MEF Standard

MEF 83

Network Resource Model - OAM

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1 List of Contributing Members

The following members of the MEF participated in the development of this document and have requested to be included in this list.

- CenturyLink
- NEC
- Nokia
- Spirent

2 Abstract

This specification describes the MEF Network Resource Management Information Model (NRM IM), specifically for Carrier Ethernet Operations, Administration and Maintenance (OAM) related management features.

Lifecycle Service Orchestration Reference Architecture (LSO RA, MEF 55 [8]) extends the traditional MEF scope concerning Service Modeling, from a pure view "from outside the network" to cover a range of Operational, Orchestration, and Network Management behaviors, including SDN and NFV paradigms.

In support to MEF 55 [8], NRM IM (MEF 59 [9]) and NRP IPS (MEF 60 [10]) have been defined to manage the Network Infrastructure, through SDN Controllers, WAN Controllers, OTN Subnetwork Managers, and other legacy Network Management Systems.

This document adds to MEF 59 [9] the management features related to Operations, Administration and Maintenance (OAM). This model can be used as the basis for LSO RA PRESTO Interface Profiles defining APIs for the OAM.

The NRM IM structure is based on current and developing best network management solutions by ITU-T, ONF, TM Forum, to allow wider and future proof interoperability across multi-vendor and multi-technology networks. Examples of reference network management solutions are ITU-T G.7711/Y.1702 [12], ONF TR-512 [15], ONF TR-527 [16], TM Forum MTNM [20] and MTOSI [21].

This document normatively includes the content of the following Papyrus [18] UML files as if they were contained within this document (pull request **#14,** GitHub Repository [11]):

- NRM_OAM.di
- NRM_OAM.notation
- NRM_OAM.uml

3 Terminology and Abbreviations

This section defines the terms used in this document. In many cases, the normative definitions to terms are found in other documents. In these cases, the third column is used to provide the reference that is controlling, in other MEF or external documents.

In addition, terms defined in MEF 7.3 [5], MEF 30.1[6], MEF 35.1 [7], MEF 55 [8], TMF GB922 [19] are included in this document by reference, and are not repeated in the table below, unless when mentioned in local definitions, e.g. ICM.

Term	Definition	Reference
ICM	Infrastructure Control and Management: The set of functionality providing domain specific network and topology view resource management capabilities including configuration, control and supervision of the network infrastructure.	MEF 55 [8]
Internal Network-to-Network Interface (INNI)	A reference point representing the boundary between two networks or network elements that are operated within the same administrative domain. Note: In this specification, the "networks or network elements" refers to those in a given ICM Domain, hence, between two ICM domains.	MEF 4 [1] MEF 55 [8]
MEP	Maintenance Entity Group (MEG) End Point	ITU-T G.8021 [13]
NRM IM	Network Resource Management Information Model	This document
Product Instance	Specific implementation of a Product Offering dedicated to the benefit of a party.	TMF GB922 [19]
Product Offering	An externally facing representation of a Service and/or Resource procurable by the Customer.	TMF GB922 [19]
Product Specification	The detailed description of product characteristics and behavior used in the definition of Product Offerings.	TMF GB922 [19]
Resource	A physical or non-physical component (or some combination of these) within a Service Provider's infrastructure or inventory.	TMF GB922 [19]

Term	Definition	Reference
Service	Represents the Customer experience of a Product Instance that has been realized within the Service Provider's and / or Partners' infrastructure.	TMF GB922 [19]
Service Component	A segment or element of a Service that is managed independently by the Service Provider.	MEF 55 [8]
TAPI or T-API	Transport API Information Model	ONF TR-527 [16] ONF TAPI IM [17]
UML	Unified Modeling Language	OMG UML, Infrastructure, Version 2.5

Table 1 – Terminology and Abbreviations

4 Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 (RFC 2119 [2], RFC 8174 [3]) when, and only when, they appear in all capitals, as shown here. All key words must be in bold text.

Items that are **REQUIRED** (contain the words **MUST** or **MUST NOT**) are labeled as **[Rx]** for required. Items that are **RECOMMENDED** (contain the words **SHOULD** or **SHOULD NOT**) are labeled as **[Dx]** for desirable. Items that are **OPTIONAL** (contain the words **MAY** or **OPTIONAL**) are labeled as **[Ox]** for optional**.**

5 Introduction

The scope of this specification is a protocol neutral definition of the information, i.e., the attributes (or properties), of the network resource management objects modeling the Carrier Ethernet OAM features according to the requirements defined by MEF 30.1 [6] and MEF 35.1 [7] Implementation Agreements.

MEF 59 [9] includes Carrier Ethernet connectivity resource management features, identified as the set of management features supported by MEF 7.3 [5] at service level. The model defined in this specification adds OAM management features to MEF 59.

Similarly to MEF 59 [9], the MEF NRM OAM IM reuses and extends the definitions of the ONF Transport API Information Model (TAPI IM [16], [17]), which is derived from the ONF Core Information Model ([15]). For more information regarding the ONF Specification approach and the usage of Papyrus [18] UML constructs, refer to MEF 59 related chapters.

The ONF Core IM is a common information model for network/transport technologies, evolution of TMF and ITU-T models. It is extensible to new features/functions.

The TAPI model is derived from the ONF Core IM to make this more oriented to an implementation of transport network management interface. It standardizes a single core technology-agnostic model that abstracts common transport network functions.

The TAPI capabilities are extended through the specification approach. The essential concept is to associate an instance of a TAPI class with a set of extensions that account for the specific case (specification class). These specification classes are definitions of specific cases of usage of a class to be extended.

The modeling of capability necessarily involves the modeling of constraints and rules, as a specific capability is always restricted in some way with respect to the maximum possible capability. The ONF Specification approach focusses on model of constrained capability.

Clearly a UML class model provides a definition of capability in terms of things that can be created and values that can be set. However, the full ONF Core IM and TAPI go way beyond the capability of any real solution. It is therefore necessary for any particular solution to be able to state its specific capabilities. The term used by ONF for the modeling of capabilities is "Capability Specification" or "Specification" or "Spec" for short.

See TR-512.7 Specification Model [15], “2.2 Rationale for, and features of, the ONF Specification approach”.

The MEF 59 [9], (NRM IM Connectivity model) is designed around a set of *specification classes* which extends, or augments, TAPI classes. See Figure 1.

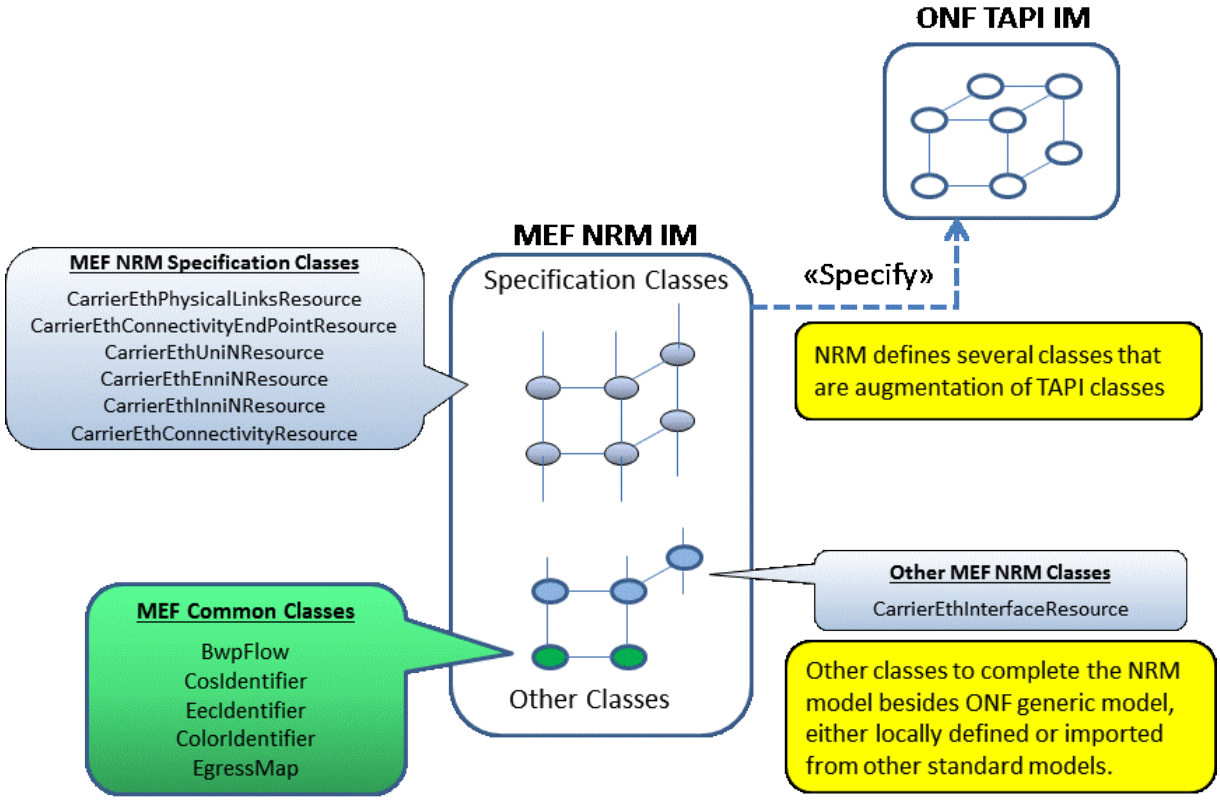

Figure 1 – MEF NRM extending ONF TAPI

The MEF NRM IM classes are applicable to PRESTO Interface Reference Point (MEF 55 [8]), see Figure 2.

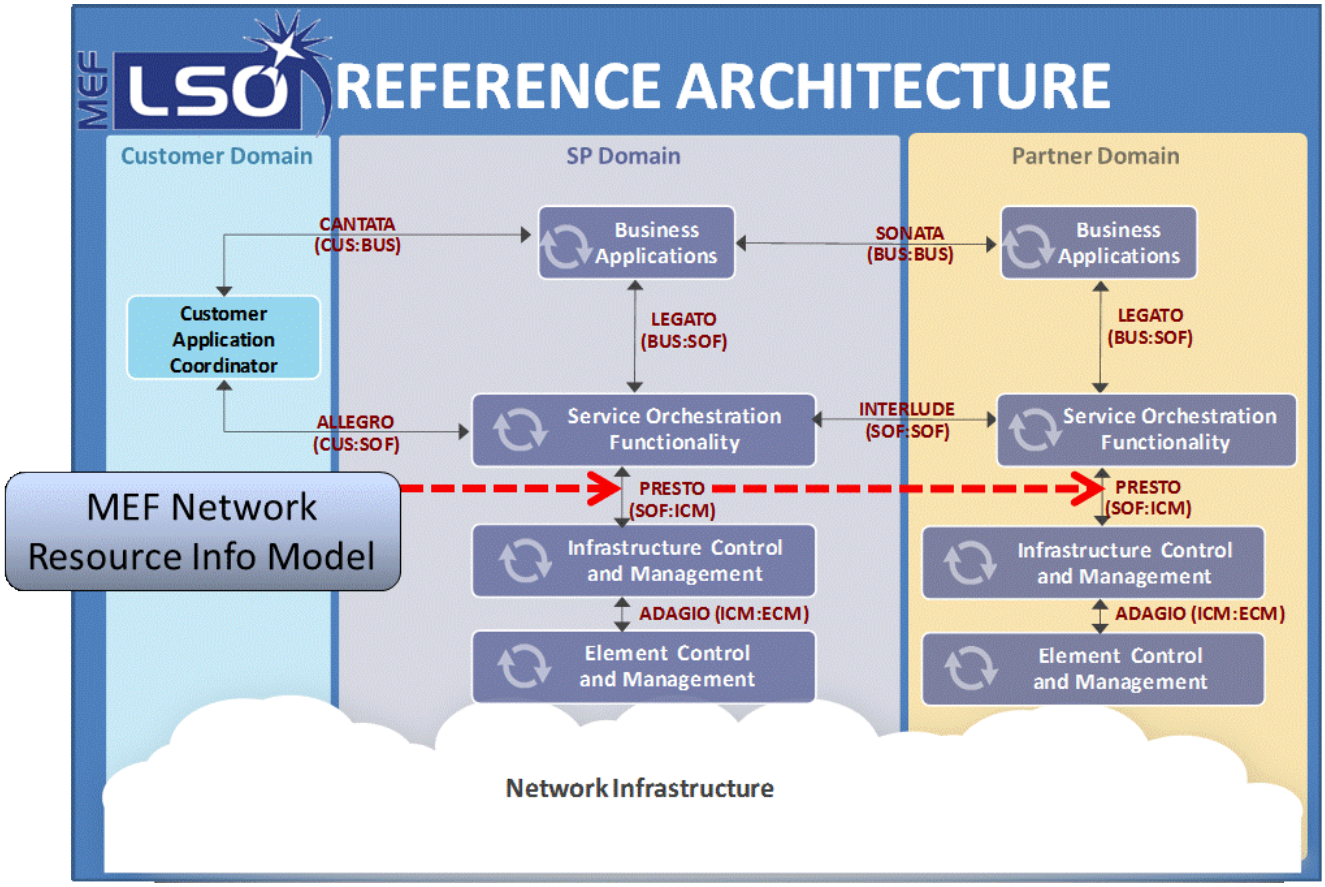

Figure 2 – MEF NRM positioning in LSO RA

This specification includes the Carrier Ethernet OAM resource management features

- as defined by ITU-T G.8052 ([13]) through TAPI Ethernet Model [17]
    - including a selection of IEEE 802.1Q CFM management items [1]
- as necessary to fulfil MEF 30.1 and MEF 35.1 requirements

Some of the UML diagrams are very dense. To view them either zoom (sometimes to 400%) or open the corresponding UML diagram via Papyrus [18] (for each figure with a UML diagram the UML model diagram name is provided under the figure in *italic* font).

6 Content

The following sections of this document include:

- The overview of NRM IM OAM classes (7)
- The list of all defined object classes and their attributes for:
  - Carrier Ethernet OAM Service Points (8.1)
  - Carrier Ethernet OAM PM Jobs (8.2)
  - Carrier Ethernet OAM FM Jobs and Metrics (8.3)
  - Carrier Ethernet OAM PM Metrics (8.4)
  - Carrier Ethernet OAM Thresholds Configuration and Notification (8.5)
- The diagrams related to Interfaces and Operations
  - Carrier Ethernet OAM Service Interfaces (8.6)
  - Carrier Ethernet OAM PM Job Interfaces (8.7)
  - Carrier Ethernet OAM FM Job Interfaces (8.8)
  - Carrier Ethernet OAM Threshold Interface (8.9)
- The definitions of data types and enumerations (9.1), (9.2)
- The definition of imported types (10)
- References (11)
- Appendix A lists the relevant network scenarios
- Appendix B shows the ONF TAPI OAM diagrams
- Appendix C provides the detailed mapping with MEF 35.1 defined PM Metrics
- Appendix D provides the detailed mapping with MEF 30.1 defined FM Metrics
- Appendix E shows main PM collection scenarios

7 Network Resource Information Model Overview

Figure 4 (with Figure 3 as key) shows an example of class instances and their augmentations. There is a ConnectivityService instance, which is ended by two ConnectivityServiceEndPoints, which are augmented by MEF specific attributes, as defined in CarrierEthConnectivityEndPointResource class. Each ConnectivityServiceEndPoint is *monitored* by an EthOamMepServicePoint, which represents the "service view" (in ONF terminology) of the Ethernet MEP. The EthOamMepServicePoint is augmented by MEF specific attributes, as defined in CarrierEthOamSrvMepResource class. Note that TAPI OAM technology independent classes, like Meg and Mep, are augmented by TAPI Ethernet specific classes, resp. EthMegSpec and EthMepSpec. EthMepCommon, EthMepSource and EthernetMepSink classes provide all the Ethernet MEP parameters. EthOamMepServicePoint reuses these classes for provisioning purposes.

