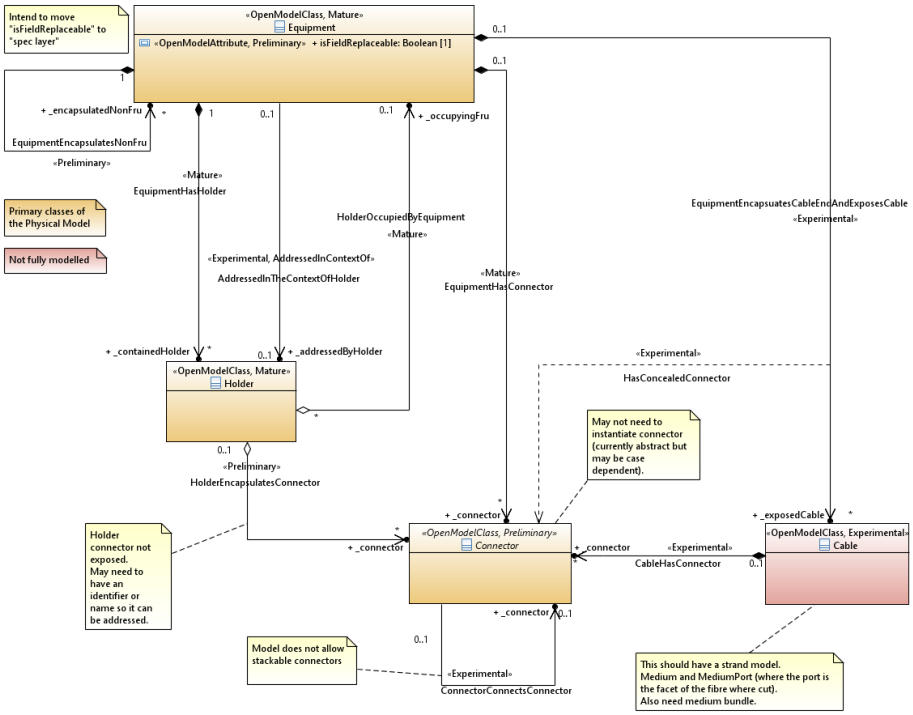
CoreModel diagram: Resilience-Pattern

Figure 2-6 Basic resilience pattern

2.1.5 Core Physical Model (TR-512.6)

The Physical model document provides a view of the model for physical entities (including equipment, holders and connectors). The document:

- Introduces the Physical model structure
- Describes the key classes of the Physical model
- Explains the attributes of the Physical model
- Describes the relationship between the connector and the LTP
- Shows how the model deals with the relationship between physical and functional views including resilience
- Explains how the Specification model describes equipment schemes (e.g. rules, etc.)
- Highlights work in progress to further advance the Equipment model



CoreModel diagram: Equipment-Pattern

Figure 2-7 Basic equipment pattern

2.1.6 Specification Model (TR-512.7)

There are several related needs that have given rise to the Specification model:

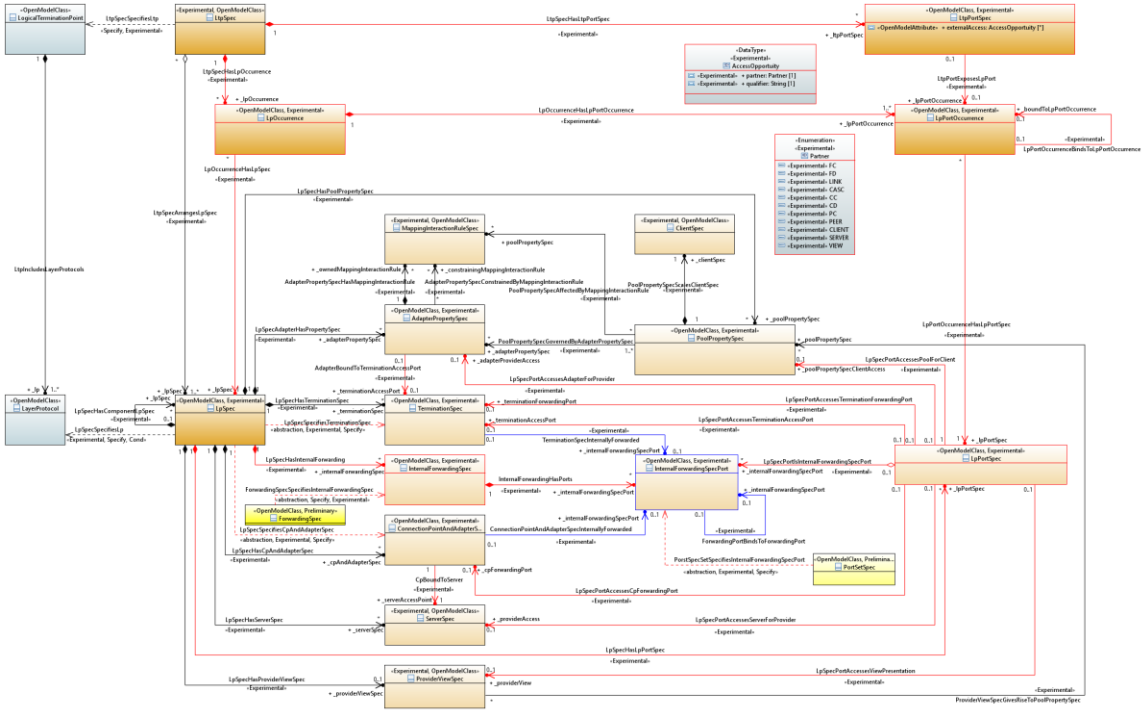
- Provide machine-interpretable form of specific localized behavior:
  - Representing rules related to restrictions of specific cases of use of the model
  - Representing capabilities of specific cases of use
- Enable the introduction of run time schema where the essential structure of the model is known up front (at compile time), but the details are not
- Reduce the clutter in a representation where a set of details take the same values for all instances that related to a specific case
- Allow leverage of existing standards definitions (e.g., technology/application specific) in a machine-interpretable language

The combination of the above resulted in a separation in the model of definitions of structure and content such that an instance of a class from one model fragment could have an association instance to another model fragment to enable the provision of a fragment of definition of the class and of subordinates.

The aim of all specification definitions is that they be rigorous definitions of specific cases of usage and enable machine interpretation where traditional interface designs would only allow human interpretation.

The following dedicated spec structures have been considered:

- FC spec: Main focus is to provide a representation of the effective internal structure of a ForwardingConstruct (FC)
- LTP and LP spec: Main focus is to provide a representation of Layer Protocol (LP) specific parameters for the Logical Termination Point (LTP)
- FD and Link spec: Main focus is on capacity and forwarding enablement restrictions
- Equipment spec: Main focus is to provide a representation of equipping constraints
- Scheme spec: Main focus is to provide a mechanism to describe any pattern (arrangement) of entities from the model for some specific purpose (e.g. to describe the structure of a [ITU-T G.8032] protection scheme



CoreModel diagram: Spec-LtpCapabilitySpecWithLtp

Figure 2-8 Class Diagram of the Spec Model of LTP and LP

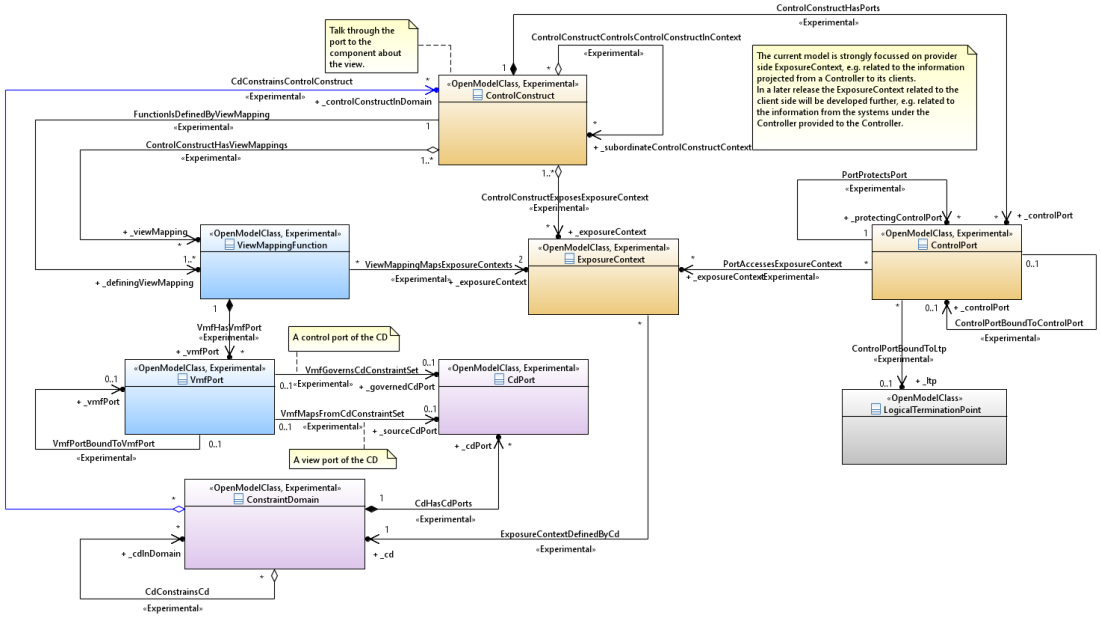
In addition, there is work on a generalized spec pattern with the main focus to provide a common representation of the mechanism for relating a class to its spec, accounting for implementation needs.

2.1.7 Control Model (TR-512.8)

The ONF Architecture [ONF TR-521] talks of a recursion of control aligning well with the more general concept of the Management-Control Continuum from [TMF IG1118]. The control model in [ONF TR-512 V1.2] showed a traditional hierarchy rather than a generalized recursion.

Over many years it has become apparent that the traditional representation of the Network Element and of the Managed Element was not correct. It is clear that from one perspective the Network Element is simply a lower-level member of the Management-Control Continuum. It is also apparent that all other aspects of the NE are covered by other parts of the model.

It was concluded that the NE should be remodeled as simply a control capability and that that capability should be generalized so that it could handle all aspects of the Management Control Continuum.



CoreModel diagram: Control-ControlConstructAndExposureContextCore

Figure 2-9 Core Control Model

As explained in TR-512.8 the classes SdnController, NetworkControlDomain and NetworkElement[7] have been reassessed and deprecated and new classes have been developed to replace them. It has been recognized that a uniform recursive model of control can be developed that provides a consistent treatment of what were previously seen as completely different things.

2.1.8 OAM Model (TR-512.9)

This document is not part of this release, it will be provided in a later release. The document will provide a view of the multi-technology OAM model.