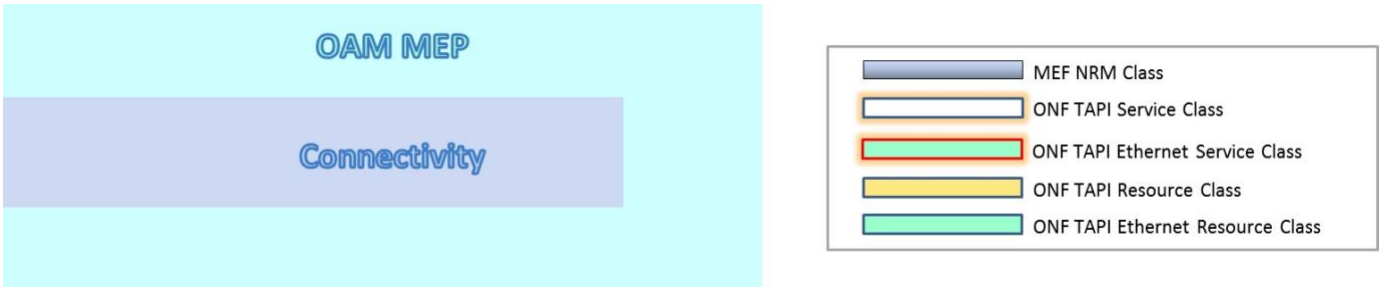

Figure 3 – Legend

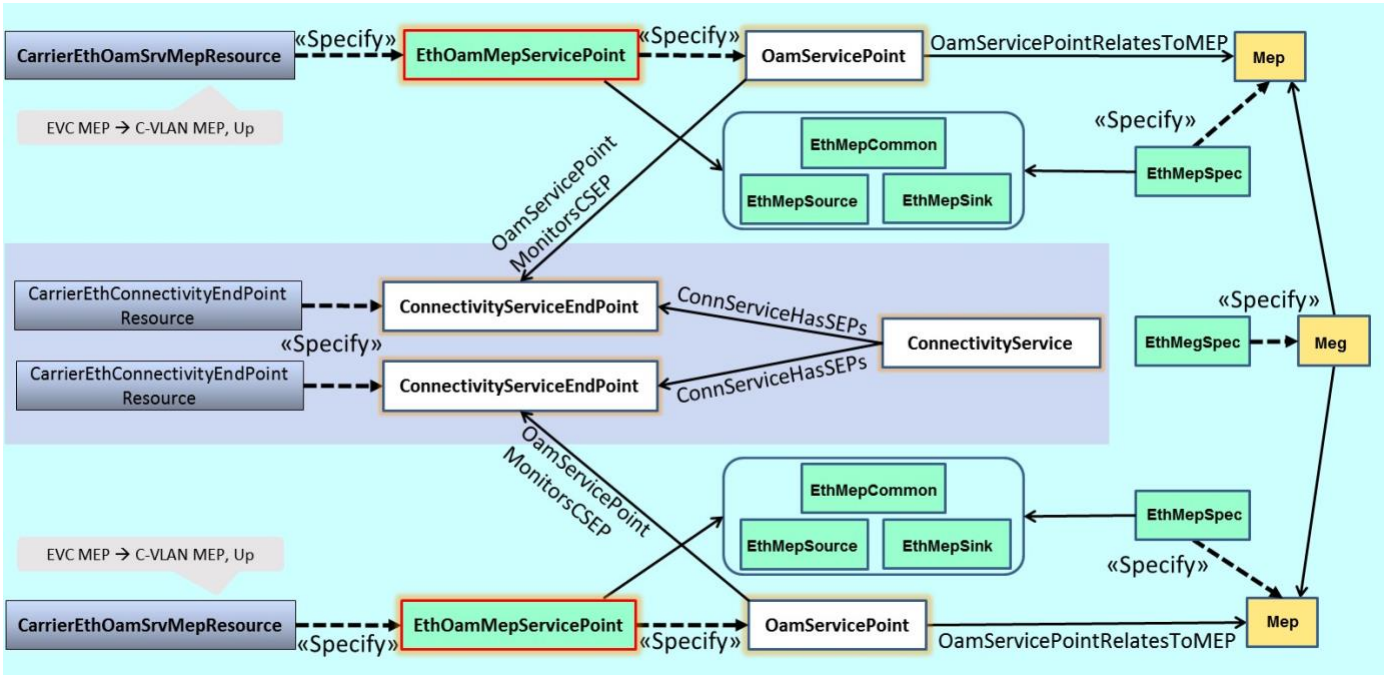

Figure 4 – Relationships with ONF TAPI OAM: the two MEPs monitoring an EVC

- The **CarrierEthOamSrvMepResource** represents the MEF Ethernet MEP, which augments the TAPI EthOamMepServicePoint .

Figure 5 shows how TAPI is augmented by MEF specific attributes, regarding OAM Job and Performance Metrics. Note that TAPI OAM technology independent classes, like OamJob, CurrentData and HistoryData, are augmented by TAPI Ethernet specific classes, resp. EthProActiveSingle/DualEndedMeasurementJob and EthProactiveLmPerformanceData. MEF specific attributes, as defined by CarrierEthOamJobProActDualEndSyntLossResource, CarrierEthOamJobProActSingleEndSyntLossResource and CarrierEthOamMetrics1EndSynthLossResource, augment TAPI Ethernet specific classes.

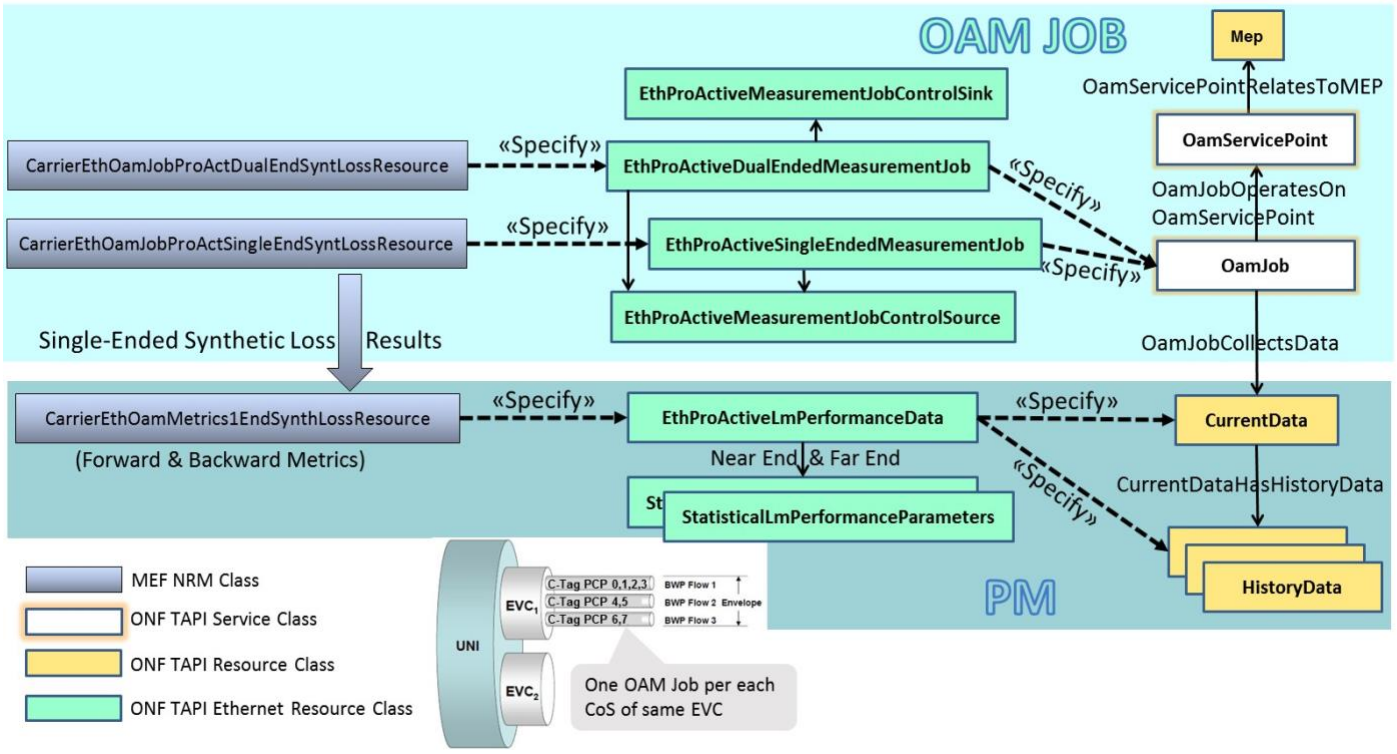

Figure 5 – Relationships with ONF TAPI OAM: OAM Job and PM

- The **CarrierEthOamJobProActDualEndSyntLossResource , CarrierEthOamJobProActSingleEndSyntLossResource** represent attributes of the MEF Ethernet Synthetic Loss PM Job, which augments the TAPI Ethernet PM Job.

Following sections specify all defined NRM OAM classes and the TAPI classes and operations being augmented.

Note that the "specify" associations may appear twice between same classes, this is necessary to drive the automatic translation to YANG (e.g. because both Current and History Data are augmented). Future version of the translation tools will make these duplications unnecessary.

8 Network Resource Information Model Classes

8.1 Carrier Ethernet OAM Service Points

Figure 6 illustrates the NRM OAM IM *specification classes* representing OAM Service and OAM Service MEP and MIP Points, with their attributes and associations with other object classes.

Note that MEP direction is modeled through ***codirectional*** attribute of **EthMepCommon** TAPI class. "Codirectional" is equivalent to "down" direction, "contradirectional" to "up" direction. See also Figure 40.

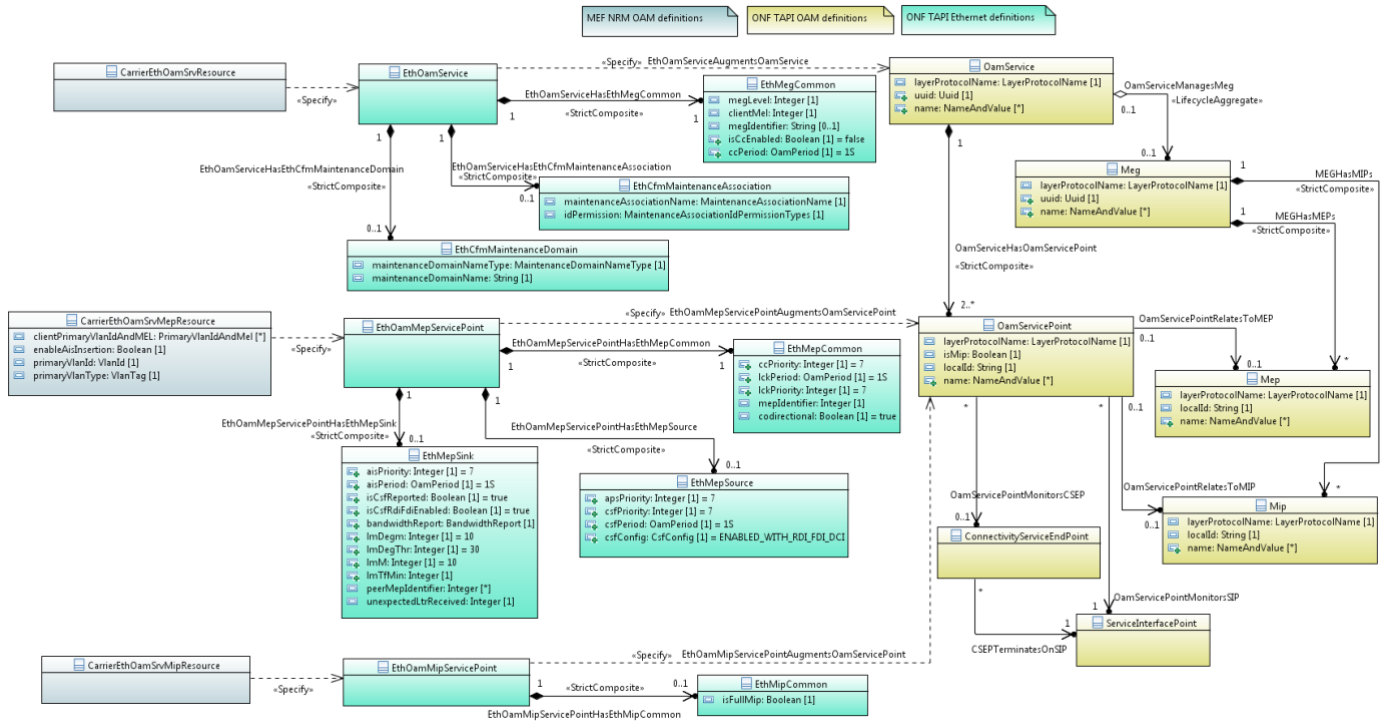

Figure 6 – *NRM_OAM_SERVICE* Diagram

8.1.1 CarrierEthOamSrvResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.1.2 CarrierEthOamSrvMepResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
clientPrimaryVlanIdAndMEL	PrimaryVlanIdAndMel	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Client MEG Level and the primary VID for each client MEG for AIS insertion feature. MEF 30.1: If the client MEG does not have a MEP on the same interface as the injecting MEP, i.e., it has a MIP or has no MP at all, then injecting an AIS involves transmitting an AIS PDU at the client MEG Level, with the appropriate VLAN tags for the client MEG, in the opposite direction to that in which the MEP normally sends CFM frames (that is, an Up MEP would send AIS PDUs out towards the wire, and a Down MEP would send AIS PDUs in towards the bridging function). Note that in this case, the injecting MEP requires knowledge (e.g., by configuration) of the MEG Level and (where the client MEGs have additional VLAN tags) the primary VID for each client MEG.
enableAisInsertion	Boolean	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Enable/disable AIS PDU transmission.
primaryVlanId	VlanId	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	An integer indicating the Primary VID of the MEP. Note that a value of 0 indicates that no VID is associated with MEP, e.g. in case of UNI/ENNI/INNI MEG (Service Provider/Network Operator/Domain Manager monitoring of a UNI/ENNI/INNI), i.e. monitoring reachability regardless tags and including possible LAG scheme (which is different from LAG Link MEG, which is used to monitor an individual LAG link).
primaryVlanType	VlanTag	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Tag type

8.1.3 CarrierEthOamSrvMipResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2 Carrier Ethernet OAM PM Jobs

Figure 7 illustrates the NRM OAM IM *specification classes* representing OAM PM Jobs, with their attributes and associations with other object classes.