2.1.9 Operations Pattern Model (TR-512.10)

The work has been carried out with the assumption that the future is cloud oriented such that the controllers are an interconnected system of cloud-based components. It is assumed that in a cloud environment the operations will be "outcome-oriented" interaction[8] where the focus is on stating the constraints that form a boundary that defines the desired target. In outcome-oriented

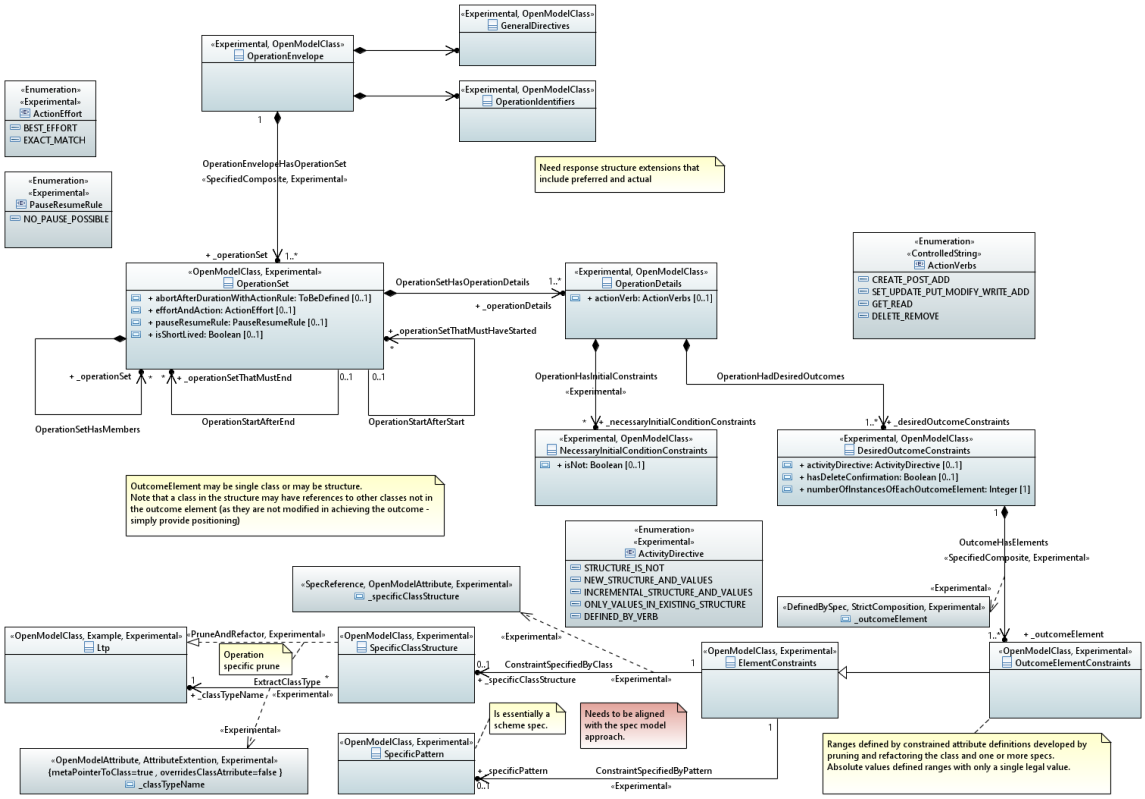
[7] The Network Element scope of the direct interface from a SDN controller to a Network Element in the infrastructure layer is similar to the EMS-to-NE management interface defined in the information models [ITU-T G.875] (OTN), [ITU-T G.8052] (Ethernet), and[ITU-T G.8152] (MPLS-TP).
[8] Intent is an outcome-oriented form of interaction.

interaction the operations/methods/activities/tasks used to achieve the desired outcome are firmly in the domain of the provider. The client simply provides information about the desired outcome in the context of what has been agreed as possible. Hence the essential need of any interaction is the provision of information about the desired outcome in terms of constraints and potentially in the context of some expected initial system state. Whilst the content of any message may differ per interaction the structure will be consistent[9].

- The Operations Pattern Model is intended to provide a dynamic sophisticated structure that has "foldaway" parts
- The aim is to provide one structure:
    - For all outcome-oriented constraint-based forms including intent
    - Supports traditional Verb driven forms
        - with constrained valued
        - with absolute values
    - Enables operations that:
        - Act on multiple separate independent things
        - Have sequence and interdependency between parts and with other separate interactions
        - Are long lived or short lived (where the life may depend upon the case and may not be knowable before the request
- The aim is that the model will be used to generate schema where there is a continuum of compatible schema from the most basic simple CRUD (Create/Read/Update/Delete) forms to the most sophisticated forms such that the CRUD form can be seen as a tiny subset of the sophisticated form

The following figure shows the model of the request.

[9] Again, human language is a good analogy. The grammar remains constant, simple and repeating but the vocabulary is broad and changes/grows often rapidly.



CoreModel diagram: Operation-Structure

Figure 2-10 The structure of an operation (request)

2.1.10 Processing Construct Model (TR-512.11)

The ProcessingConstruct (PC) represents generalized functionality. The PC is used in conjunction with the ConstraintDomain (CD) that groups PCs and constrains their usage. In addition to being general applicable to represent functionality that is not being modeled in detail the PC and CD form the fundamental pattern that allows an important transition in the representation of a 'device'[10].

In the ONF CIM there are already separate classes for special types of functions:

- ForwardingConstruct to represent forwarding functionality
- LogicalTerminationPoint to represent termination, and
- ForwardingDomain to represent forwarding scope constraints.

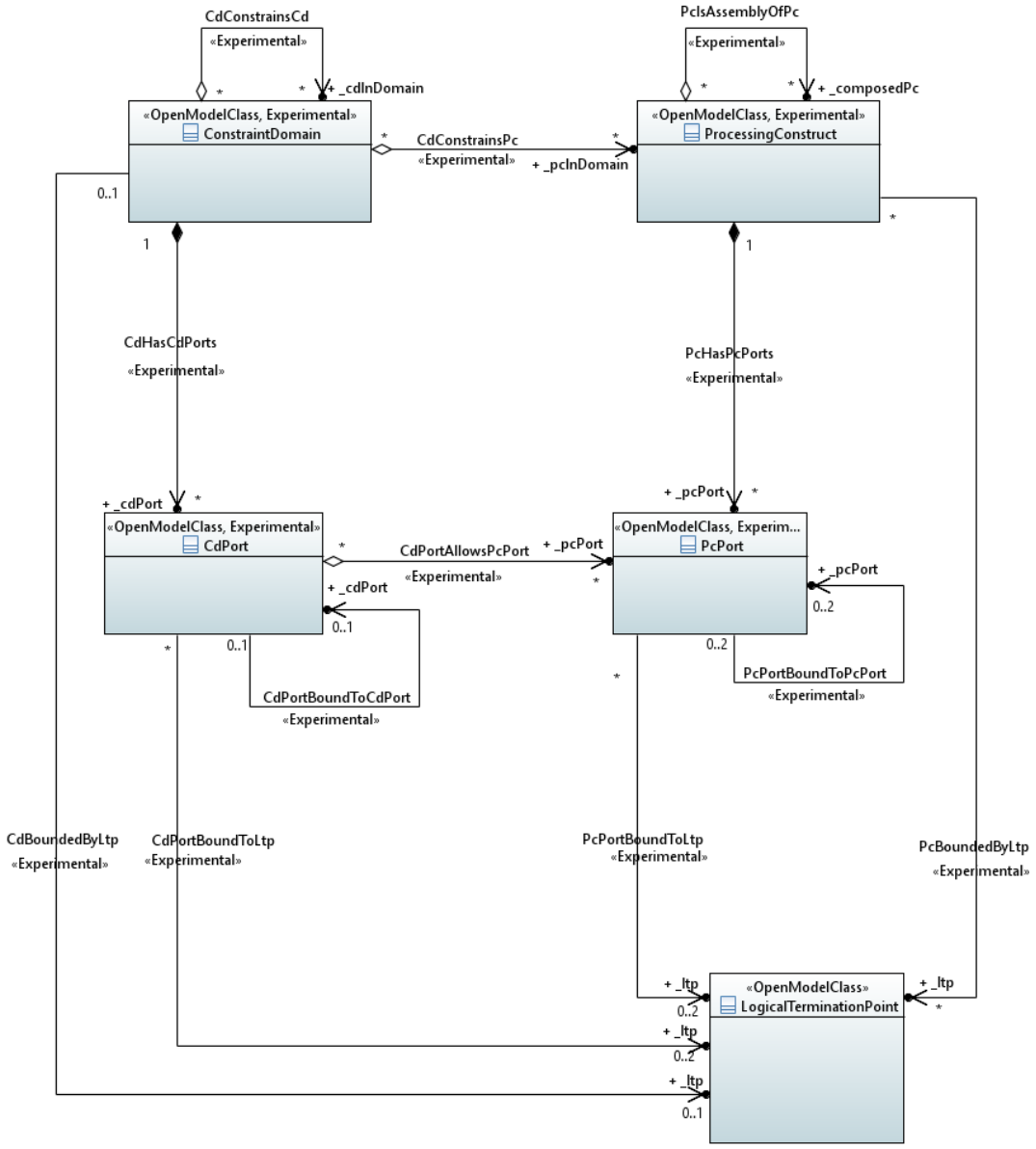
ProcessingConstruct is in addition to these concepts and is to be used where the major function of interest is related to processing rather than forwarding of information.

While there are a number of grey areas between processing and forwarding, there are a few 'pure' ProcessingConstructs:

[10] Here we will use the term ‘device’ in a loose and undefined manner to aid in the discussion. The term is not defined because it is not important for our discussion, the generally understood concept is sufficient.

- Memory
- CPU
- Storage

Another use for ProcessingConstruct is for representing control plane processes such as packet routing processes. Packet routers commonly run many routing protocols and may also run many instances of each routing protocol. Each routing process instance peers independently and using ProcessingConstruct we can show the actual control plane topologies.



CoreModel diagram: ProcessingConstruct-Core

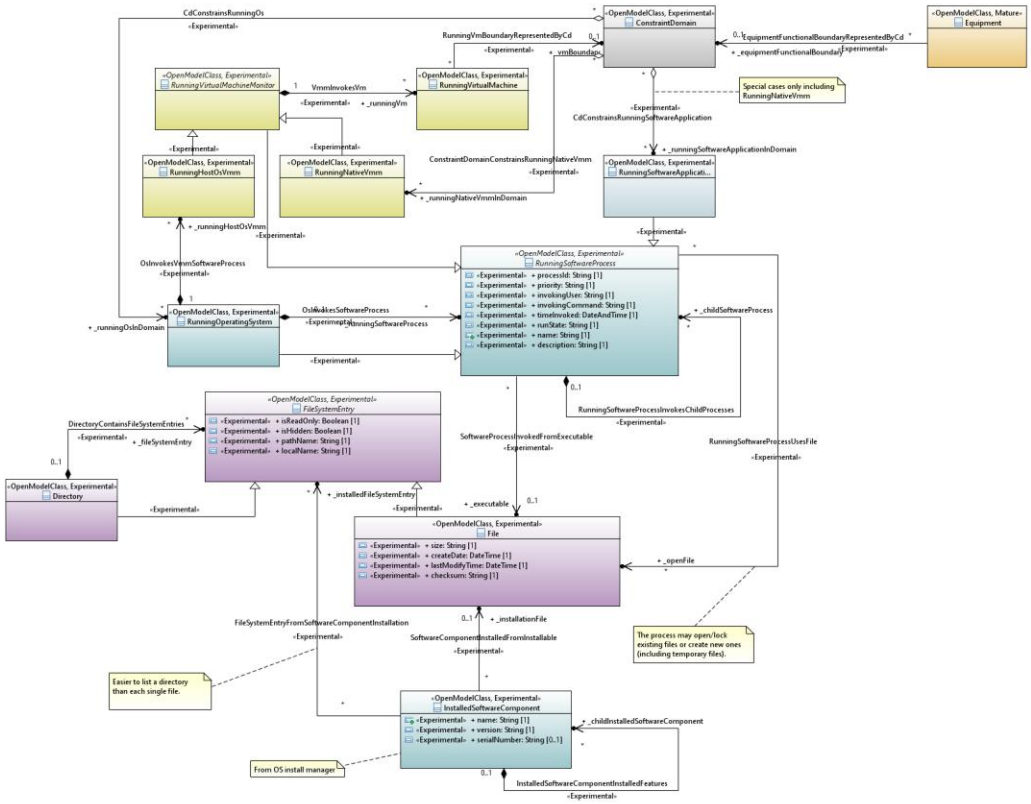
Figure 2-11 Processing Construct and Constraint Domain core model

2.1.11 Software Model (TR-512.12)

The software model provides a representation of software aspects of network devices and compute hosts, and can be split into two broad areas:

1. Software inventory (similar to hardware inventory)
2. Software functionality (equivalent to 'running hardware', which isn't explicitly modelled in the ONF CIM)

The figure below shows the support for a Virtual Machine.