Note that for dual ended jobs, where the MEPs are in different ICM domains, if only the source/controller MEP is in the managed domain, none of the attributes in the NRM classes are needed.

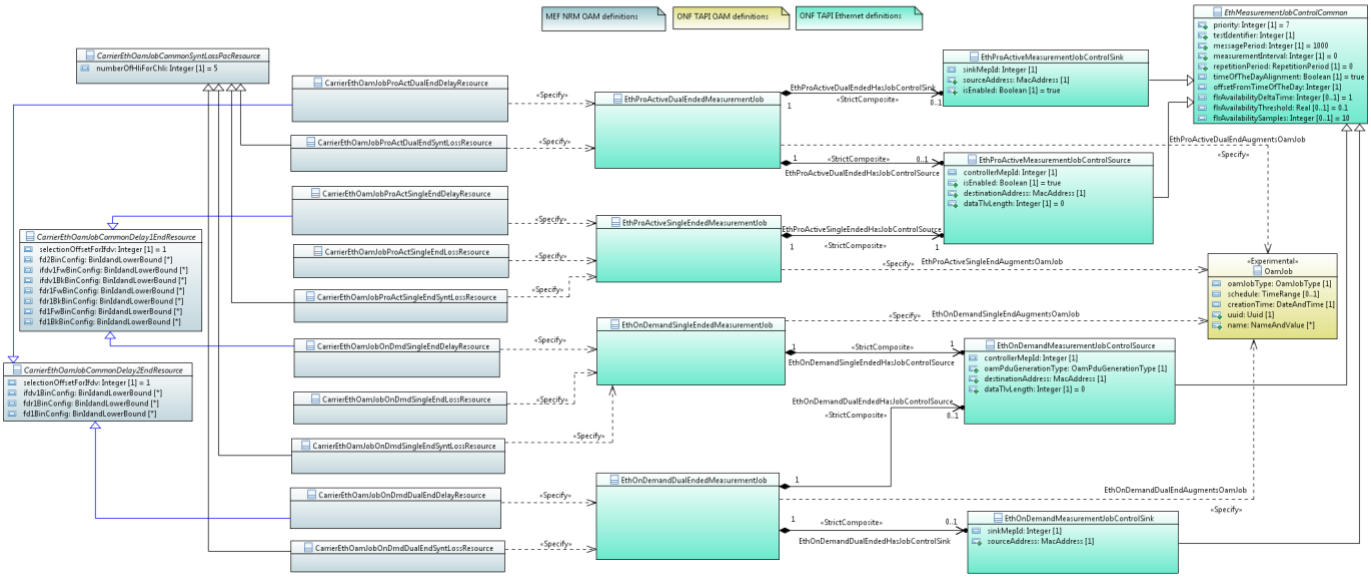

Figure 7 – *NRM_OAM_PM_JOBS* Diagram

8.2.1 CarrierEthOamJobCommonSyntLossPacResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
numberOfHliForChli	Integer	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	The number of High Loss Intervals that constitute a Consecutive High Loss Interval. MEF 35.1: The number of HLIs (High Loss Interval) that constitute a CHLI (Consecutive High Loss Interval). MEF 10.3: A High Loss Interval (HLI) is a small time interval contained in T (having the same duration as the interval delta-t) with a high frame loss ratio. When sufficient HLIs are adjacent, the interval is designated as a Consecutive High Loss Interval (CHLI). [R86]/[CR66] A SOAM PM Implementation MUST support a configurable parameter to indicate the number of HLIs that constitute a CHLI. This is equivalent to p in MEF 10.3. [D34]/[CD19] The default value for the number of HLIs that constitute a CHLI SHOULD be 5.

8.2.2 CarrierEthOamJobCommonDelay1EndResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
selectionOffsetForIfdv	Integer	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint support: MANDATORY	Value of parameter n, to control DMR PDU pair selection for IFDV measurement purposes. MEF 35.1: [O5] A SOAM PM Implementation MAY support the configurable selection of DMR frame pairs for IFDV measurement purposes. A parameter, n, is used to control DMR PDU pair selection, where n is the selection offset. Given a sequence of received periodic DMR frames, the set of DMR frame pairs can be expressed as { {f1, f1+n}, {f2, f2+n}, {f3, f3+n}, …}. [CO3] [O6] A SOAM PM Implementation MAY support the configurable selection of received 1DM PDU pairs for IFDV measurement purposes. A parameter, n, is used to control 1DM PDU pair selection, where n is the selection offset. Given a sequence of received periodic 1DM frames, the set of 1DM frame pairs can be expressed as { {f1, f1+n}, {f2, f2+n}, {f3, f3+n}, …}. [D24]/[CD8] The default selection offset for IFDV SHOULD be 1.
fd2BinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to bidirectional delay ranges.
ifdv1FwBinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to IDFV ranges in the Forward direction.
ifdv1BkBinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to IDFV ranges in the Backward direction.
fdr1FwBinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to FDR ranges in the Forward direction.
fdr1BkBinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to FDR ranges in the Backward direction.
fd1FwBinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to delay ranges in the Forward direction.

Attribute Name	Type	Mult.	Access	Stereotypes	Description
fd1BkBinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to delay ranges in the Backward direction.

8.2.3 CarrierEthOamJobCommonDelay2EndResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
selectionOffsetForIfdv	Integer	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint support: MANDATORY	Value of parameter n, to control DMR PDU pair selection for IFDV measurement purposes. MEF 35.1: [O5] A SOAM PM Implementation MAY support the configurable selection of DMR frame pairs for IFDV measurement purposes. A parameter, n, is used to control DMR PDU pair selection, where n is the selection offset. Given a sequence of received periodic DMR frames, the set of DMR frame pairs can be expressed as { {f1, f1+n}, {f2, f2+n}, {f3, f3+n}, …}. [CO3] [O6] A SOAM PM Implementation MAY support the configurable selection of received 1DM PDU pairs for IFDV measurement purposes. A parameter, n, is used to control 1DM PDU pair selection, where n is the selection offset. Given a sequence of received periodic 1DM frames, the set of 1DM frame pairs can be expressed as { {f1, f1+n}, {f2, f2+n}, {f3, f3+n}, …}. [D24]/[CD8] The default selection offset for IFDV SHOULD be 1.
ifdv1BinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to IDFV ranges.
fdr1BinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to FDR ranges.
fd1BinConfig	BinIdandLowerBound	0..*	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Configuration of bins associated to delay ranges.

8.2.4 CarrierEthOamJobProActDualEndDelayResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.5 CarrierEthOamJobProActDualEndSyntLossResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.6 CarrierEthOamJobProActSingleEndDelayResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.7 CarrierEthOamJobProActSingleEndLossResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.8 CarrierEthOamJobProActSingleEndSyntLossResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.9 CarrierEthOamJobOnDmdDualEndDelayResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.10 CarrierEthOamJobOnDmdDualEndSyntLossResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.11 CarrierEthOamJobOnDmdSingleEndDelayResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.12 CarrierEthOamJobOnDmdSingleEndLossResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.2.13 CarrierEthOamJobOnDmdSingleEndSyntLossResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.3 Carrier Ethernet OAM FM Jobs and Metrics

Figure 8 illustrates the NRM OAM IM *specification classes* representing MEF specific OAM FM Jobs (Loopback, Link Trace, Test) and related Metrics, with their attributes and associations with other object classes.

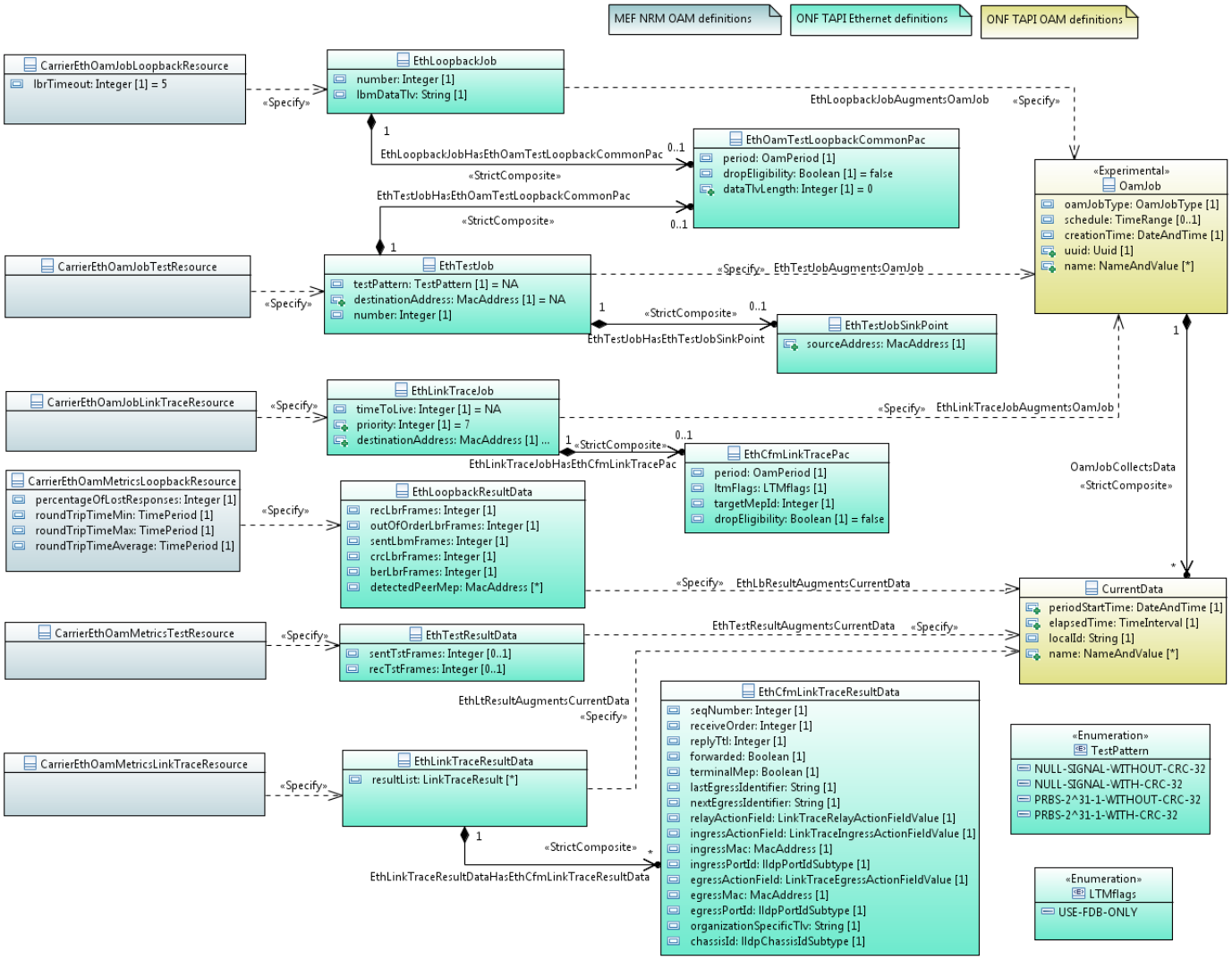

Figure 8 – *NRM_OAM_FM_JOBS* Diagram

8.3.1 CarrierEthOamJobLinkTraceResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.3.2 CarrierEthOamMetricsLinkTraceResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.3.3 CarrierEthOamJobLoopbackResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
lbrTimeout	Integer	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Timeout for expected LBR reception after LBM transmission. MEF 30.1: [D48] For each LB session, the timeout for an expected LBR result after a LBM transmission SHOULD be configurable. [D49] The default value of the LBR timeout SHOULD be 5 seconds.

8.3.4 CarrierEthOamMetricsLoopbackResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
percentageOfLostResponses	Integer	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Percentage of responses lost (timed out). MEF 30.1: [D57] For an LB Session, the initiating MEP SHOULD be able to report the percentage of responses lost (timed out).
roundTripTimeMin	TimePeriod	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Minimum round trip time. MEF 30.1: [D58] For an LB session, the round trip time (RTT) min/max/average statistics SHOULD be supported by the initiating MEP.
roundTripTimeMax	TimePeriod	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Maximum round trip time. MEF 30.1: [D58] For an LB session, the round trip time (RTT) min/max/average statistics SHOULD be supported by the initiating MEP.
roundTripTimeAverage	TimePeriod	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Average round trip time. MEF 30.1: [D58] For an LB session, the round trip time (RTT) min/max/average statistics SHOULD be supported by the initiating MEP.

8.3.5 CarrierEthOamJobTestResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.3.6 CarrierEthOamMetricsTestResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

No attributes defined.

8.4 Carrier Ethernet OAM PM Metrics

Figure 9 and Figure 10 illustrate the NRM OAM IM *specification classes* representing MEF specific OAM Metrics of PM Jobs, with their attributes and associations with other object classes.

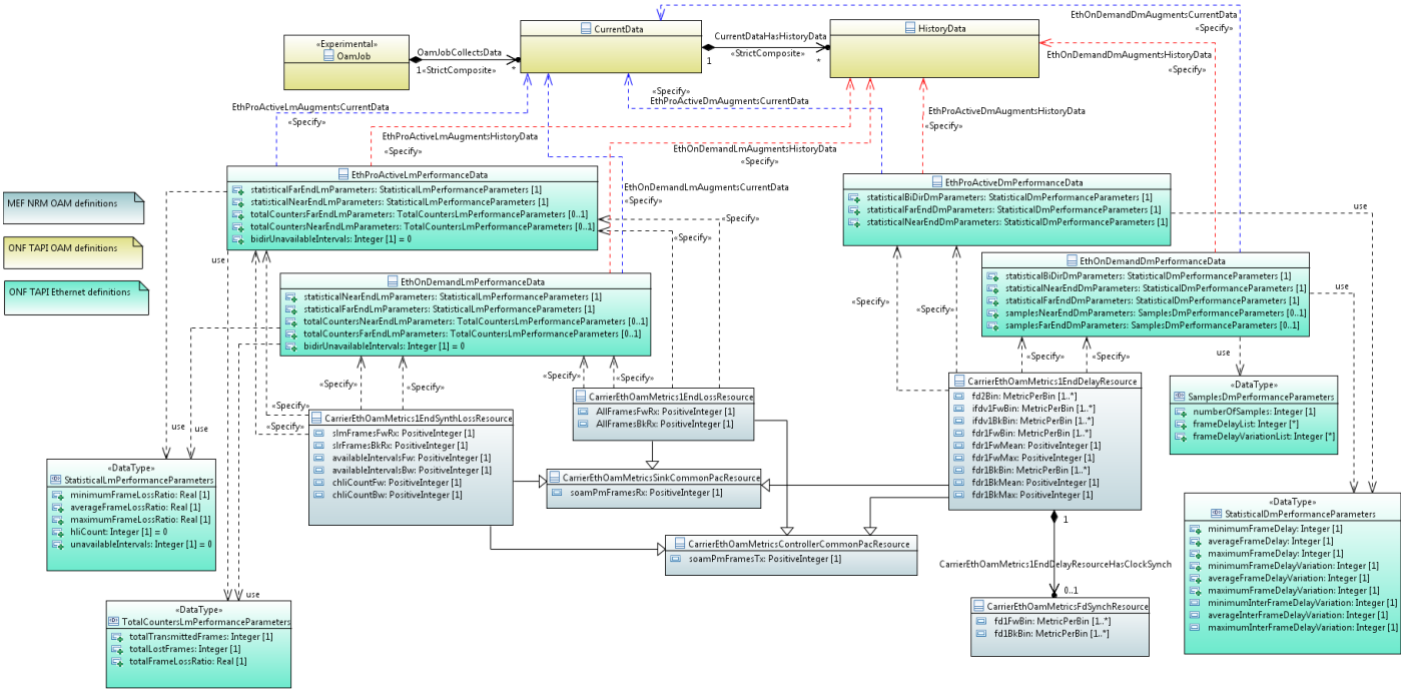

Figure 9 – *NRM_OAM_PM_METRICS_SINGLE_ENDED* Diagram

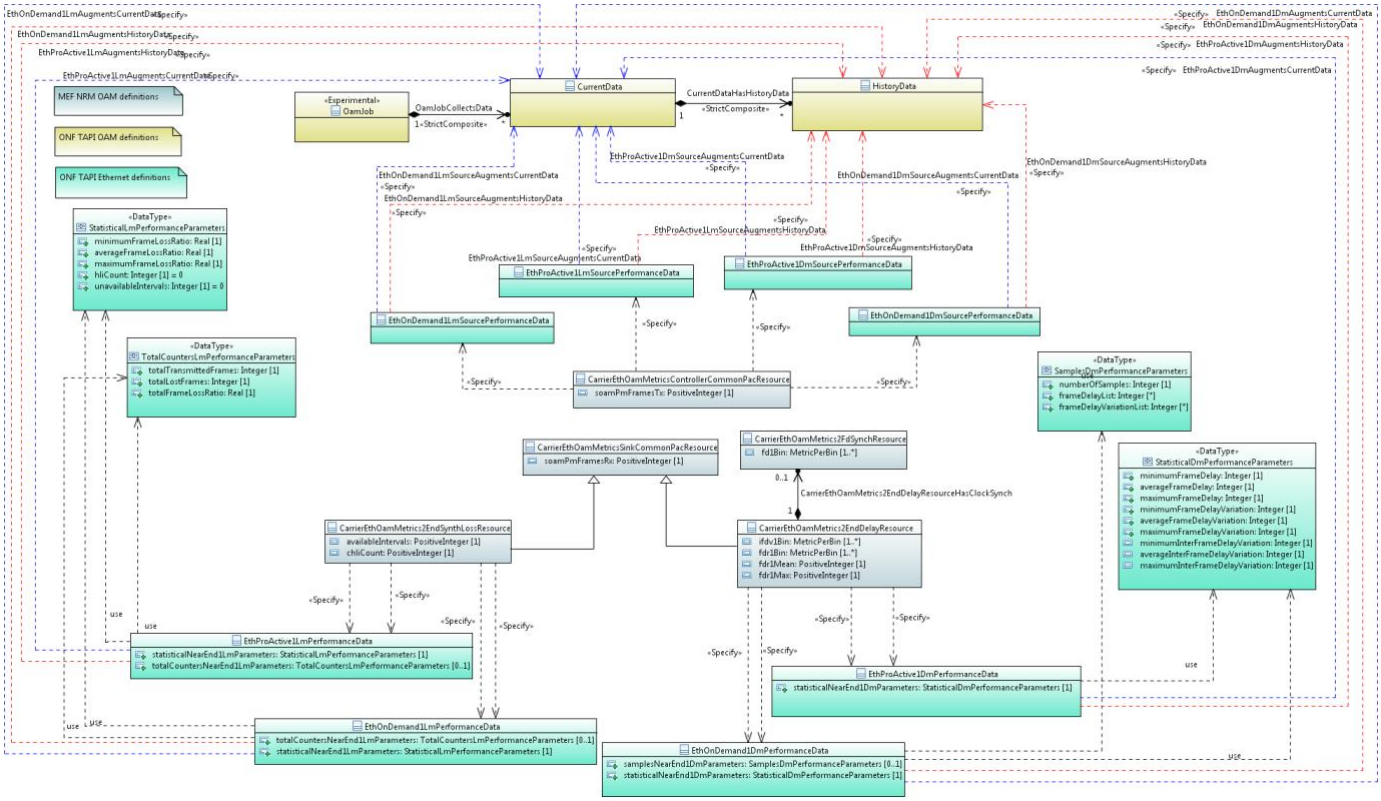

Figure 10 – *NRM_OAM_PM_METRICS_DUAL_ENDED* Diagram

8.4.1 CarrierEthOamMetricsControllerCommonPacResource

MEF 35.1: Common Counters, source.

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
soamPmFramesTx	PositiveInteger	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter reflecting the number of SOAM PM Frames sent.

8.4.2 CarrierEthOamMetricsSinkCommonPacResource

MEF 35.1: Common Counters, sink.

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
soamPmFramesRx	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter reflecting the number of SOAM PM Frames received.

8.4.3 CarrierEthOamMetrics1EndDelayResource

MEF 35.1: Mandatory Single-Ended Delay Data Set (PM-1 Solution)

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
fd2Bin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of FD measurements that fall within the configured range.
ifdv1FwBin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of IFDV measurements (i.e., each instance of |Di – Dj| in the Forward direction) that fall within a configured bin.
ifdv1BkBin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of IFDV measurements in the Backward direction that fall within a configured bin.
fdr1FwBin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of FDR measurements in the Forward direction that fall within a configured bin.
fdr1FwMean	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit integer reflecting the average (arithmetic mean) One-way FDR measurement in the Forward direction in microseconds.
fdr1FwMax	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit integer reflecting the maximum One-way FDR measurement in the Forward direction in microseconds.
fdr1BkBin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of FDR measurements in the Backward direction that fall within a configured bin.
fdr1BkMean	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit integer reflecting the average (arithmetic mean) One-way FDR measurement in the Backward direction in microsecond.
fdr1BkMax	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit integer reflecting the maximum One-way FDR measurement in the Backward direction in microseconds.
_carrierEthOamMetricsFdSynchResource	CarrierEthOamMetricsFdSynchResource	0..1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	

8.4.4 CarrierEthOamMetricsFdSynchResource

MEF 35.1: Mandatory Single-Ended Delay Data Set with Clock Synchronization (PM-1 Solution) [R67] If time-of-day clock synchronization is in effect for both MEPs in the ME, a SOAM PM Implementation MUST be able to support the additional data at the Controller MEP per Measurement Interval per PM Session.

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
fd1FwBin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of One-way FD measurements in the Forward direction that fall within the configured bin.
fd1BkBin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of One-way FD measurements in the Backward direction that fall within the configured bin.

8.4.5 CarrierEthOamMetrics1EndLossResource

MEF 35.1: Mandatory Single-Ended Service Loss Data Set (PM-3 Solution)

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
AllFramesFwRx	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 64-bit counter reflecting the number of frames received in the Forward direction.
AllFramesBkRx	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 64-bit counter reflecting the number of frames received in the Backward direction.

8.4.6 CarrierEthOamMetrics1EndSynthLossResource

MEF 35.1: Mandatory Single-Ended Synthetic Loss Data Set (PM-1 Solution)

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
slmFramesFwRx	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter reflecting the number of SLM frames received in the Forward direction.
slrFramesBkRx	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter reflecting the number of SLR frames received in the Backward direction.
availableIntervalsFw	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter reflecting the number of delta-t intervals evaluated as Available in the Forward direction (i.e., for which A<Controller, Responder>(delta-t) = 1).
availableIntervalsBw	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter reflecting the number of delta-t intervals evaluated as Available in the Backward direction (i.e., for which A< Responder, Controller>(delta-t) = 1).
chliCountFw	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: Count of CHLIs in the Forward direction during the Measurement Interval.
chliCountBw	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: Count of CHLIs in the Backward direction during the Measurement Interval.

8.4.7 CarrierEthOamMetrics2EndDelayResource

MEF 35.1: Mandatory Dual-Ended Delay Data Set (PM-2 Solution)

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
ifdv1Bin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of IFDV measurements that fall within the configured bin.
fdr1Bin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of FDR measurements that fall within a configured bin.
fdr1Mean	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit integer reflecting the average (arithmetic mean) One-way FDR measurement in microseconds.
fdr1Max	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit integer reflecting the maximum One-way FDR measurement in microseconds.
_carrierEthOamMetrics2FdSynchResource	CarrierEthOamMetrics2FdSynchResource	0..1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	

8.4.8 CarrierEthOamMetrics2FdSynchResource

MEF 35.1: Mandatory Dual-Ended Delay Data Set with Clock Synchronization (PM-2 Solution)
[CR36]< [O6] If clock synchronization is in effect a SOAM PM Implementation MUST support the additional data at the Sink MEP per Measurement Interval per PM Session.

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
fd1Bin	MetricPerBin	1..*	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter per Measurement Bin that counts the number of One-way FD measurements that fall within the configured bin.

8.4.9 CarrierEthOamMetrics2EndSynthLossResource

MEF 35.1: Mandatory Dual-Ended Synthetic Loss Data Set (PM-4 Solution)

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
availableIntervals	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: A 32-bit counter reflecting the number of delta-t intervals evaluated as Available (i.e., for which A<Controller, Sink>(delta-t) = 1).
chliCount	PositiveInteger	1	R	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1: Count of CHLIs during the Measurement Interval.

8.5 Carrier Ethernet OAM Thresholds Configuration and Notifications

Figure 11 illustrates the NRM IM *specification class* representing the OAM Thresholds configuration and related notification, with their attributes and associations with other object classes.

The thresholdParameter attribute of TAPI PmThresholdData and TcaInfo is structured in three items, pmParameter, thresholdLocation and thresholdCrossing. The pmParameter is defined to be generic for all technologies, as it includes the pmParameterName enumeration together with bin number, integer and real types.

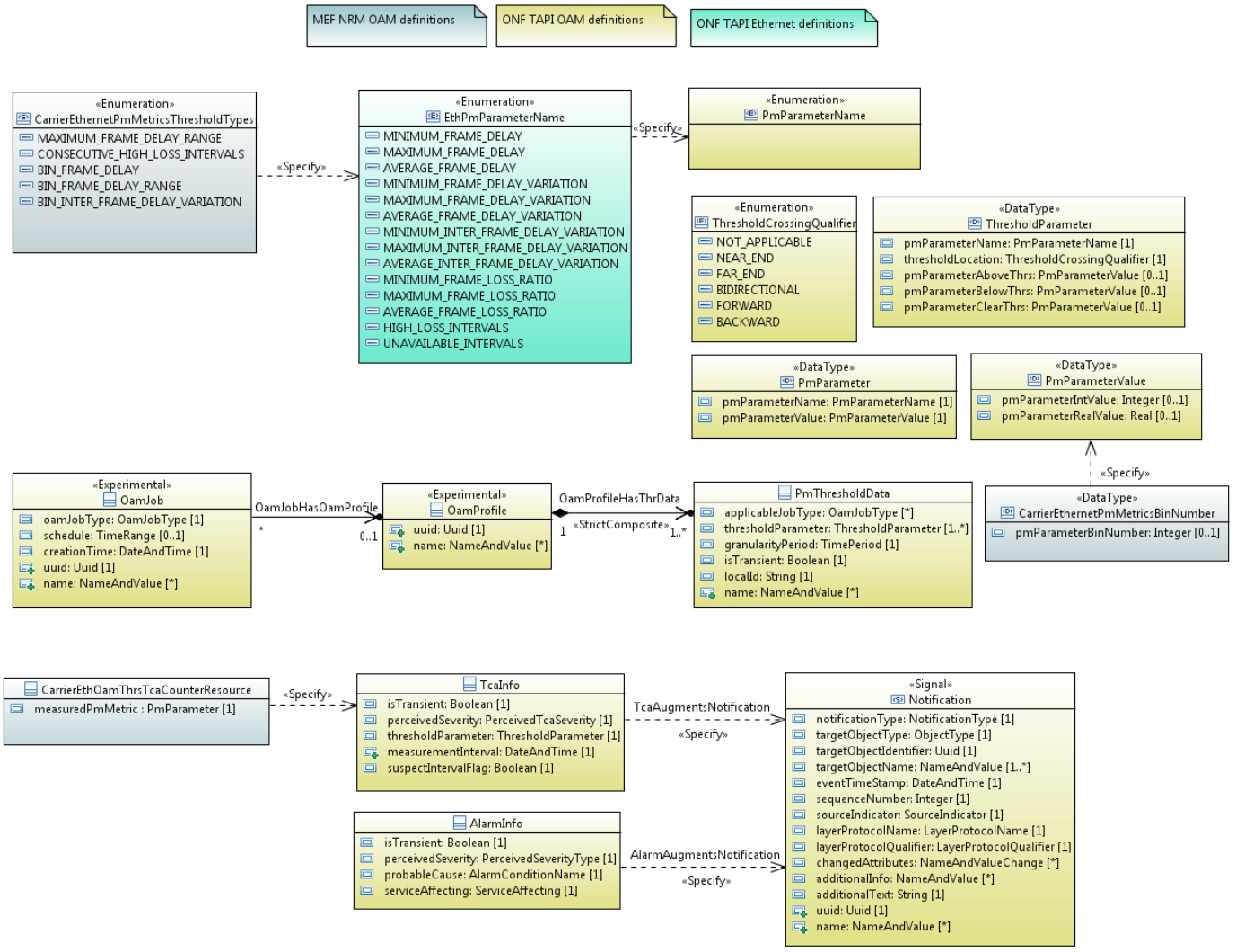

Figure 11 – *NRM_OAM_THRS* Diagram

8.5.1 CarrierEthOamThrsTcaCounterResource

Applied stereotypes:

- OpenModelClass
  - support: MANDATORY

Attribute Name	Type	Mult.	Access	Stereotypes	Description
measuredPmMetric	PmParameter	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	MEF 35.1 Measured value that caused the TCA to be generated. For bin-based thresholds configured as (N, k), this is always equal to N for stateless TCAs and stateful SET TCAs; for stateful CLEAR TCAs, it is the value of UBC(k) at the end of the Measurement Interval. For "maximum" performance metrics, for stateless TCAs and stateful SET TCAs, this is the first value in the Measurement Interval that reaches or exceeds the configured threshold; for stateful CLEAR TCAs it is the maximum value at the end of the Measurement Interval. For HLI and CHLI thresholds, this is always equal to the configured threshold value for stateless TCAs and stateful SET TCAs; for stateful CLEAR TCAs it is the total count at the end of the Measurement Interval.