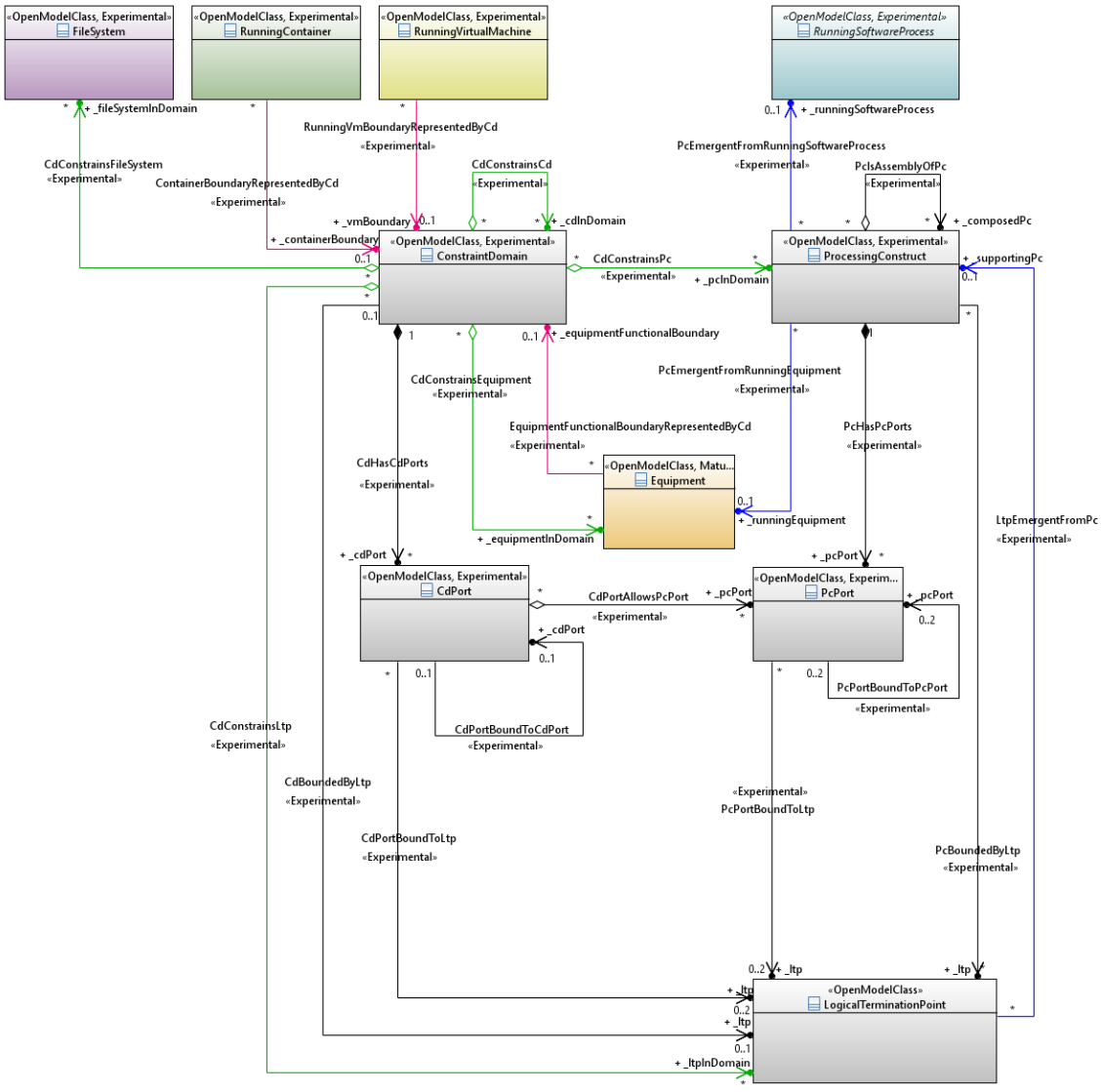
CoreModel diagram: Software-VirtualMachine

Figure 2-12 Skeleton Class Diagram of key object classes

The Software model strengthens linkage between various other parts of the model, so that the model can:

- Show how running software provides functionality (similar to running hardware)
- Support management of memory, CPU and storage capacity (related back to its usage by running software)
- Show how the combination of hardware and software together produces functionality
- Consistently represent software running directly on hardware CPU and memory as well as the VMM/VM and container cases

In combination with other parts of the software model further supports the representation of functions emerging from a equipment.



CoreModel diagram: Software-SoftwareWithPcAndCd

Figure 2-13 Software Model in context

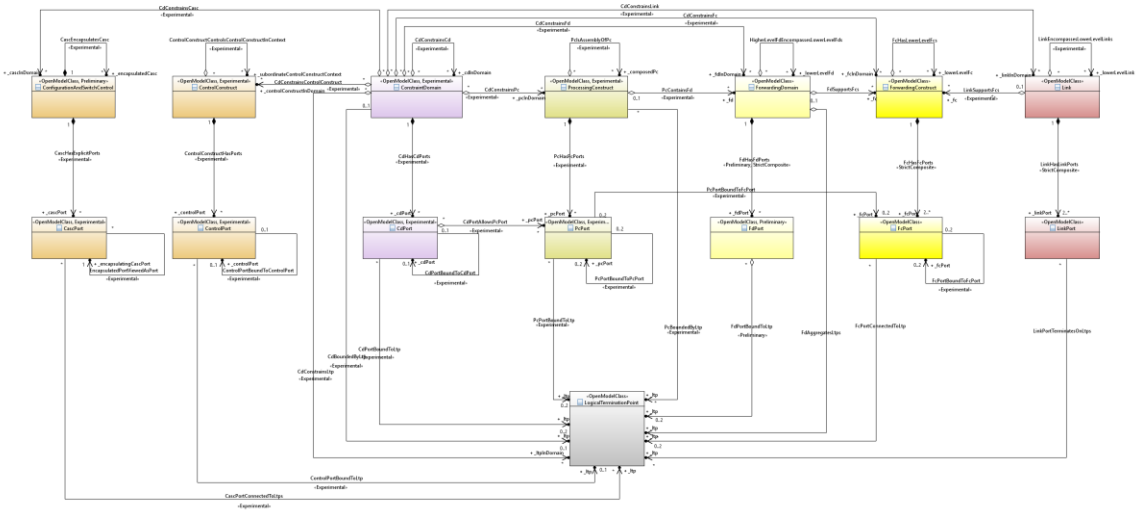
Note that there are a number of scenarios that the software model should cover, including:

- Hypervisor/VMM as running software hosts VMs
- VM as running software has guest operating system
- operating system as running software enables running applications
- VM Image is installed element
- (Linux) container as running software enables running applications

- Software agent as running software
- Container engine as running software hosts containers
- Container as running software enables running applications
- Container image is installed element

Various examples are provided in an appendix (seeTR-512.A.1 for an explanation of the Appendix).

TEST TEST



CoreModel diagram: Control-ControlConstructPattern

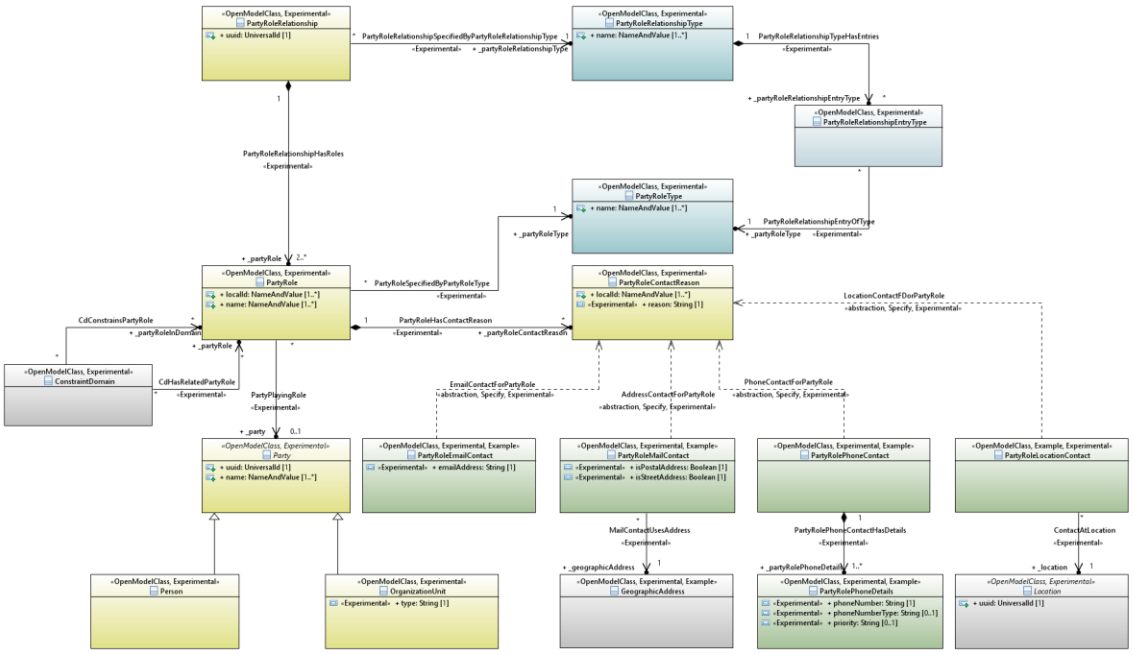
Figure 2-14 Key Model Classes

2.1.12 Party Model (TR-512.13)

The Party model focusses on concepts relating to "who". Recording information about a person will be useful, but in business, many interactions are done via legal (company) entities.

The model links the company organization to the people it employs and who interact on its behalf. The common modelling term used for both person and organization is party.

It is intended that the model be augmented with specific party structure and details.



CoreModel diagram: Party

Figure 2-15 Party Model

2.1.13 Location Model (TR-512.14)

The Location model focusses on concepts relating to 'where' something is. All location related information is modelled to be referenced from the rest of the model as required.

The model supports both textual based and map-based locations. It also supports locations 'internal' to a building as well as 'outside' locations.

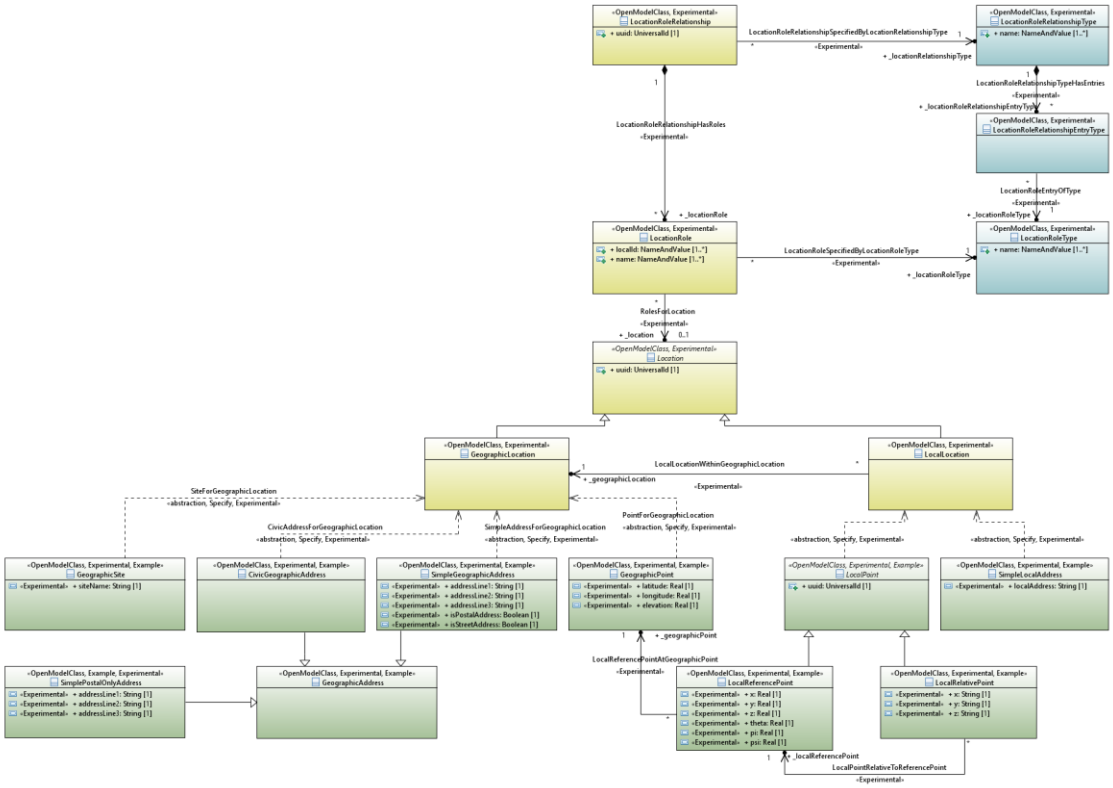
This model covers the most common alternatives for external location:

- (named) site
- (postal) Address
- (Geospatial) position (such as GPS coordinates)

For internal locations, the model will cover:

- Local address (such as a bin location in a warehouse)
- (local) position in a cartesian reference system (often relative to an internal reference point, and more accurate than GPS)

It is intended that the model be augmented with specific location structure and details.