8.6 Carrier Ethernet OAM Service Interfaces

Figure 12 illustrates the NRM IM *specification classes* representing OAM Service and OAM Service MEP and MIP classes augmenting the TAPI defined interfaces.

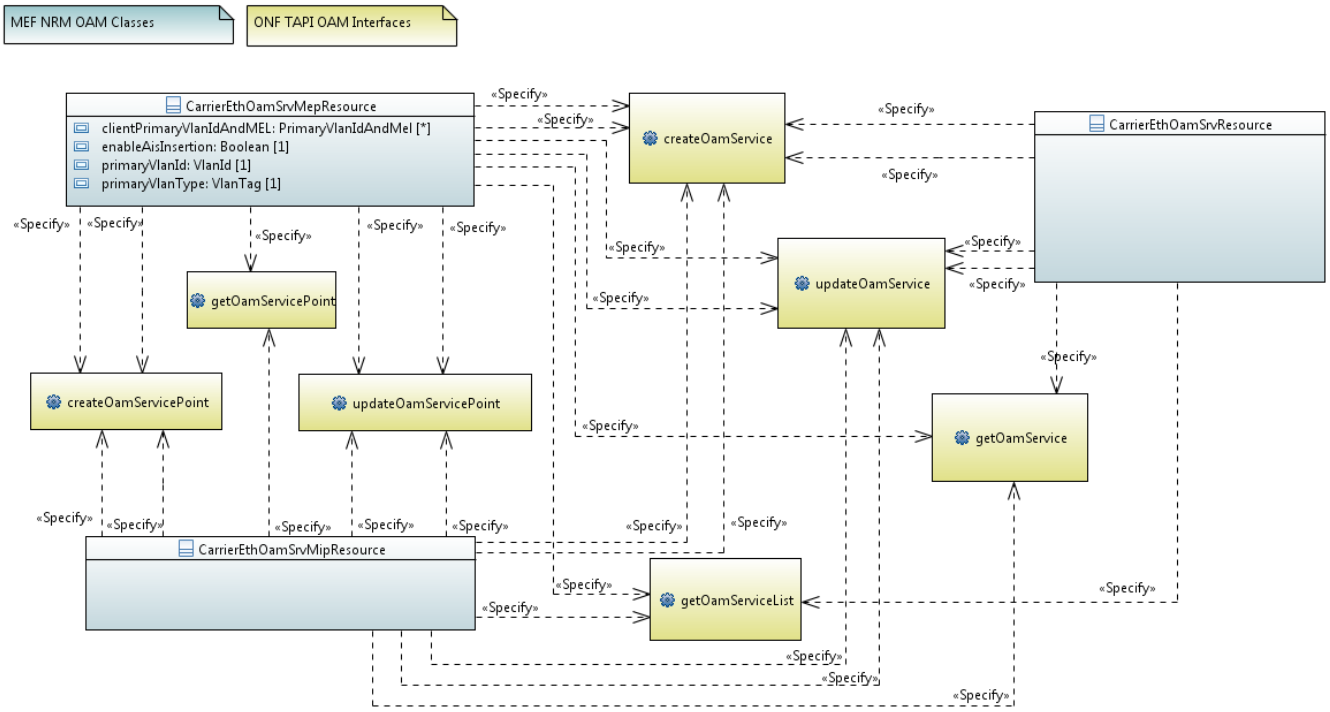

Figure 12 – *NRM_INTERFACES_OAM_SERVICE* Diagram

8.7 Carrier Ethernet OAM PM Job Interfaces

Figure 13, Figure 14, Figure 15, Figure 16 illustrate the NRM IM *specification classes* representing OAM Proactive and On-Demand PM Job classes augmenting the TAPI defined interfaces.

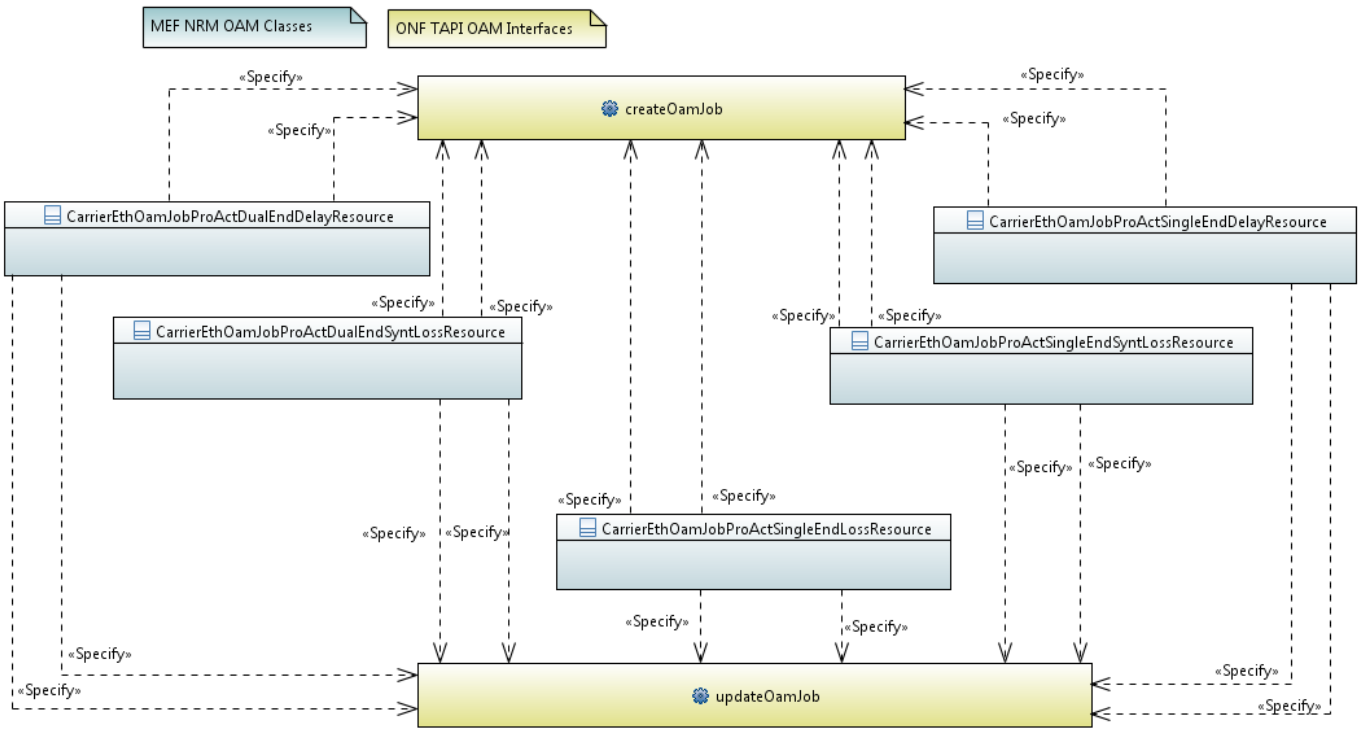

Figure 13 – *NRM_INTERFACES_OAM_PM_PROACT_JOB* Diagram

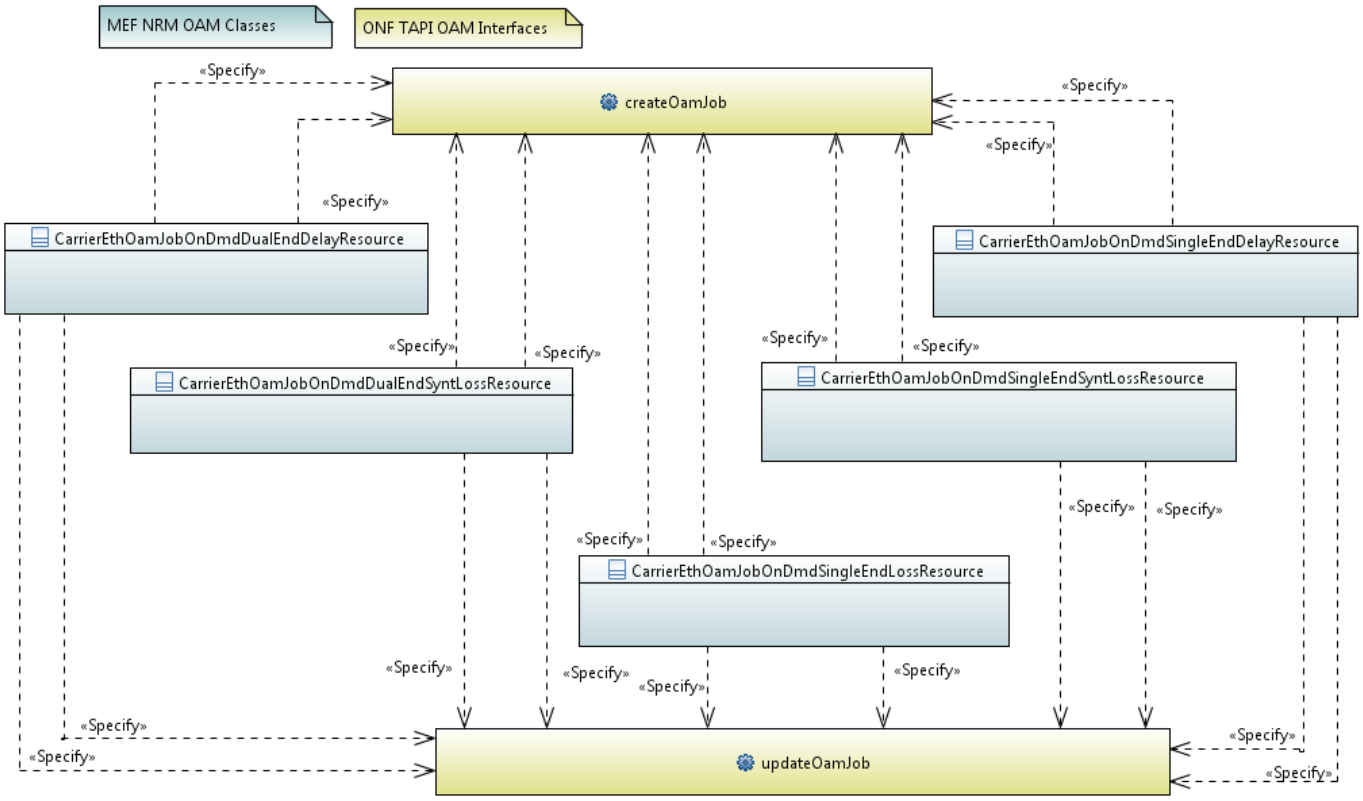

Figure 14 – *NRM_INTERFACES_OAM_PM_ONDMD_JOB* Diagram

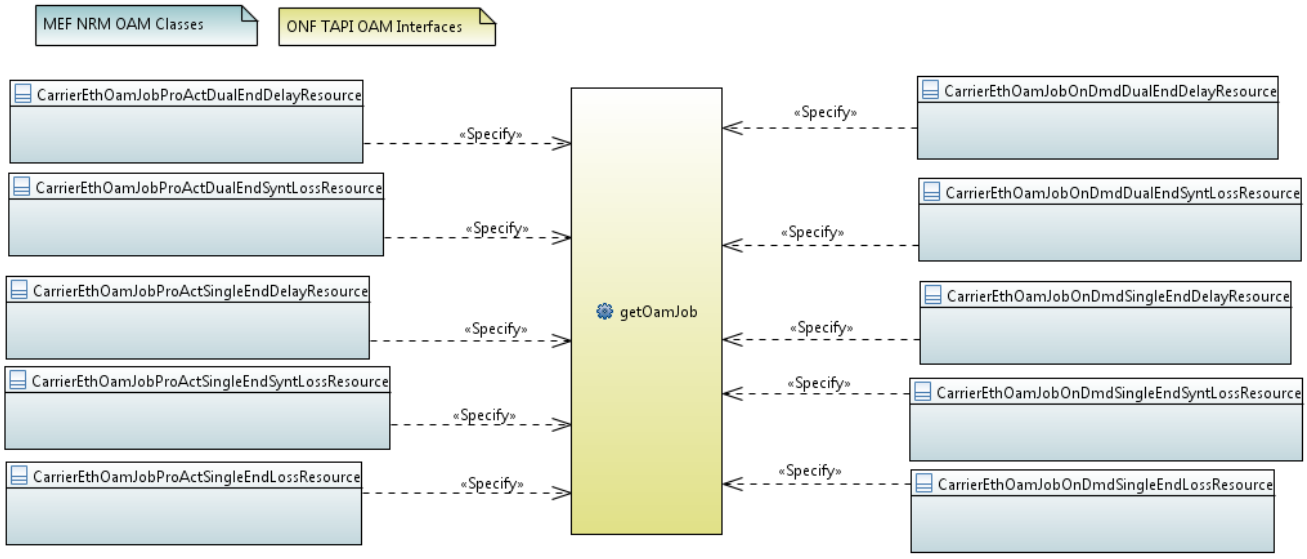

Figure 15 – *NRM_INTERFACES_OAM_GET_PM_JOB* Diagram

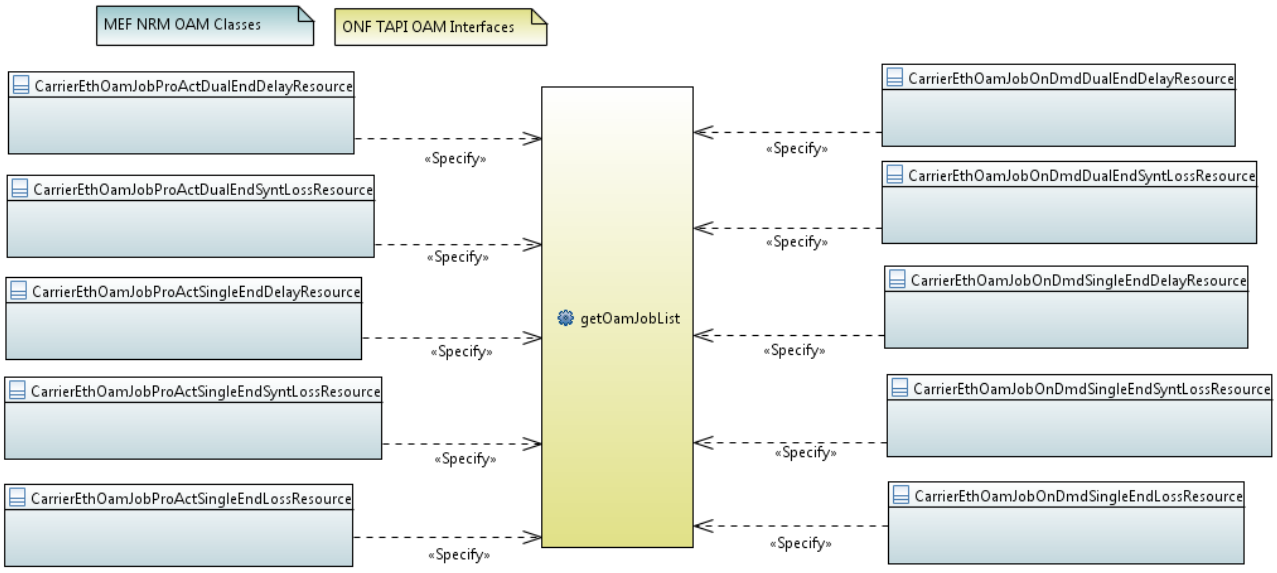

Figure 16 – *NRM_INTERFACES_OAM_GETLIST_PM_JOB* Diagram

8.8 Carrier Ethernet OAM FM Job Interfaces

Figure 17 illustrates the NRM IM *specification classes* representing OAM FM Job classes augmenting the TAPI defined interfaces.