CoreModel diagram: Location

Figure 2-16 Location Model

2.1.14 Storage TR-512.15

This document is not part of this release, it will be provided in a later release. The document will provide a view of a generalized storage model.

2.1.15 CPU and Memory TR-512.16

This document is not part of this release, it will be provided in a later release. The document will provide a view of a generalized compute model.

2.1.16 Core Foundation Model – States (TR-512.17)

See section 2.1.2.2 States (TR-512.17) on page 11.

2.2 Supporting documents

There are further supporting documents described below:

- The "A" series of explanatory documents (see TR-512.A.1)
- The "double letter" series of supporting documents (described below)
    - The documents of this series were issued in V1.2 as part of the numeric series (e.g., TR-512.DD was TR-512.8 in V1.2)

2.2.1 Appendix Overview (TR-512.A.1)

There is a set of supporting appendix documents (the "A" series) that provide further examples and explanation of the model. These documents are briefly summarized in TR-512.A.1.

2.2.2 Data Dictionary (TR-512.DD)

The data dictionary provides details of the classes, attributes and data types (i.e., syntax) that are used in the model. The individual "model focuses" documents provide details on key classes and attributes but do not provide all details to avoid clutter and replication.

An extract from the data dictionary is shown below.

5.1.1.6 ForwardingConstruct

Qualified Name: CoreModel::CoreNetworkModel::ObjectClasses::ForwardingConstruct

The ForwardingConstruct (FC) object class models enabled potential for forwarding between two or more LTPs at a particular specific layerProtocol. Like the LTP the FC supports any transport protocol including all circuit and packet forms. It is used to effect forwarding of transport characteristic (layer protocol) information. An FC can be in only one FD. The ForwardingConstruct is a Forwarding entity. At a low level of the recursion, a FC represents a cross-connection within an NE. It may also represent a fragment of a cross-connection under certain circumstances. The FC object can be used to represent many different structures including point-to-point (P2P), point-to-multipoint (P2MP), rooted-multipoint (RMP) and multipoint-to-multipoint (MP2MP) bridge and selector structure for linear, ring or mesh protection schemes.

Applied stereotypes:

- OpenModelClass
  - objectCreationNotification: NA
  - objectDeletionNotification: NA
  - support: MANDATORY

Table 1: Attributes for ForwardingConstruct

Attribute Name	Type	Multiplicity	Access	Stereotypes	Description
layerProtocolName	LayerProtocolName	1	RW	OpenModelAttribute • AVC: NA • valueRange: no range constraint • support: MANDATORY	The layerProtocol at which the FC enables potential for forwarding.
_lowerLevelFcRefList	ForwardingConstruct	0..*	RW	OpenModelAttribute • AVC: NA • valueRange: no range constraint • support: MANDATORY	An FC object supports a recursive aggregation relationship such that the internal construction of an FC can be exposed as multiple lower level FC objects (partitioning). Aggregation is used as for the FD to allow changes in hierarchy. FC aggregation reflects FD aggregation. The FC represents a Cross-Connection in an NE. The Cross-Connection in an NE is not necessarily the lowest level of FC partitioning.

Figure 2-17 Extract from data dictionary (V1.2)

2.2.3 Terminology mapping (TR-512.TM)

The terminology mapping document contains a table that provides overview translations from classes in the ONF-CIM to classes (and concepts) in other models. It will be helpful for someone who is familiar with one of the other industry standard terminology sets when working through the ONF-CIM.

2.2.4 Core Model Future Enhancements (TR-512.FE)

This document provides fragments of ongoing work and lists all work areas known to require further development. The data dictionary document does NOT include entities from this document. All the work mentioned in this document is experimental.

2.2.5 Gendoc fragment definitions (TR-512.GT)

This document provides a base document from which all other documents are derived. The document provides some examples of usage.

Note that Gendoc is the tool used to extract model element details and diagrams from the .uml and .notation files and to insert those into the TR-512 documentation.

Note all Gendoc templates are provided in the Gendoc folder.

2.3 Supporting Guidelines

Several guideline documents have been constructed to maintain consistency in the models generated by ONF. These guidelines have also been shared with organizations outside ONF and are now developed in a collaborative mode across multiple bodies in an activity called IISOMI under OIMT in ONF [ONF-IISOMI].

- **[ONF TR-513]:** This document specifies the principles and guidelines for the development and use of the ONF-CIM, including guidelines for deriving purpose-specific information model views (through pruning and refactoring selected subsets of artifacts from the ONF-CIM), and mapping to data schemas for protocol-specific control interfaces.
- **[ONF TR-514]:** The ONF-CIM is expressed in a formal language called UML (Unified Modeling Language). UML has a number of basic model elements, called UML artifacts. In order to assure consistent modeling, only a subset of the UML artifacts is used in the development of the ONF-CIM. The selected subset of UML artifacts is documented.
- **[ONF TR-515]**: This document specifies the guidelines for using the Papyrus tool used in the development of the ONF-CIM. It also describes how the ONF CIM modeling teams can cooperate in the GitHub environment for separate and coordinated development of the ONF-CIM fragments.
- [ONF TR-531]: This document defines the guidelines for mapping protocol-neutral UML information models to YANG data schemas. The UML information model to be mapped has to be defined based on the UML Modeling Guidelines defined in [ONF TR-514].
- [ONF TR-543]: This document defines the guidelines for mapping protocol-neutral UML information model to OpenAPI (also a.k.a Swagger API), which is a RESTful API with JSON data schema. The UML information model to be mapped has to be defined based on the UML Modeling Guidelines defined in [ONF TR-514].
- [ONF TR-544]: This document defines the guidelines for mapping protocol-neutral UML information model to the ProtoBuf schema language. The UML information model to be mapped has to be defined based on the UML Modeling Guidelines defined in [ONF TR-514].

2.4 Key reference material

In the development of the CoreModel, information model work from other SDOs has been used as input, including [TMF TR215], [TMF TR225], [TMF SID 5LR], [ITU-T G.7711], [ITU-T G.875], [ITU-T G.8052], and [ITU-T G.8152]. The CoreModel is being shared with other bodies via various mechanisms including publication of a view of the model as an IETF draft [draft-lam].

2.5 Papyrus File

This section provides the link to the information model file and the companion Open Model Profile file specified using the "Papyrus" modeling tool.

Link to the Core Model files: OnfModel folder.

The file structure is as follows:

- .project,
- CoreModel.di,
- CoreModel.notation
- CoreModel.uml
- OpenModel_Profile.profile.di
- OpenModel_Profile.profile.notation
- OpenModel_Profile.profile.uml
- Location.di
- Location.notation
- Location.uml
- Party.di
- Party.notation
- Party.uml
- Experimental.profile.di[11]
- Experimental.profile.notation
- Experimental.profile.uml

In order to view and further extend or modify the information model, install the open source Eclipse software and the Papyrus tool. The installation guide for Eclipse and Papyrus can be found in [ONF TR-515].

2.6 Boundary of the work

As noted, the ONF Core IM does not cover interface definition. As a consequence, certain stereotype values are not relevant and hence are left at default including objectCreationNotification, objectDeletionNotification and passByReference. A majority of the attributes are read/write as in most cases a view can be conceived that will allow the attribute to be written.

2.7 Key Model Classes

This section aims to take a different approach to introducing the CIM Core model classes. Note that this section is non-normative, that is it is a simplified introductory section only and not the actual model definition.

[11] The Experimental profile provides some stereotypes related to experimental rules (e.g. in the Physical model). The relevant stereotypes in this profile will be moved to a formal profile in the next release.

One of the key principles that the model is based on is that the physical[12] inventory needs to be clearly segregated from the (logical) functional model. It is important that there is a clean boundary as any mixing will cause problems that then 'distort the rest of the model'.

The physical inventory model has two key classes, Equipment and Holder. Equipment is the physical unit and the holders are the 'places' that can hold other physical units. This allows us to show the physical interrelationships but no functional ones, so for example concepts like a switch stack need to be done in the logical model.

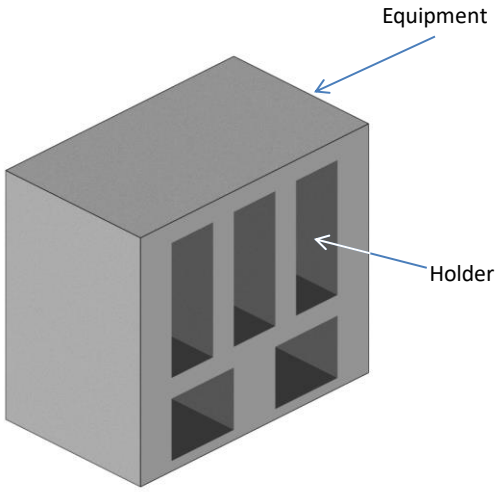


Figure 2-18 – Physical Inventory

On the logical side of the model, it is useful to categorize the functions in a network in terms of the type of functions that they provide. Two key function types are processing and transport of information.

For both of these logical function types it is useful to represent their association[13] using a common pattern. Each of the logical functions can be thought of as a component. If the component is 'symmetric' then the association is between the components. If the component is asymmetric and the asymmetry is relevant to the association, then the component needs to have ports defined and the association is between the ports.

The figure below shows the key model entities and the functions that they perform.

[12] A Physical thing is a thing that can be measured with a ruler.
[13] A binding together in some way such that the components are adjacent and such that information flows between them.

Key Class	Processing Function	Transport Function	Constraint
LTP	✓ - protocol stack termination (Transform)	-	✓ - client creation
Forwarding Construct	-	✓ - forwarding (Transfer)	✓ - bounded forwarding
Forwarding Domain	-	-	✓ - FC creation, LTP creation
Link	-	-	✓ - FC creation, LTP creation
Control Construct	✓ - management-control plane (communications)	-	-
Configuration and Switch Control (CASC)	✓ - management-control plane (control)	-	-
Constraint Domain	-	-	✓ - general constraints (augmenting above)
Processing Construct	✓ - any hybrid functions and any other function not above	-	-

- = insignificant (may be non-zero – e.g. all Processing Functions are bound to encapsulate some forwarding and it can be argued that forwarding is a form of processing)
There is a 3rd function , Storage that isn't supported by any of these

Figure 2-19 Key Class Functions

The first set of logical functions that we will discuss is those related to information transport.

The key transport classes are ForwardingDomain, ForwardingConstruct and Link.

ForwardingDomain and Link are both constraint boundaries that allow ForwardingConstruct creation between the LTPs that their ports are bound to. Links are also constrained in that their ports need to be bound to ForwardingDomain port LTP.