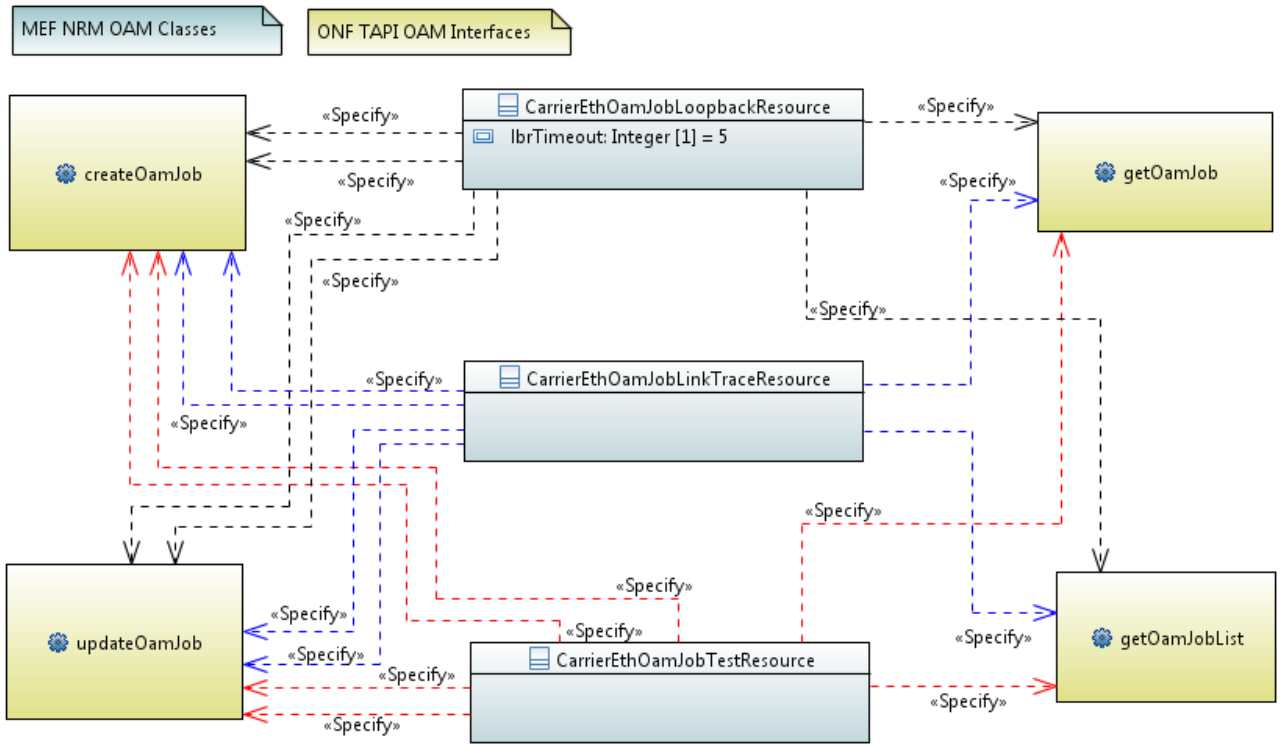

Figure 17 – *NRM_INTERFACES_OAM_FM_JOB* Diagram

8.9 Carrier Ethernet OAM Threshold Interface

Figure 18 illustrates the NRM IM *specification class* representing OAM Threshold class augmenting the TAPI defined interface.

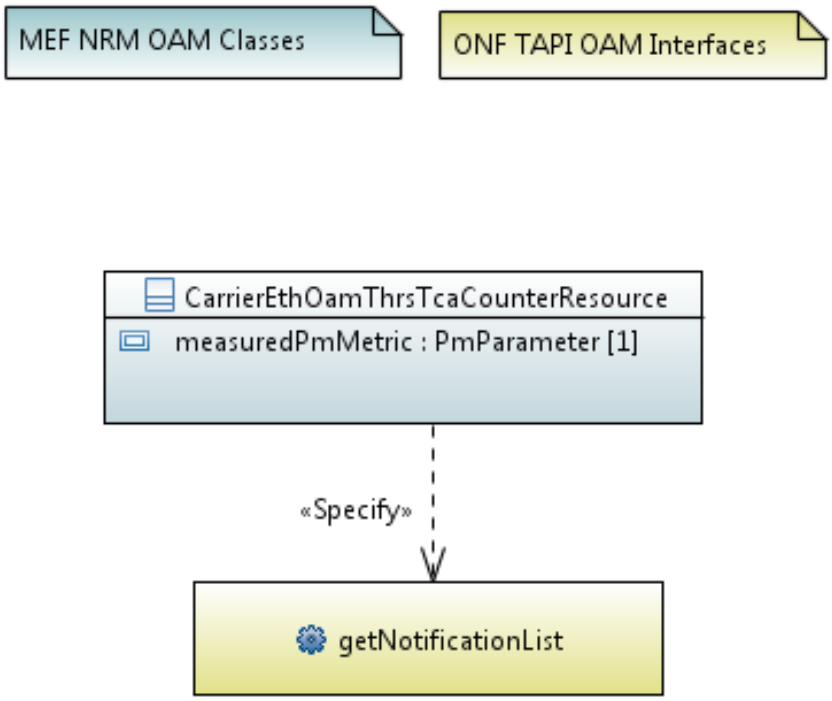

Figure 18 – *NRM_INTERFACES_OAM_THRESHOLD* Diagram

9 Network Resource Information Model Type Definitions

9.1 Data Types

The following data types are locally defined by NRM OAM IM, i.e. are not imported from any other model.

9.1.1 BinIdandLowerBound

MEF 35.1: Each bin is associated with a specific range of observed delay, IFDV or FDR (frame delay, inter-frame delay variation, and frame delay range). Bins are defined to be contiguous, and each is configured with its lower bound. Because the bins are contiguous, it is only necessary to configure the lower bound of each bin. Furthermore, the lowest bin is assumed to always have a lower bound of 0, and the highest bin is assumed to have an upper bound of infinite.

Attribute Name	Type	Mult.	Access	Stereotypes	Description
binIndex	Integer	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	Index or Id of the BIN, natural number 1,2,3, ...
lowerBound	Integer	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	

9.1.2 CarrierEthernetPmMetricsBinNumber

MEF 35.1: For performance metrics that use Measurement Bins, thresholds are defined in terms of an Upper Bin Count (UBC). The Upper Bin Count of bin k is the total of the counts for bins k and above, i.e. UBC(k) = count of bin (k) + count of bin (k+1) + ... + count of bin (n), where n is the last bin. To configure a threshold, both the bin number, k, and the total count, N, need to be specified - this is represented as (N, k). A threshold (N, k) is considered to have been crossed when UBC(k) >= N.

Attribute Name	Type	Mult.	Access	Stereotypes	Description
pmParameterBinNumber	Integer	0..1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY OpenInterfaceModelAttribute • AVC: NA	

9.1.3 MetricPerBin

MEF 35.1: [metric property represents] the number of measurements that fall within a configured bin. The configured bin is identified by the metric type of the attribute (FD/FDR/IFDV) plus the bin index [binIndex property].

Attribute Name	Type	Mult.	Access	Stereotypes	Description
metric	PositiveInteger	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	
binIndex	PositiveInteger	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	

9.2 Enumerations

The following enumeration is locally defined by NRM OAM IM, i.e. is not imported from any other model.

9.2.1 CarrierEthernetPmMetricsThresholdTypes

Contains Enumeration Literals:

- MAXIMUM_FRAME_DELAY_RANGE:
  - MEF 35.1: One-way Maximum FDR in the Forward or Backward direction. A 32-bit integer reflecting the maximum One-way FDR measurement in the Forward or Backward direction in microseconds. Threshold Crossing Detection: Max FDR >= Forward or Backward One-way V(max(FDR))
- CONSECUTIVE_HIGH_LOSS_INTERVALS:
  - MEF 35.1: One-way CHLI in the Forward or Backward direction. Count of CHLIs in the Forward or Backward direction during the Measurement Interval. Threshold Crossing Detection: CHLI count >= Forward or Backward One-way N(CHLI)
- BIN_FRAME_DELAY:
  - MEF 35.1: One-way FD in the Forward or Backward direction, or Two-way FD. A 32-bit counter per Measurement Bin that counts the number of Two-way FD or One-way FD measurements in the Forward or Backward direction that fall within the configured bin. Threshold Crossing Detection: UBC(k) >= Forward One-way or Backward One-way or Two-way N(FD)
- BIN_FRAME_DELAY_RANGE:
  - MEF 35.1: One-way FDR in the Forward or Backward direction. A 32-bit counter per Measurement Bin that counts the number of FDR measurements in the Forward or Backward direction that fall within a configured bin. Threshold Crossing Detection: UBC(k) >= Forward or Backward One-way N(FDR)
- BIN_INTER_FRAME_DELAY_VARIATION:
  - MEF 35.1: One-way IFDV in the Forward or Backward direction. A 32-bit counter per Measurement Bin that counts the number of IFDV measurements (i.e., each instance of |Di – Dj| in the Forward or Backward direction) that fall within a configured bin. Threshold Crossing Detection: UBC(k) >= Forward or Backward One-way N(IFDV)

10 Imported Type Definitions

Data types imported from MEF model [11] “MEF_Types”:

- PositiveInteger
- PrimaryVlanIdAndMel
  - VlanId
  - AvailableMegLevel
- VlanId
- VlanTag

Data types imported from ONF TAPI model [17] “TapiCommon”:

- TimePeriod
  - TimeUnit

Data types imported from ONF TAPI model [17] “TapiOam”:

- PmParameter
  - PmParameterValue
  - PmParameterName

10.1 AvailableMegLevel

This enumeration is for available MEG level, can be either NONE or value 0..7. NONE indicates that SOAM EI Frames are not guaranteed to pass over at any MEG Level.

Contains Enumeration Literals:

- NONE:
  - Indicates that SOAM EI Frames are not guaranteed to pass over this OVC at any MEG Level.
- 0:
- 1:
- 2:
- 3:
- 4:
- 5:
- 6:
- 7:

10.2 PmParameter

Attribute Name	Type	Mult.	Access	Stereotypes	Description
pmParameterName	PmParameterName	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY OpenInterfaceModelAttribute • AVC: NA	
pmParameterValue	PmParameterValue	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY OpenInterfaceModelAttribute • AVC: NA	

10.3 PmParameterName

Contains Enumeration Literals:

Empty: is augmented by technology specific models.

10.4 PmParameterValue

Attribute Name	Type	Mult.	Access	Stereotypes	Description
pmParameterIntValue	Integer	0..1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY OpenInterfaceModelAttribute • AVC: NA	
pmParameterRealValue	Real	0..1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY OpenInterfaceModelAttribute • AVC: NA	

10.5 PositiveInteger

An integer >0

Attribute Name	Type	Mult.	Access	Stereotypes	Description
positiveInt	Integer	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	This attribute is an integer >0.

10.6 PrimaryVlanIdAndMel

Attribute Name	Type	Mult.	Access	Stereotypes	Description
primaryVlanId	VlanId	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	
mel	AvailableMegLevel	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	

10.7 TimePeriod

Attribute Name	Type	Mult.	Access	Stereotypes	Description
value	Integer	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	
unit	TimeUnit	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	

10.8 TimeUnit

Contains Enumeration Literals:

- YEARS:
- MONTHS:
- DAYS:
- HOURS:
- MINUTES:
- SECONDS:
- MILLISECONDS:
- MICROSECONDS:
- NANOSECONDS:
- PICOSECONDS:

10.9 VlanId

This is for VLAN ID from 1 to 4094

Attribute Name	Type	Mult.	Access	Stereotypes	Description
vlanId	PositiveInteger	1	RW	OpenModelAttribute • isInvariant: false • valueRange: no range constraint • support: MANDATORY	This is the Vlan ID value.

10.10 VlanTag

This is for Vlan Tag type, i.e., S-tag or C-tag.

Contains Enumeration Literals:

- S_TAG:
- C_TAG:

11 References

[1] IEEE Std 802.1Q™-2018 - IEEE Standard for Local and Metropolitan Area Networks - Bridges and Bridged Networks - Approved 7 May 2018

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[7] MEF 35.1, *Service OAM Performance Monitoring Implementation Agreement*, May 2015

[8] MEF 55, *Lifecycle Service Orchestration Reference Architecture and Framework*, 2016

[9] MEF 59, *Network Resource Management - Information Model: Connectivity*

[10] MEF 60, *Network Resource Provisioning - Interface Profile Specification*

[11] MEF Resource Info Model GitHub repository: **“**https://github.com/MEF-GIT/Resources-Common-Model”

[12] ITU-T G.7711/Y.1702 Generic protocol-neutral information model for transport resources, March 2018

[13] ITU-T G.8021/Y.1341 Characteristics of Ethernet transport network equipment functional blocks, June 2018

[14] ITU-T G.8052/Y.1346 Protocol-neutral management information model for the Ethernet transport capable network element, December 2018

[15] ONF TR-512 Core Information Model, Version 1.4, November 2018

[16] ONF TR-527 Functional Requirements for Transport API, June 10, 2016

[17] ONF Transport API (TAPI) Information Model, SDK 2.2 - “https://github.com/OpenNetworkingFoundation/TAPI”, April 2019

[18] Papyrus UML Tool - Version Neon "https://www.eclipse.org/papyrus/documentation.html" Copyright © 2015 The Eclipse Foundation. All Rights Reserved.

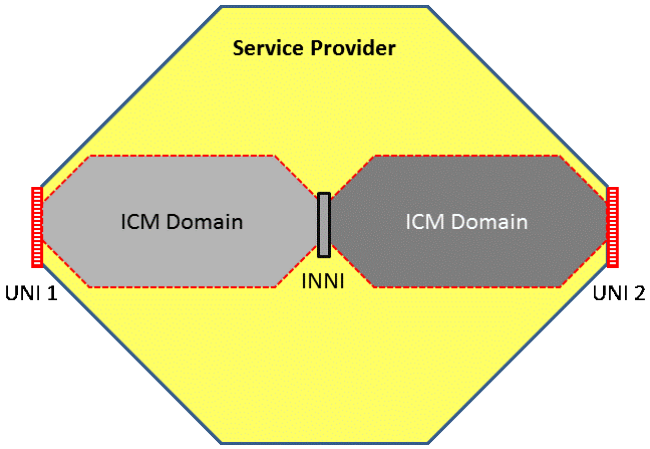
[19] TM Forum, Information Framework (SID), GB922, Release 17.0.0, June 2017.

[20] TM Forum MTNM 4.5, July 2015

[21] TM Forum MTOSI 4.0, July 2015

Appendix A Examples of Network Scenarios (Informative)

In the following are depicted some network scenarios.



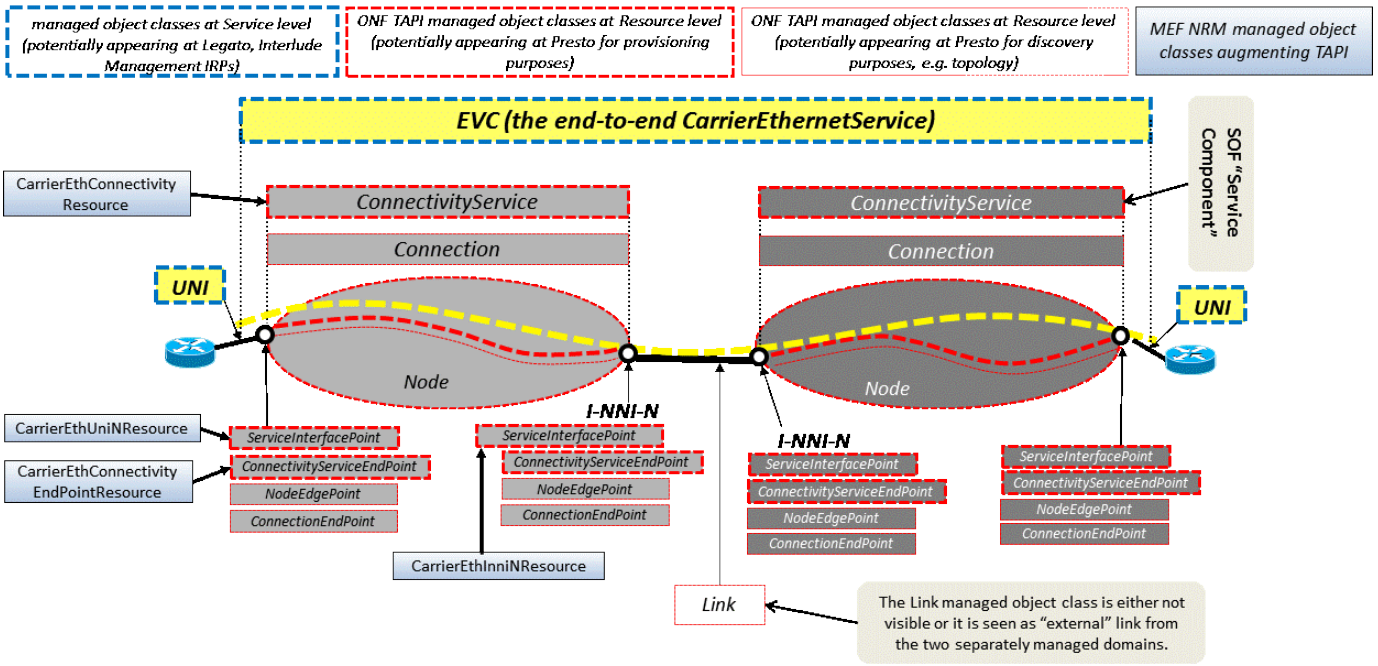


Figure 19 – Single Provider, separately managed domains

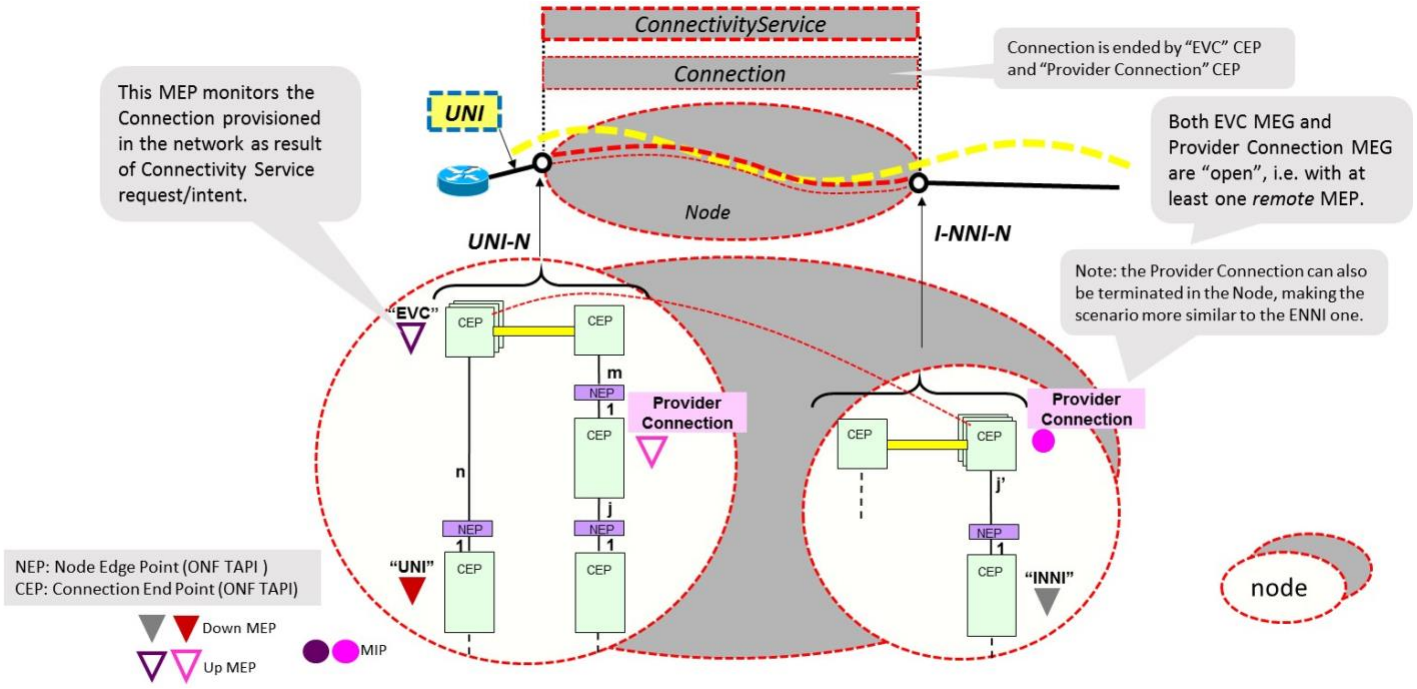


Figure 20 – Single Provider, separately managed domains, positioning of MEPs and MIPs