ForwardingConstruct represents enabled forwarding capability.

LogicalTerminationPoint and LayerProtocol are specialized processing functions used to terminate the forwarding capability and process the information.

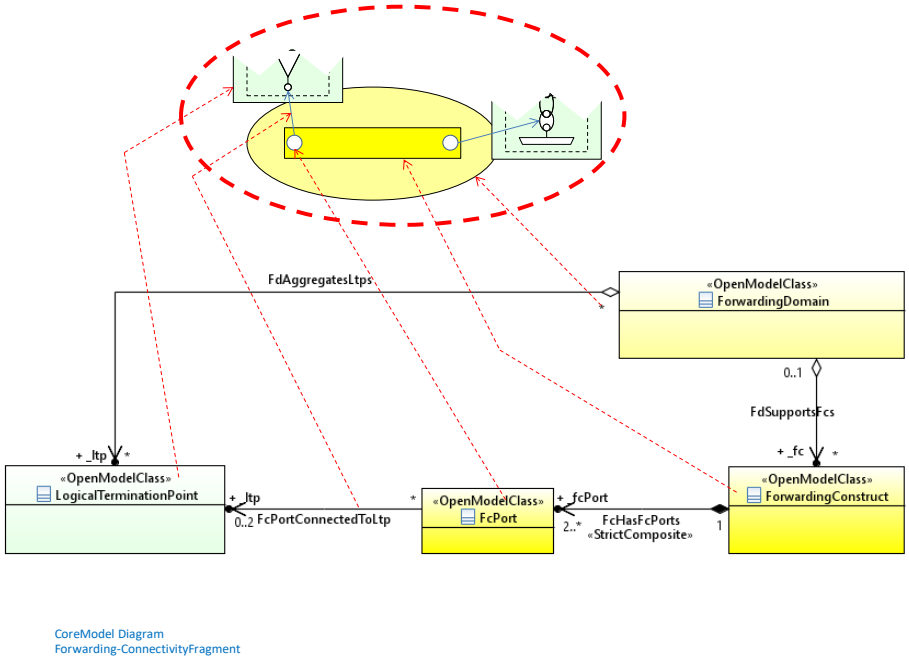


Figure 2-20 – Key Transport classes

For the processing functions we also have ProcessingConstruct and ControlConstruct.

Both ProcessingConstruct and ControlConstruct perform processing functions, but while a ProcessingConstruct just processes its own information, a ControlConstruct processes information to control other functions (such as ProcessingConstructs, ForwardingConstructs etc.). It is this additional controlling responsibility that means that it makes sense to have a separate model entity for ControlConstruct.

The last class that we will discuss is ConstraintDomain. ConstraintDomain provides general grouping / scoping and a place to attach constraints (to be added in a later release of the model).

The figure below shows the key model classes, and we can see the common component-port pattern repeated.

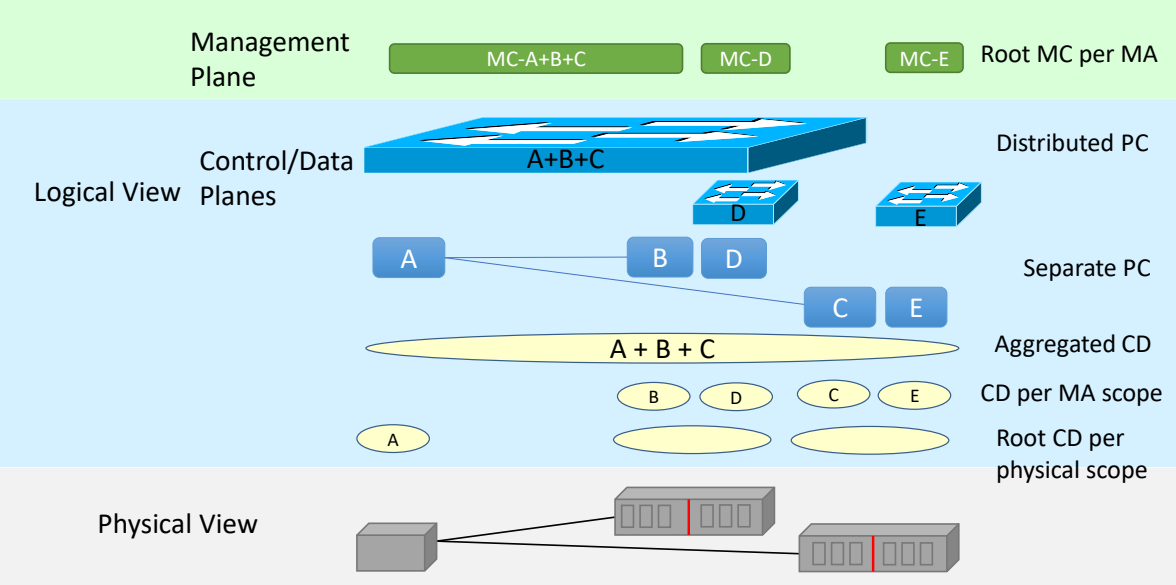
Note that LogicalTerminationPoint plays a special role in the model. It is like a 'binding post' that is used to decouple the associations between each of the other classes. Without it we would need N * (N-1) /2 associations to show the options (possibly 55 associations instead of the 11 in the model above). The table below summarizes the association options in the model.

Key Class	Symmetric Option	Asymmetric Option
LTP	✓	- #
Forwarding Construct	-	✓
Forwarding Domain	✓	✓
Link	-	✓
Control Construct	-	✓
Configuration and Switch Control (CASC)	-	✓
Constraint Domain	✓	✓
Processing Construct	✓	✓

- will be added when LTP Port is added in a future model release

Figure 2-21 – Key Model Class Association Options

Now we can see how the model fits together. The loose coupling between the physical inventory and the logical functions allows for complex physical – logical mappings as shown in the diagram below.



The management plane may be global or partitioned, or both (as shown).
Root MC, Root CD and Physical Inventory have same scope.
PC = ProcessingConstruct, CD = ConstraintDomain, MC= Management Context, MA = Management Agent

Figure 2-22 - Distributed Device – Split Chassis

ConstraintDomain (CD in the diagrams) is used to scope physical, logical and control boundaries.

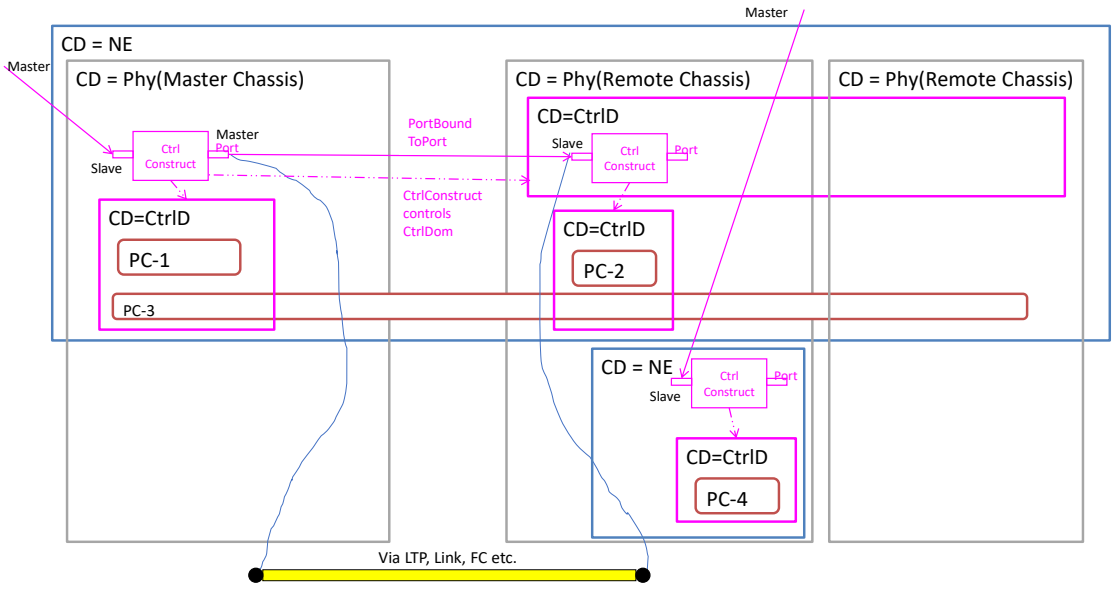


Figure 2-23- Distributed Device – Split Chassis

Rather than trying to 'decompose' a network element black-box concept, the model 'turns the network element inside-out' and focusses on the network functions and their relationships and allows these functions to be grouped as required using ConstraintDomains. The association through LTP allows for the functional port-port bindings to be related to any underlying transport objects.

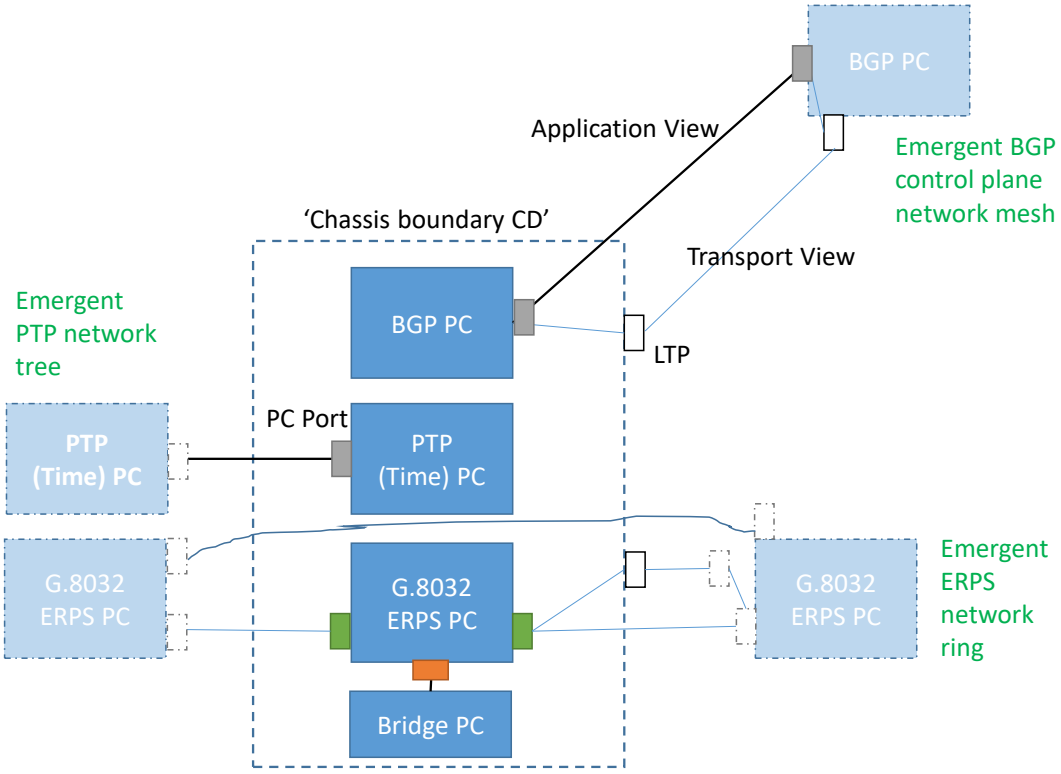


Figure 2-24 – Example network function connectivity

The figure above shows a typical device which is running many protocols, and hence will have a number of network function instances. Each network function instance may peer with different remote devices to form different network function topologies.

3 Summary of changes

3.1 Summary of main changes between version 1.1 and 1.2

Changes to the model and/or related documentation:

- General
  - Change to doc structure
  - Change to gendoc
- Forwarding and Termination

    - Minor corrections made to multiplicities
    - Improvements made to documentation
- Foundation
    - An address structure has been added as «Experimental»
- Topology
    - Change of name of TopologicalEntity to ForwardingEntity
    - Incorporation of FC under ForwardingEntity and consideration of FC as closely related to topology
    - Capacity
- Resilience
    - Protection, restoration and recovery attributes added
    - Structure enhanced
    - Association to LTP from protection added in preparation for G.8032 modeling
    - Various examples of usage developed to both prove and document the resilience model
    - Corrections made to some multiplicities
    - Lifecycle stereotypes adjusted to reflect the advancing maturity of the model
- Equipment
    - New model added as «Experimental»
    - Focus of the model is on the pattern but all experimental work has been published as equal
- Specification
    - Addition of FD/Link spec details in terms of FD/Link capability statements
    - Refinement of FC spec to accommodate the Link (removal of Fc from class names in the spec and generalization to Forwarding recognizing the Link as a Forwarding entity).
    - Addition of sketches of the generalized spec model
    - Enhancements to details on LTP/LP spec and discussion on migration

3.2 Summary of main changes between version 1.2 and 1.3

- General
    - Change to doc structure:
        - To focus numeric series on describing the model
        - Adding an appendix ("A") series that provides further explanation
        - Adding a "double letter" series to capture ongoing model support material
    - Clean up of model structure
- Forwarding and Termination
    - Photonic/Media model including examples in an Appendix
    - Deprecating of NE, SdnController and NetworkControlDomain (replaced by the Control model and ProcessingConstruct/ConstraintDomain (see below)
    - LtpHasServerLtp is changed from composition to aggregation
    - Addition of Clock
- Foundation
    - Enhancements to the state model
- Topology

    - FdPort added to model as an optional
    - Aggregation of FD by FD via HigherLeeFdEncompassesLowerLevelFDs allows for many FDs to aggregate the same subordinate FD and this is reflected in the FcHasLowerLevelFc association multiplicity
    - Added explanation of use of model to support:
        - Serial-Compound Link
        - Inverse Multiplexing
        - Transitional Link
        - Multi-Port Links
        - State depedency
    - Added a clarification of the definition of Link
    - Explained the relationship between topology and the new control model
    - Enhanced the explanation of the approach of using the FC to represent the Call
    - Added explanation of the Resource-Service Continuum
- Resilience
    - G.8032 model with examples of use in an Appendix
    - Use of scheme spec concept
    - Timing protection
- Equipment
    - Upgrade of some classes and attributes from experimental to preliminary or mature
    - Integration with PC model providing an enhanced support for "Equipment protection" (via a model of function resilience)
- Specification
    - Improved introductory material
    - Refinements to the model to improve the decoupling of specification from the specified class
    - Addition of scheme spec concept
- Addition of the Control model
    - In conjunction with Processing Construct and Constraint Domain (see below) this provides:
        - A full consistent model of control
        - A replacement for the NE
- Addition of Operations Pattern model
    - This provides a generalized model of operations for an outcome-oriented interaction
- Addition of Processing Construct (PC) and Constraint Domain (CD)
    - This provides a generalized representation of functionality beyond Forwarding and Termination
- Addition of supporting information on patterns underpinning the model

3.3 Summary of main changes between version 1.3 and 1.3.1

- General
    - An important note related to the approval status of TR-512 was added to each of the documents.

- Addition of the Circuit switched examples

Note that there were no changes in the UML model in 1.3.1.

3.4 Summary of main changes between version 1.3.1 and 1.4

- Addition of Simplified Introduction section to this document (see section 2.7 Key Model Classes on page 29).
- Additional explanation to account for monitoring and overhead of media network (TR-512.2). There has also been:
  - Addition of the PHOTONIC_MEDIA LayerProtocol string literal
  - Extension of layerProtocol to include a qualifier (relevant to both OTN and photonic-media)
- Addition of explanatory figure to show topology in a deep non-intrusive monitoring context (TR-512.4)
- Addition of description to the attributes and promotion to some model artifacts of the Physical model in TR-512.6)
- Enhancement to Forwarding Spec and Termination Spec to cater for the photonic model (TR-512.7)
  - The model now allows a recursion of specification of FCs inside LP and LPs inside FCs[14]
- Enhancements to the model of Control to improve consistency with other parts of the model and addition of representation of the operations on the ControlConstruct (TR-512.8)
  - The new work builds a bridge between the model of Control and the Operations model in TR-512.10
- Addition of the Software model (new TR-512.12) and examples (new TR-512.A.13)
- Refinement and further development to the Component-System pattern (TR-512.A.2)
- Addition of new sections to TR-512.A.4 (new section 4 on L0 monitoring and overhead, section 5 on Relationship between L0 functional and physical, section 6 on photonic cases)
- Addition of the Packet switched examples (new TR-512.A.6)
- Addition of Control and Interaction examples (new TR-512.A.7)

3.5 Summary of main changes between version 1.4 and 1.5

- Addition of models of Party (TR-512.13) and Location (TR-512.14)
- Split of Foundation across two documents (Naming and Identifiers (TR-512.3)and State (TR-512.17))
- Enhancements to state model (TR-512.17)
- Addition of model sketch of streaming and notification functions to the Control model (TR-512.8)
- Update to modeling tools (see section 1.3 Tool versions on page 7)

[14] This will probably lead to a generalized pattern for LTP, FC etc. and scheme/system spec. This will be covered in the next release.

- Enhancements to model structure in preparation for partitioning the model into separate papyrus projects.
- Removal of various broken diagrams

4 References

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[ITU-T G.780] Recommendation ITU-T G.780/Y.1351 (07/10), *Terms and definitions for synchronous digital hierarchy (SDH) networks*

[ITU-T G.798] Recommendation ITU-T G.798 (12/17), *Characteristics of optical transport network hierarchy equipment functional blocks*

[ITU-T G.800] Recommendation ITU-T G.800 (04/2016), *Unified functional architecture of transport networks*

[ITU-T G.805] Recommendation ITU-T G.805 (03/2000), *Generic functional architecture of transport networks*

[ITU-T G.808.1] Recommendation ITU-T G.808.1 (05/2014), *Generic protection switching – Linear trail and subnetwork protection*

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[ITU-T G.813] Recommendation ITU-T G.813 (03/03), *Timing characteristics of SDH equipment slave clocks (SEC)*

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[ITU-T G.852.2] Recommendation ITU-T G.852.1 (11/1996), *Enterprise viewpoint description of transport network resource model*

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[ITU-T G.874] Recommendation ITU-T G.874 (08/2017), *Management aspects of optical transport network elements*

[ITU-T G.875]	Recommendation ITU-T G.875 (06/2020), *Optical transport network: Protocol-neutral management information model for the network element view*
[ITU-T G.7702]	Recommendation ITU-T G.7702 (03/18), Architecture for SDN control of transport networks
[ITU-T G.7711]	Recommendation ITU-T G.7711/Y.1702 (03/2018), *Generic Protocol-Neutral Information Model for Transport Resources*
[ITU-T G.7712]	Recommendation ITU-T G.7712/Y.1703 (09/10), *Architecture and specification of data communication network*
[ITU-T G.8001]	Recommendation ITU-T G.8001/Y.1354 (04/16), *Terms and definitions for Ethernet frames over transport*
[ITU-T G.8013]	Recommendation ITU-T G.8013/Y.1731 (08/15), *Operations, administration and maintenance (OAM) functions and mechanisms for Ethernet-based networks*
[ITU-T G.8032]	Recommendation ITU-T G.8032/Y.1344 (08/15), *Ethernet Ring Protection Switching*
[ITU-T G.8052]	Recommendation ITU-T G.8052/Y.1346 (11/2016), *Protocol-neutral management information model for the Ethernet Transport capable network element*
[ITU-T G.8081]	Recommendation ITU-T G.8081 (02/2012), *Terms and definitions for automatically switched optical networks*
[ITU-T G.8152]	Recommendation ITU-T G.8152/Y.1375 (12/2016), *Protocol-neutral management information model for the MPLS-TP network element*
[ITU-T M.3100]	Recommendation ITU-T M.3100 (04/2005), *Generic network information model*
[ITU-T M.3400]	Recommendation ITU-T M.3400 (02/2000), *TMN management functions*
[ITU-T Q.1741.9]	Recommendation ITU-T Q.1741.9 (06/15), IMT-2000 references to Release 11 of GSM evolved UMTS core network
[ITU-T X.731]	Recommendation ITU-T X.731 (01/1992), *Information technology - Open Systems Interconnection - Systems management: State management function*
[OASIS TOSCA]	https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=tosca
[ONF]	https://www.opennetworking.org/
[ONF-TMF-MEF]	MEF ONF TMF Collaboration Agreement (see https://login.opennetworking.org/bin/c5i?mid=38&rid=61&cid=3&k1=1567&tid=1483824677)
[ONF TR-502]	TR-502 (V1.0): SDN architecture, June 2014 https://3vf60mmveq1g8vzn48q2o71a-wpengine.netdna-ssl.com/wp-content/uploads/2013/02/TR_SDN_ARCH_1.0_06062014.pdf

[ONF TR-512]	This document series (V1.3.1, V1.2) (https://www.opennetworking.org/software-defined-standards/models-apis/ for the project deliverables (including the documents), https://www.opennetworking.org/wp-content/uploads/2014/10/TR-512_CIM_(CoreModel)_1.2.zip for V1.2 and navigate the project deliverables for V1.3.1 (as the link was not available during the final editing))
[ONF TR-513]	TR-513 (V1.2): ONF Common Information Model Overview (https://www.opennetworking.org/software-defined-standards/models-apis/ for the project deliverables (including the document) and https://3vf60mmveq1g8vzn48q2o71a-wpengine.netdna-ssl.com/wp-content/uploads/2014/10/TR-513_CIM_Overview_1.2.pdf for the document)
[ONF TR-514]	TR-514 (V1.3): ONF UML Model Guidelines (https://www.opennetworking.org/software-defined-standards/models-apis/ for the project deliverables (including the document) and https://3vf60mmveq1g8vzn48q2o71a-wpengine.netdna-ssl.com/wp-content/uploads/2018/08/TR-514_UML_Modeling_Guidelines_v1.3-1-1.pdf for the document)
[ONF TR-515]	TR-515 (V1.3): ONF Papyrus Guidelines (https://www.opennetworking.org/software-defined-standards/models-apis/ for the project deliverables (including the document) and https://3vf60mmveq1g8vzn48q2o71a-wpengine.netdna-ssl.com/wp-content/uploads/2018/08/TR-515_Papyrus_Guidelines_v1.3-1-1.pdf for the document)
[ONF TR-521]	TR-521 (V1.1): ONF SDN Architecture 1.1, February 2016 (https://3vf60mmveq1g8vzn48q2o71a-wpengine.netdna-ssl.com/wp-content/uploads/2014/10/TR-521_SDN_Architecture_issue_1.1.pdf)
[ONF TR-523]	TR-523: Intent NBI – Definition and Principles, October 2016 (https://3vf60mmveq1g8vzn48q2o71a-wpengine.netdna-ssl.com/wp-content/uploads/2014/10/TR-523_Intent_Definition_Principles.pdf)
[ONF OpenFlow]	https://www.opennetworking.org/technical-communities/areas/specification/open-datapath/
[ONF-TAPI]	ONF Transport API (activity under the ONF OTCC project). (https://github.com/OpenNetworkingFoundation/TAPI and https://wiki.opennetworking.org/display/OTCC/TAPI)
[OpenConfig]	https://github.com/openconfig/public
[ONF-IISOMI]	Project EAGLE: ONF Open Model, Profiles and Tools (https://github.com/OpenNetworkingFoundation/EAGLE-Open-Model-Profile-and-Tools and https://wiki.opennetworking.org/display/OIMT/IISOMI)
[TMF 612]	TM Forum MTOSI (4.0), Multi-Technology OS Interface https://www.tmforum.org/resources/suite/mtosi-solution-suite-release-2-1/

[TMF IG1118]	TM Forum IG1118 OSS/BSS Futures – Architecture R15.5.1 (liaised to ONF) https://www.tmforum.org/resources/exploratory-report/ig1118-ossbss-futures-architecture-r15-5-1/
[TMF MTNM]	Multi-Technology Network Management (MTNM) https://www.tmforum.org/mtnm/
[TMF TR215]	TMF TR215 (V0.5.3) Logical Resource Network Model Advancements and Insights (liaised to ONF) https://www.tmforum.org/resources/standard/tr215-logical-resource-network-model-advancement-and-insightstr215-logicalresourcenetworkmodeladvancementandinsights_version0-5-3/
[TMF TR225]	TM Forum TR225 (R15.0.0), Logical Resource: Network Function Model (liaised to ONF) https://www.tmforum.org/resources/exploratory-report/tr225-logical-resource-network-function-model-r15-0-0-2/
[TMF SID 5LR]	TM Forum GB922 (R15.0.0) Information Framework (SID) Addendum 5LR (liaised to ONF) – latest version at https://www.tmforum.org/resources/reference/gb922-information-framework-model-differences-r18-0-0/
[UML-YANG GUIDE]	TR-531 (V1.1) UML- YANG Mapping Guidelines https://3vf60mmveq1g8vzn48q2o71a-wpengine.netdna-ssl.com/wp-content/uploads/2018/08/TR-531_UML-YANG_Mapping_Gdls_v1.1-1-1.pdf
[UML-YANG TOOL]	UML- YANG Mapping Tooling Navigate via https://github.com/OpenNetworkingFoundation/EAGLE-Open-Model-Profile-and-Tools

5 Definitions

5.1 Terms defined elsewhere

This document uses terms defined elsewhere. These terms are highlighted in section 5.3 Abbreviations and acronyms below by referring to the definition source document.

5.2 Terms defined in this TR

The primary purpose of TR-512 is to define terms and hence terms are defined throughout the document suite and model. Key terms are highlighted in section 5.3 Abbreviations and acronyms below. Where a term is defined elsewhere there is a reference to the document where the term is defined.

5.3 Abbreviations and acronyms

This TR uses the following abbreviations and acronyms:

Ø Phase

(A)	Assembly
(e)	electrical
(G)	Group
(O)	Overhead
(p)	photonic
Analogue	Continuously variable quantity (not relevantly quantized, not digitized). Used to convey information.
AP	Access Point [ITU-T G.805]
API	Application Programmer's Interface
BBF	BroadBand Forum (see https://www.broadband-forum.org/)
BC	Boundary Clock
BMCA	Best Master Clock Algorithm
C&SC	Configuration and Switch Controller (model entity)
CASC	C&SC
CC	ControlConstruct (see TR-512.8)
CD	ConstraintDomain (see TR-512.11)
cir	circulator
CNM	Customer Network Management
CP	Connection Point [ITU-T G.805]
CRUD	Create Read Update Delete
CTP	Connection Termination Point. Note that definitions differ between TM Forum [TMF 612] and [ITU-T M.3100]. Both usages apply here when referring to legacy cases and the abbreviation is qualified in all cases of use.
DSP	Digital Signal Processor
DSRA	Digital Services Reference Architecture (see TMF)
E-O	Electrical - Optical
ECC	Embedded Communications Channel [ITU-T G.874]
EDFA	Erbium Doped Fiber Amplifier
EMS	Element Management System [definition reference ITU-T M.3400 - TMN][15]
ERP	Ethernet Ring Protection
ERPS	Ethernet Ring Protection Switching
ETH	Ethernet MAC Layer [definition reference ITU-T G.8001]
eTOM	enhanced Telecommunications Operations Map (see TMF)
ETY	Ethernet Physical Layer [definition ITU-T G.8001]
FC	ForwardingConstruct (defined in the ONF-CIM - see TR-512.2).

[15] This term is not intended for use other than in reference to legacy systems.

	• Note that at this point the definition is subtly different to that in [TMF TR225]. The aim is to align the terms usage
FD	ForwardingDomain (defined in the ONF-CIM - see TR-512.2)
FDFr	FlowDomainFragment [TMF 612]
FRE	ForwardingRelationshipEncapsulation [TMF TR215]
FRU	Field Replaceable Unit
FTP	FloatingTerminationPoint [TMF 612]
g	Glass (used on an FC representing a fibre)
GitHub	See www.github.com
GUID	Globally Unique IDentifier (see www.wikipedia .org/Globally_unique_identifier)
H2M	Human to Machine
IISOMI	Informal Inter-SDO Open Model Initiative (see [ONF-IISOMI])
IM	Information Model (see section 1 Introduction above)
IMP	Inverse MultiPlexing [ITU-T G.805]
ISO	International Organization for Standardization (see www.iso.org)
ITC	Information Transfer Channel
ITU	International Telecommunications Union (see www.itu.int)
ITU-T	Telecommunications Standardization Sector of ITU-T (see http://www.itu.int/en/ITU-T/Pages/default.aspx)
JSON	JavaScript Object Notation (www.json.org/)
La	Laser
LP	LayerProtocol (defined in the ONF-CIM – see TR-512.2). Note that there are two related terms: • layer-protocol: used to refer to the information transfer protocol (or Characteristic Information of the signal) • layerProtcolName: used to refer to the attribute in the LP class that carries the value that identifies the characteristic layer-protocol of the LP • LayerProtocolName: used to refer to the data type that holds the formal name of the layer-protocol
LTP	LogicalTerminationPoint (defined in the ONF-CIM - see TR-512.2)
M2M	Machine to Machine
MA	Management Agent
MAC	Media Access Control
MC	Media Channel
MCA	Media Channel Assembly
MCC	Management Control Continuum (see [TMF IG1118]
MCG	Media Channel Group

ME	Managed Element OR Media Element (clarified per usage)
Media	Substances (singular Medium) through which signal carrier is conveyed. In this case a vacuum is also considered as a medium.
MEF	MEF Forum (see https://mef.net/)
MEG	Maintenance Entity Group
MEP	MEG End Point
MFDFr	MatrixFlowDomainFragment
MIP	MEG Intermediate Point
MLSN	MultiLayerSubNetwork [TMF 612]
MP2MP	Multi-Point to Multi-Point
MPLS-TP	Multi-Protocol Label Switching Transport Profile [definition reference RFC6378]
MSS	Multiple Strand Span
NCD	NetworkControlDomain
NDC	Network Domain Channel
NE	NetworkElement
NFV	Network Function Virtualization
NMC	Network Media Channel
NMCA	Network Media Channel Assembly
NMCG	Network Media Channel Group
NMS	Network Management System
NVP	Name-Value Pair
OAM	Operations Administration and Maintenance
OC	Ordinary Clock OR Overall Controller
OCh	Optical Channel
ODU	Optical Data Unit
OIF	Optical Interworking Forum (see http://www.oiforum.com/)
OIMT	Open Information Model & Tooling (an ONF project)
OME	Optical Maintenance Entity
OMS	Optical Multiplex Section
OMS-O	Optical Multiplex Section-Overhead
ONF	Open Networking Foundation
ONF-CIM	ONF Common Information Model
OPS	Optical Protection Switch
OS	Operations System (same as OSS) OR Optical Section
OSC	Optical Supervisory Channel
OSME	Optical Signal Maintenance Entity

OSNR	Optical Signal to Noise Ratio
OSS	Operation Support System
OTCC	Open Transport Configuration and Control (an ONF project)
OTN	Optical Transport Network
OTS	Optical Transmission Section
OTS-O	Optical Transmission Section-Overhead
OTSi	Optical Tributary Signal
OTSiG	Optical Tributary Signal Group
OTSiG-O	Optical Tributary Signal Group-Overhead
OTU	Optical Transport Unit
OTU-CN	Optical Transport Unit beyond 100G (B100G)
P&R	Pruning and Refactoring (Prune and Refactor)
P2MP	Point to Multi-Point
P2P	Point to Point
PC	ProcessingConstruct (see TR-512.11)
Pd	Photodiode
Pe	Pump of electrons (constant power stream)
Pm	Phase modulation
PoC	Proof of Concept
PON	Passive Optical Network
Pp	Pump of photons (constant power stream)
PRC	Primary Reference Clock
PTP	Physical Termination Point [TMF 612]
PTP	Precision Time Protocol [IEEE 1588]
RMP	Rooted Multi-Point
ROADM	Reconfigurable Optical Add-Drop Multiplexor
SD FEC	Soft Decision Forward Error Correction
SDN	Software Defined Networking [ONF]
SDO	Standards Development Organization
Se	Signal encoded on an electron stream
Si	Signal
SID	Shared Information and Date model (see TMF)
SiG	Signal Group
SNC	SubNetworkConnection [TMF 612]
SNP	SubNetworkPoint [ITU-T G.8081]
Sp	Signal encoded on a photon stream

SSM	Synchronization Status Message
TAPI	Transport API
TBD	To Be Defined
TC	Transparent Clock
TCP	Termination Connection Point [ITU-T G.805]
TDM	Time Division Multiplex
TL1	Transaction Language 1 (https://en.wikipedia.org/wiki/Transaction_Language_1)
TMF	TeleManagement Forum (see www.tmforum.org)
TOSCA	[OASIS TOSCA]
TP	Termination Point [ITU-T M.3100]
TPE	TerminationPointEncapsulation [TMF TR215]
TR	Technical Recommendation [ONF] Technical Report [TM Forum]
TRI	Transport Resource Identifier [ITU-T G.8081]
TTP	Trail Termination Point [ITU-T M.3100]
UML	Unified Modelling Language (see www.omg.org)
UUID	Universally Unique IDentifier (see https://en.wikipedia.org/wiki/Universally_unique_identifier)
VCAT	Virtual Concatenation
VM	Virtual Machine
VMM	Virtual Machine Manager
VNE	Virtual Network Element
VNF	Virtual Network Function
XC	CrossConnection
YANG	https://en.wikipedia.org/wiki/YANG

6 Conventions

6.1 Lifecycle Stereotypes

Lifecycle stereotypes (see [ONF TR-514]) are applied to entities in the model to indicate their degree of maturity[16]. These are made visible in many of the figures in this document.

The following stereotypes appear in TR-512:

- «Experimental»: 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[17].
- «Preliminary»: 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.

If no stereotype is shown (or the entity is marked «Mature») the entity is mature. Other Lifecycle Stereotypes are defined in [ONF TR-514].

6.2 Key to diagram symbol set

This document set includes a number of UML diagrams. The UML symbol set is suitably explained in [ONF TR-514]. Many of the UML diagrams in this document have small font (due to density of information conveyed). It will be necessary for the reader to zoom in and pan across the figure to see the detail[18].

This document set also contains a number of non-UML diagrams, which use the symbols highlighted below in pictorial representations of network examples. The symbol set is an advanced partial hybrid of symbols used by other bodies (see [TMF TR215] and [ITU-T G.805]).

[16] The whole model including all degrees of work in progress has been published to allow the user maximum opportunity to set a most consistent direction with the work at hand. It is considered important to expose work in progress especially where this may have an impact on a choice of implementation. There may be some experimental structure that contains some very stable parts, without that structure those parts might be quite uninterpretable. A user who decides to take a low risk approach can ignore preliminary and experimental parts. A user who is more inclined to take a risk or who is looking for inspiration for their work can take the experimental and preliminary parts, understanding the risk involved.

[17] The implementer can clearly choose to use the item at risk (expecting change and accounting for this in deployments etc.)

[18] The aim is to improve the figure readability in future releases.

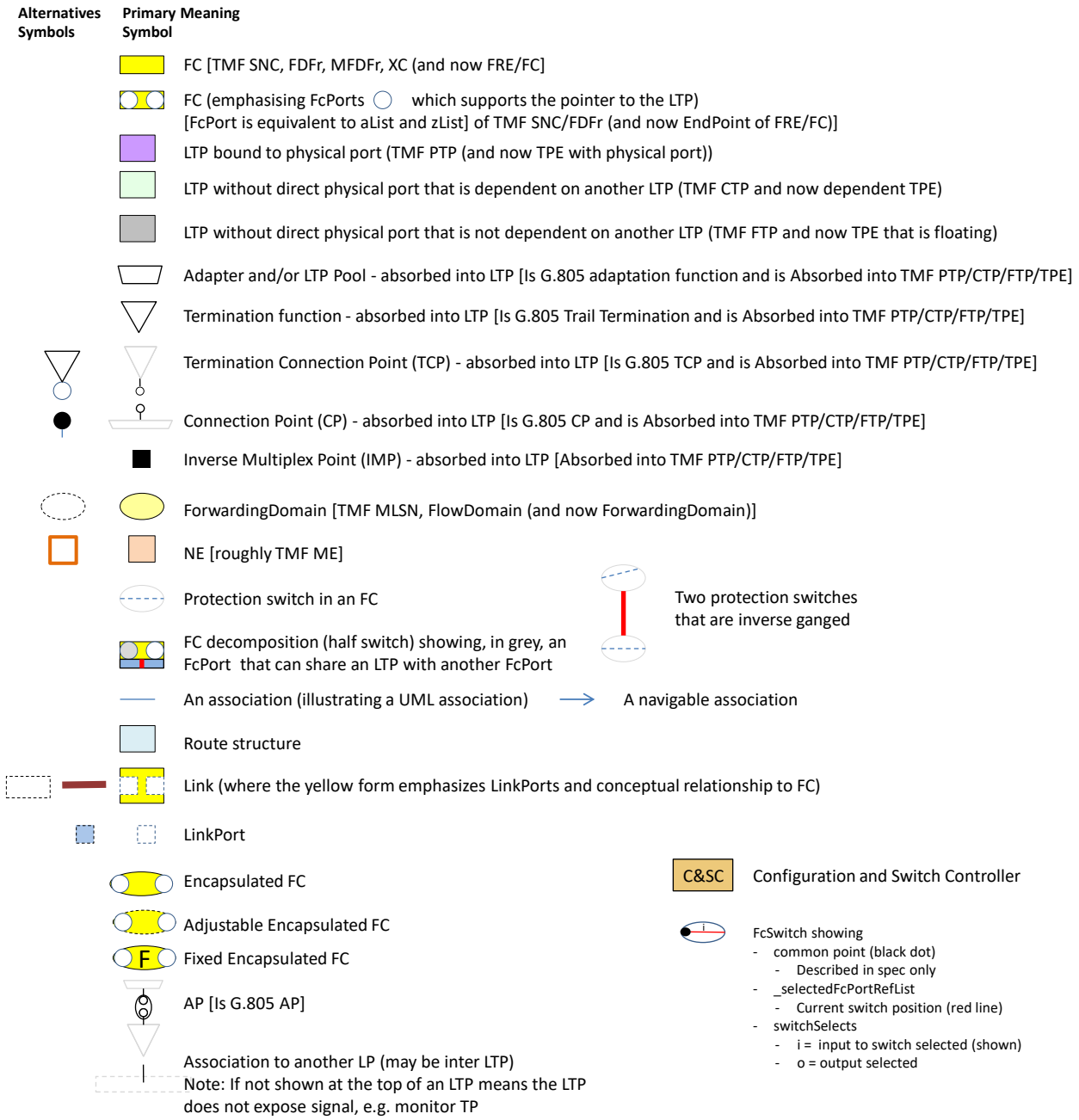

Figure 6-1 Network diagram symbol set[19]

In addition, in the diagrams related to media the following symbols and labels are used.

[19] It should be noted that in this version and future versions the terms ForwardingDomain (FD) and ForwardingConstruct (FC) are used in place of SubNetwork (SN) and SubNetworkConnection (SNC) (used in the earlier versions of the ONF-CIM).

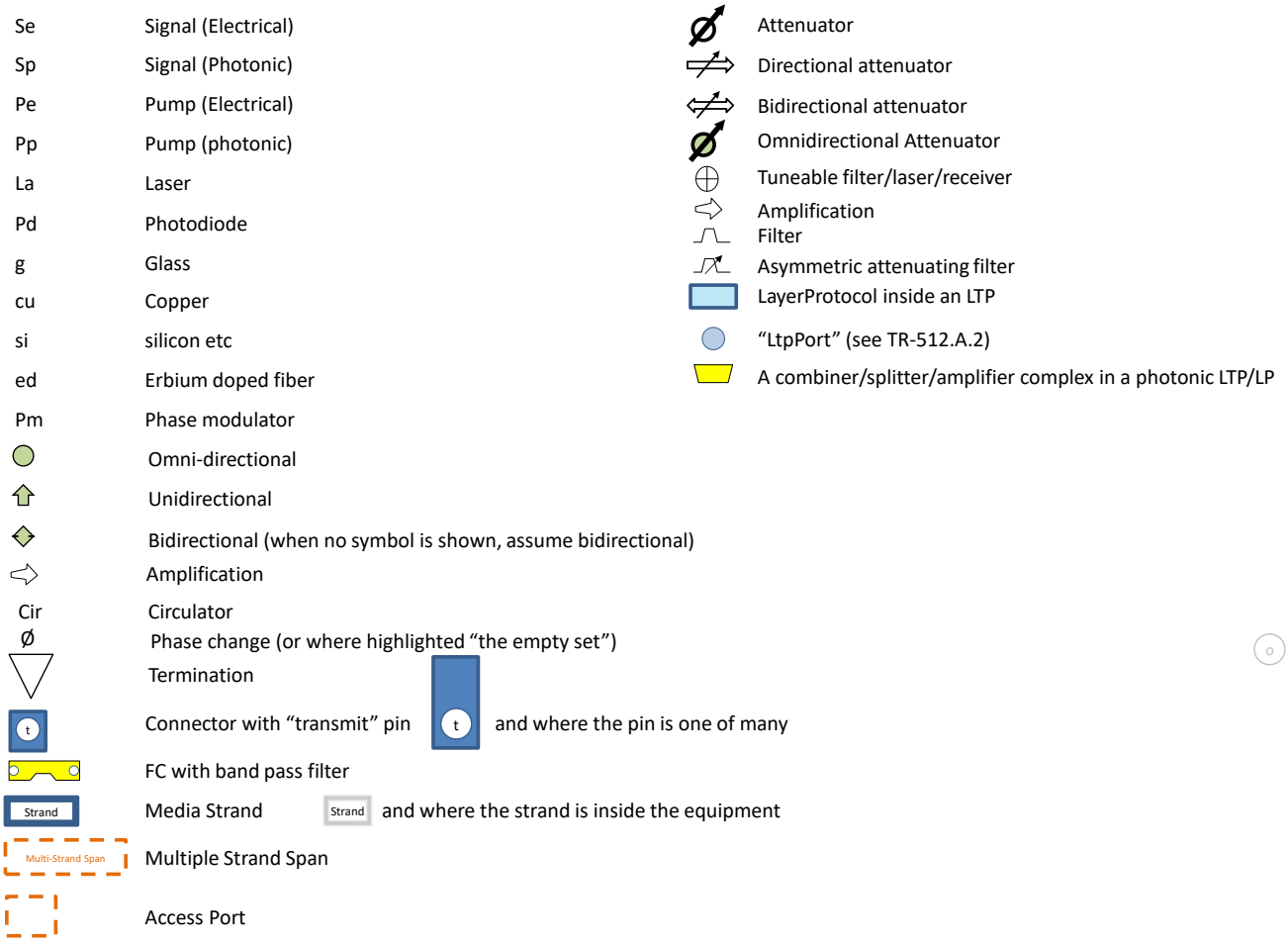

Figure 6-2 Additional media diagram symbol set

7 Future CoreModel work areas

Future work areas are covered in TR-512.FE.

8 Terminology Translation table

The translations provided in this release are early draft (see TR-512.TM). There may be errors in the table and the table is not complete. It should be used for guidance only.

9 Documentation structure

TR-512 is delivered in a .zip file. The file has key documents at the top level and several folders that contain other documents, UML figures and the model.

The .zip file is structured as below:

- ReadMe.txt
- TR-512.1_OnfCoreIm-Overview.pdf (inc. Links to ModelDescription documents and OnfModel folder)
- ModelDescriptions folder (each document includes navigable links to other relevant documents)
    - TR-512.2_OnfCoreIm-ForwardingAndTermination.pdf
    - TR-512.3_OnfCoreIm-Foundation.pdf
    - TR-512.4_OnfCoreIm-Topology.pdf
    - TR-512.5_OnfCoreIm-Resilience.pdf
    - TR-512.6_OnfCoreIm-Physical.pdf
    - TR-512.7_OnfCoreIm-Specification.pdf
    - TR-512.8_OnfCoreIm-Control.pdf
    - TR-512.10_OnfCoreIm-OperationPatterns.pdf
    - TR-512.11_OnfCoreIm-ProcessingConstruct.pdf
    - TR-512.12_OnfCoreIm-Software.pdf
    - TR-512.13_OnfCoreIm-Party.pdf
    - TR-512.14_OnfCoreIm-Location.pdf
    - TR-512.17_OnfCoreIm-FoundationState.pdf
    - TR-512.A.1_OnfCoreIm-AppendixOverview.pdf
    - TR-512.A.2_OnfCoreIm-Appendix-ModelStructurePatternsAndArchitecture.pdf
    - TR-512.A.3_OnfCoreIm-Appendix-ModelRationale.pdf
    - TR-512.A.4_OnfCoreIm-Appendix-AnalogueAndMediaExamples-L0.pdf
    - TR-512.A.5_OnfCoreIm-Appendix-CircuitSwitchedExamples-L1-L2-gd.pdf
    - TR-512.A.6_OnfCoreIm-Appendix-PacketSwitchedExamples-L2-L3-gd.pdf
    - TR-512.A.7_OnfCoreIm-Appendix-ControlAndInteractionExamples-gd.pdf
    - TR-512.A.8_OnfCoreIm-Appendix-TimingAndSynchronizationExamples.pdf
    - TR-512.A.9_OnfCoreIm-Appendix-ProcessingConstructExamples.pdf
    - TR-512.A.10_OnfCoreIm-Appendix-SpecificationExamples.pdf
    - TR-512.A.11_OnfCoreIm-Appendix-ResilienceExamples.pdf
    - TR-512.A.13_OnfCoreIm-Appendix-SoftwareExamples.pdf
    - TR-512.DD_OnfCoreIm-DataDictionary.pdf
    - TR-512.FE_OnfCoreIm-FutureEnhancements.pdf
    - TR-512.GT_OnfCoreIm-CommonGendocTemplate.pdf
    - TR-512.TM_OnfCoreIm-TerminologyMapping.pdf
- UmlFigures folder (has a subfolder for each document that includes one or more UML figures. These figures have been included to aid viewing as some are very detailed (as the .pdf figures do not scale sufficiently)).
    - TR-512.1
    - TR-512.2
    - TR-512.3
    - TR-512.4
    - TR-512.5
    - TR-512.6
    - TR-512.7
    - TR-512.8
    - TR-512.10
    - TR-512.11
    - TR-512.12
    - TR-512.13
    - TR-512.14
    - TR-512.17
    - TR-512.A.2
    - TR-512.FE
- OnfModel folder
    - .project,
    - CoreModel.di,
    - CoreModel.notation
    - CoreModel.uml
    - Location.di
    - Location.notation
    - Location.uml
    - Party.di
    - Party.notation
    - Party.uml
    - CoreCommonDataTypes.di
    - CoreCommonDataTypes.notation
    - CoreCommonDataTypes.uml
    - CommonDataTypes folder
    - UmlProfiles folder

The Gendoc Templates used to generate the TR-512 documents and other documentation aids are provided via another .zip file. They have been delivered to ensure inter-release continuity and will be used as a basis for the construction of the documentation for the next release of model.

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