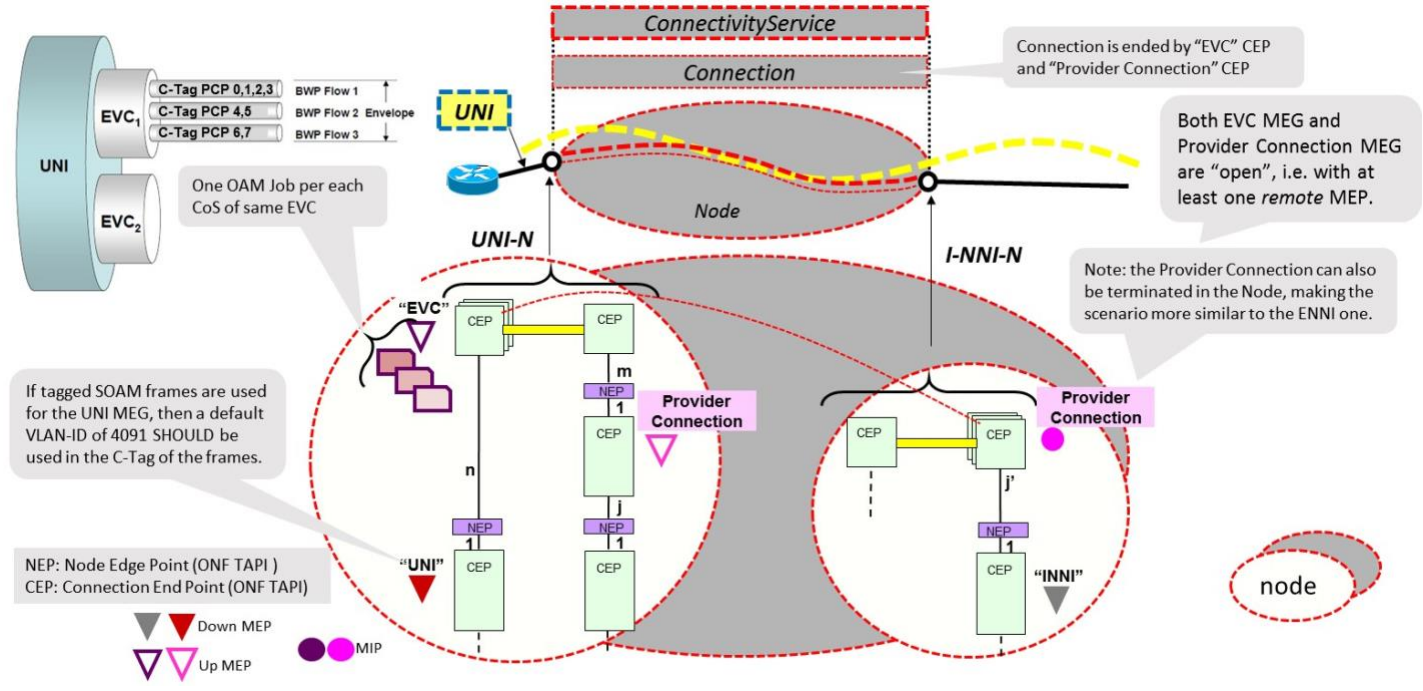


Figure 21 – Single Provider, separately managed domains, more CoS per EVC

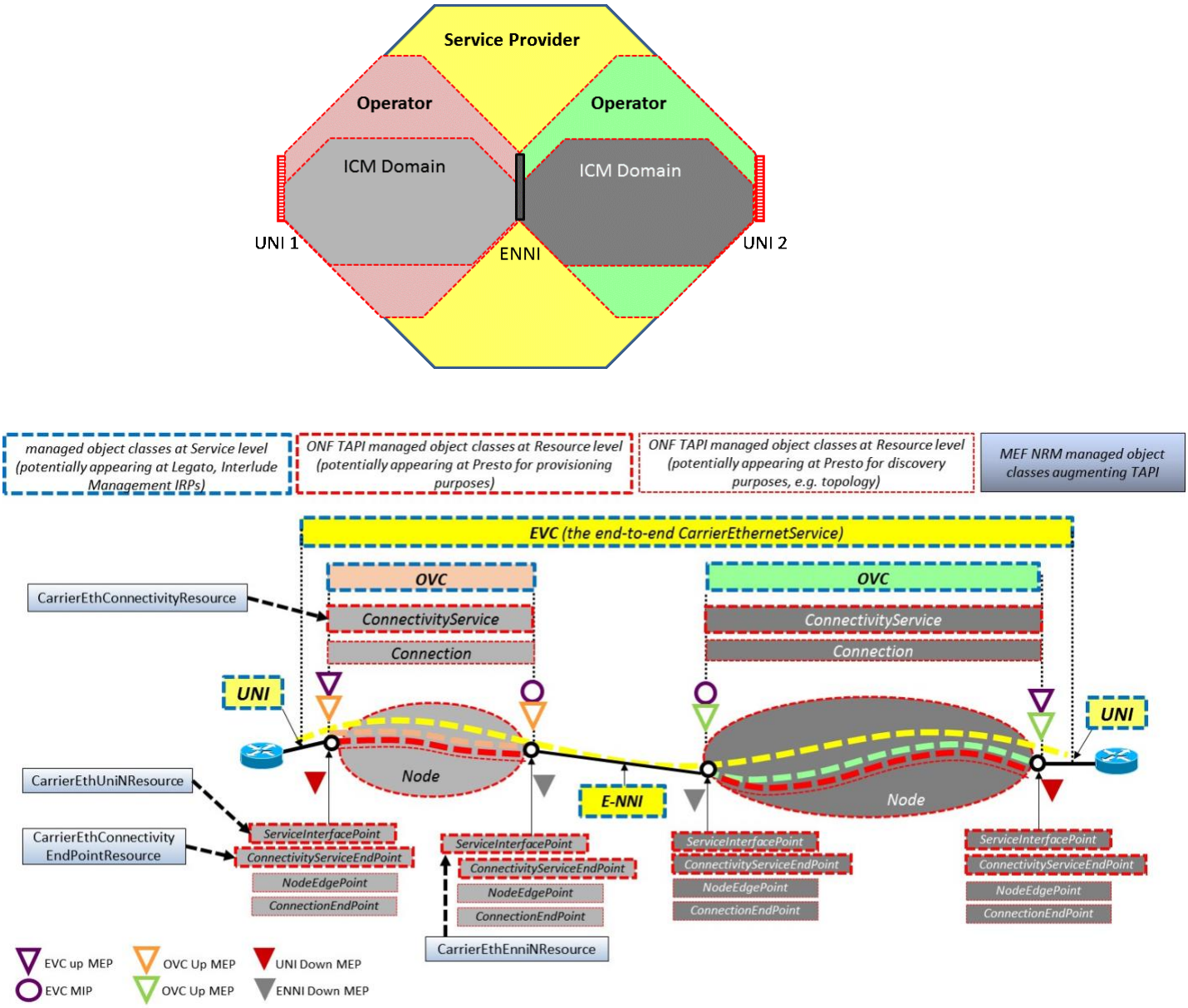


Figure 22 – Different Operators

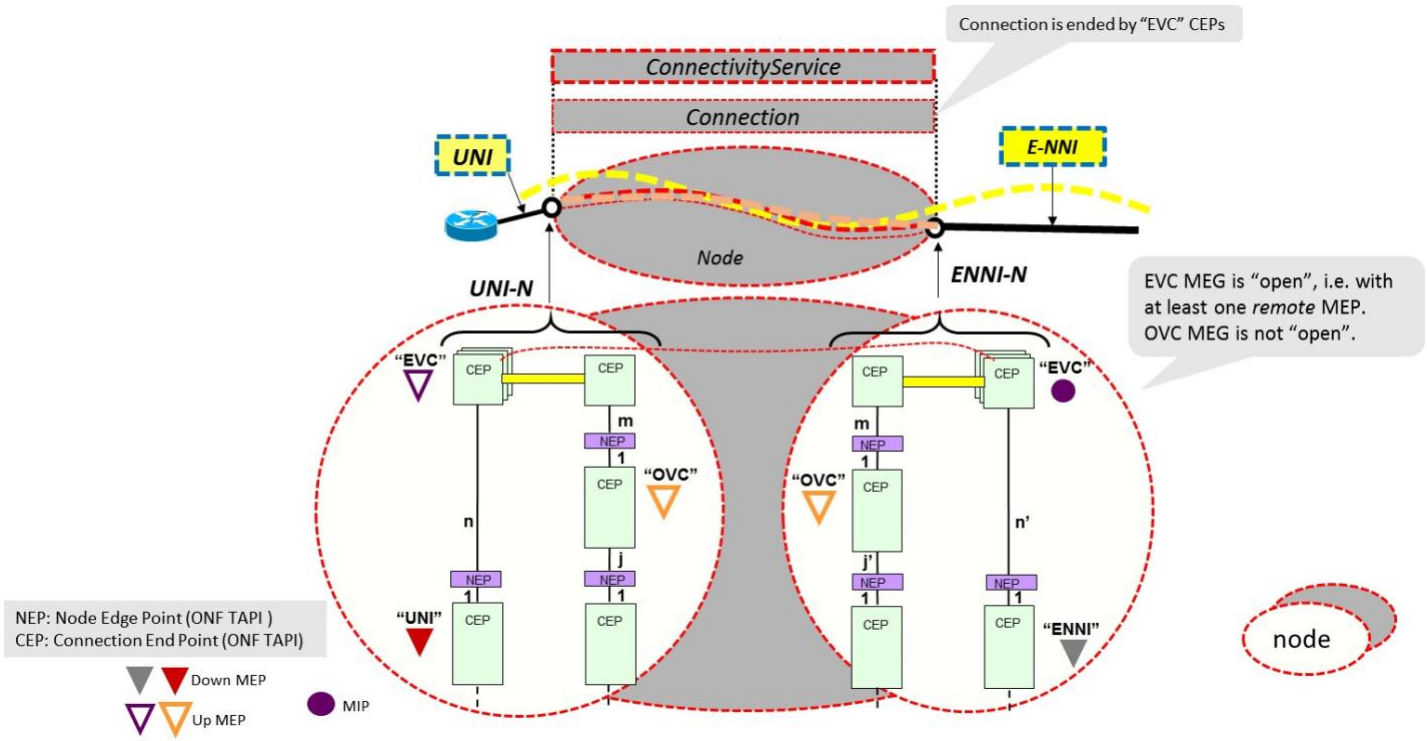


Figure 23 – Different Operators, positioning of MEPs and MIPs

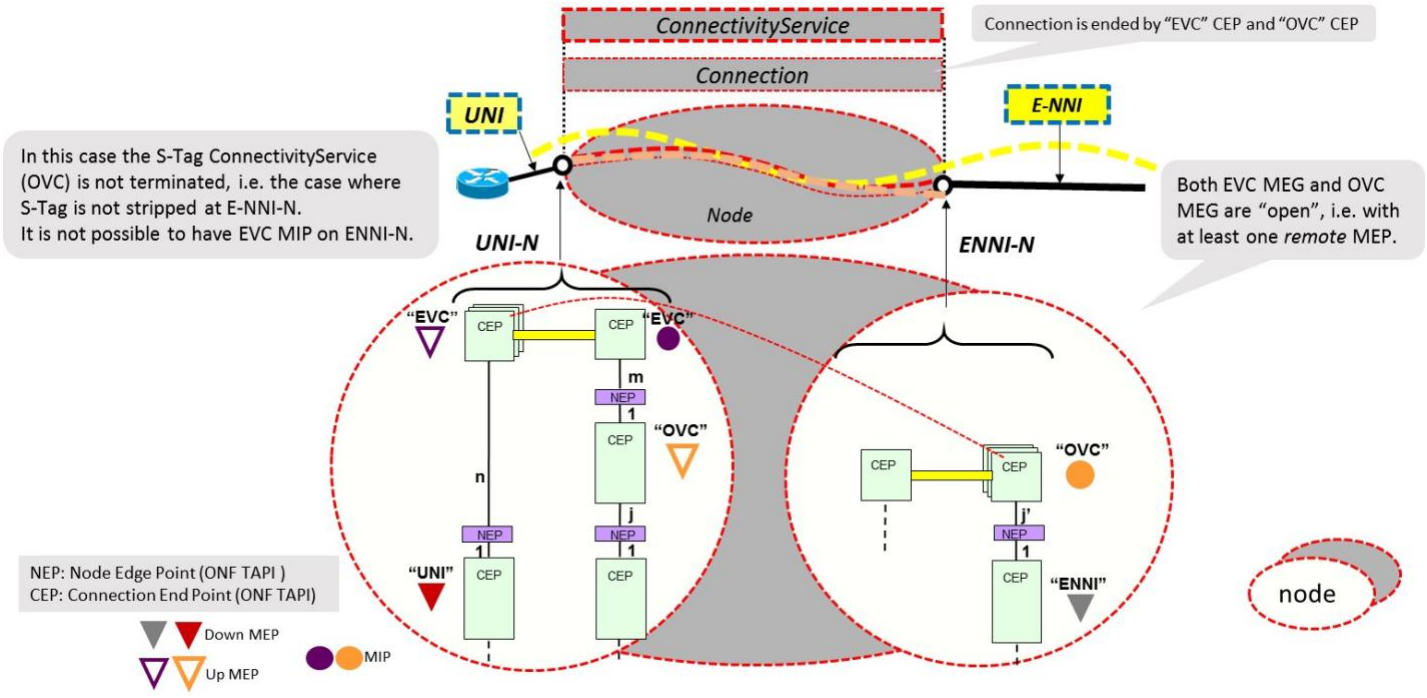


Figure 24 – Different Operators, positioning of MEPs and MIPs, OVC *not terminated*

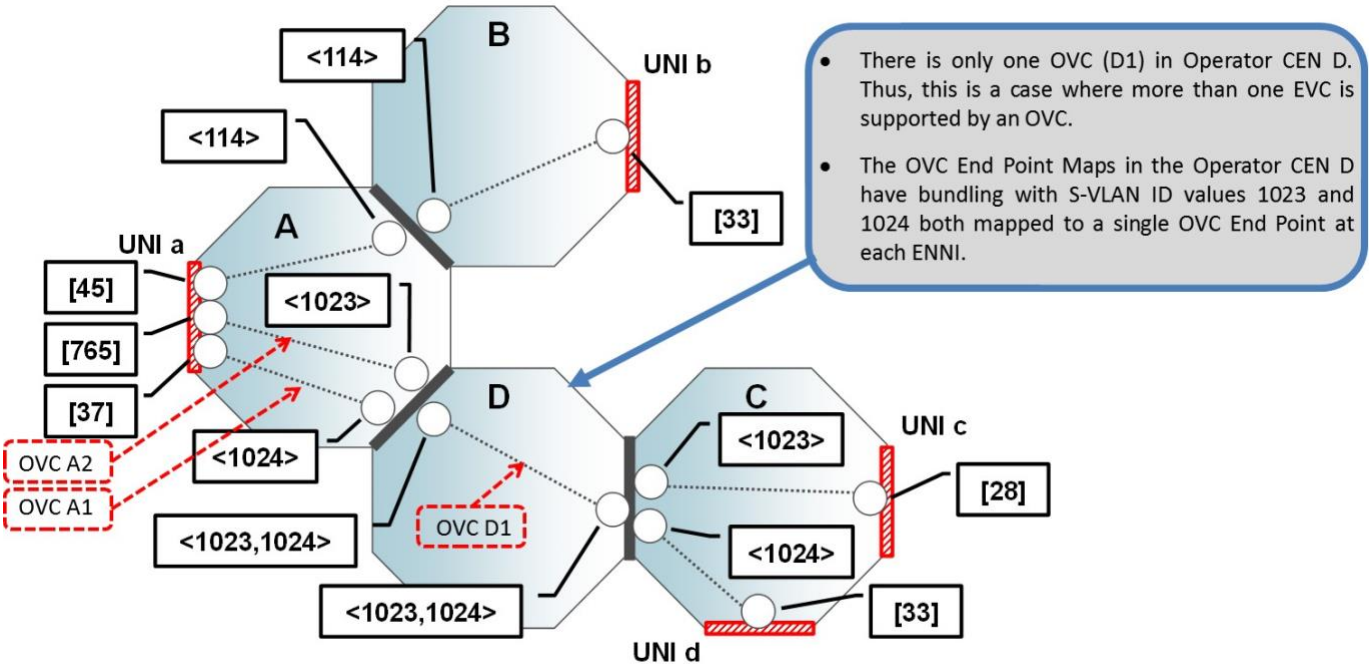


Figure 25 – Example of Using OVC End Point Map Bundling

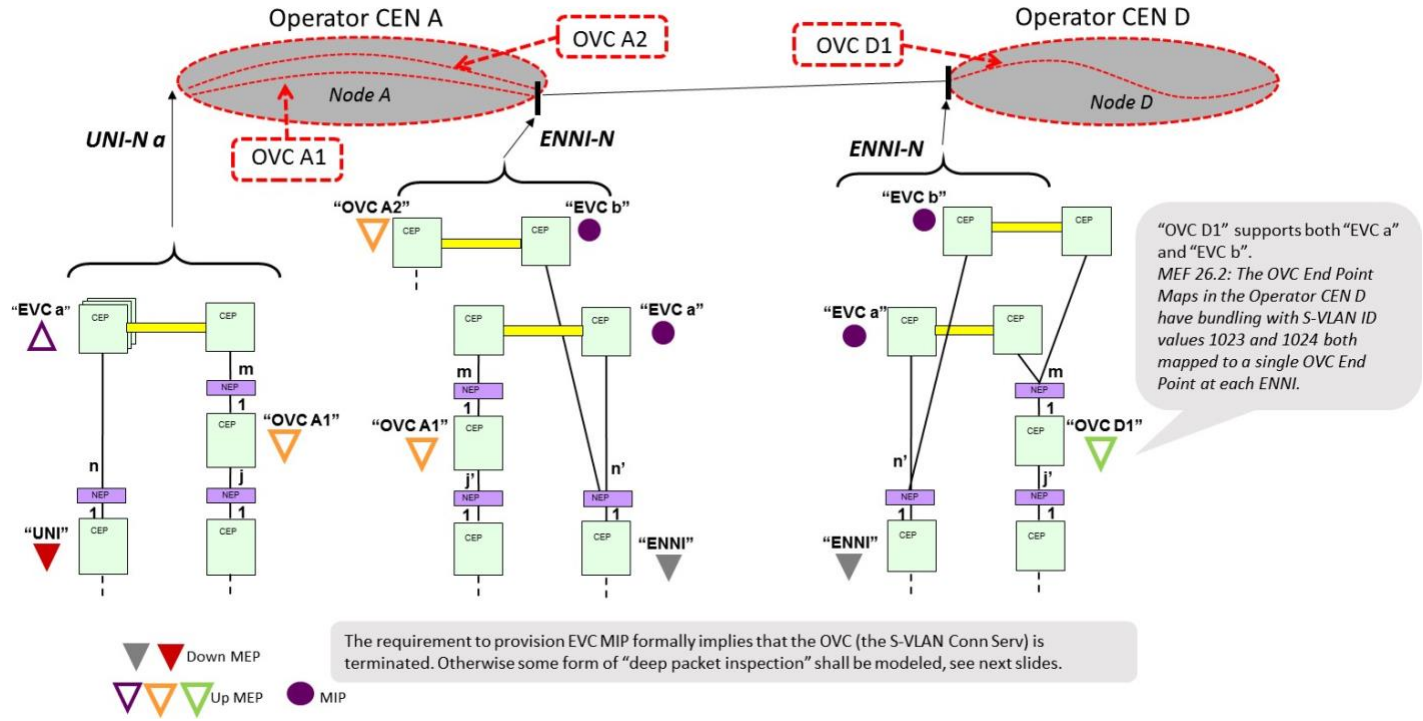


Figure 26 – Different Operators, positioning of MEPs and MIPs, OVC *bundling*

Appendix B ONF TAPI OAM and Ethernet Model (Informative)

B.1 OAM Technology Independent Model

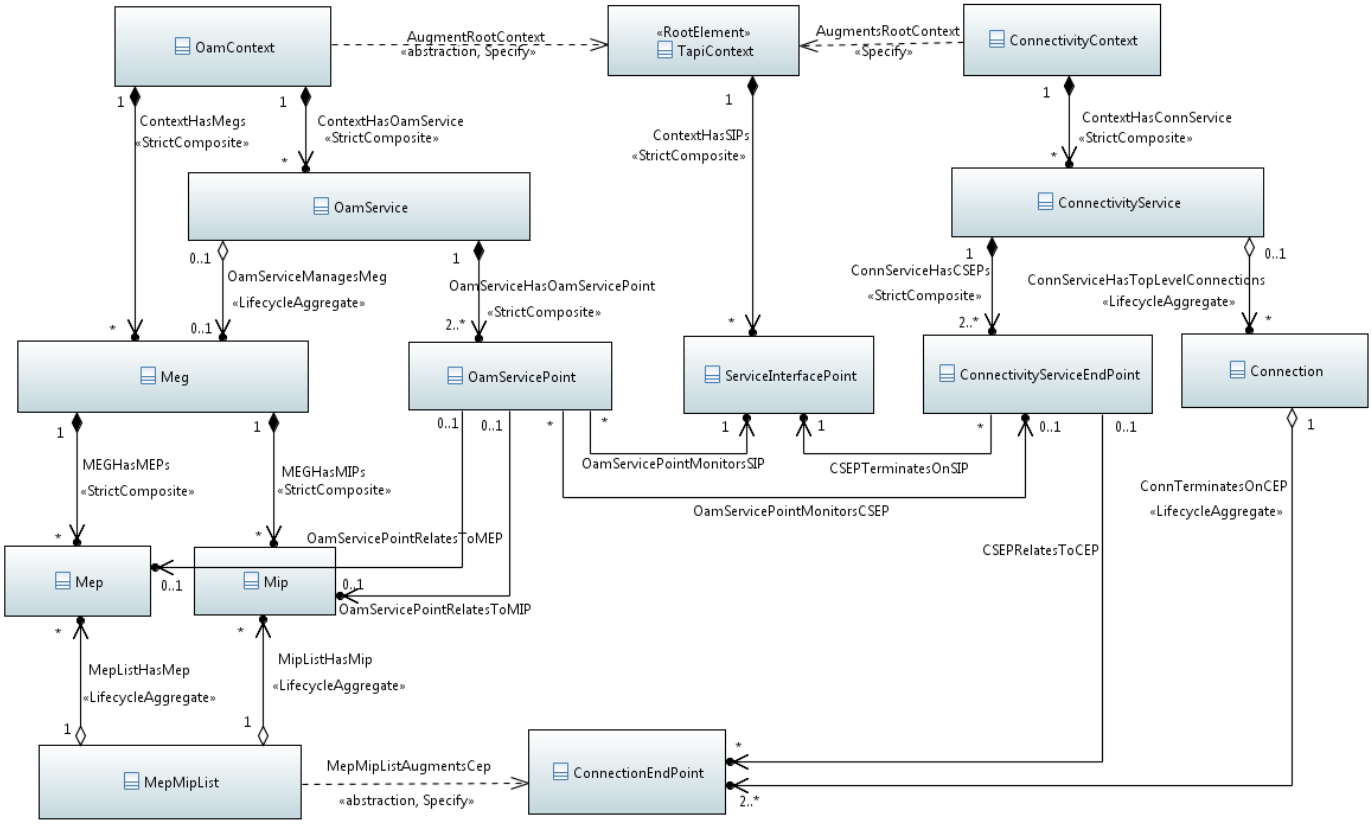


Figure 27 – *OamConnSkeleton* Diagram

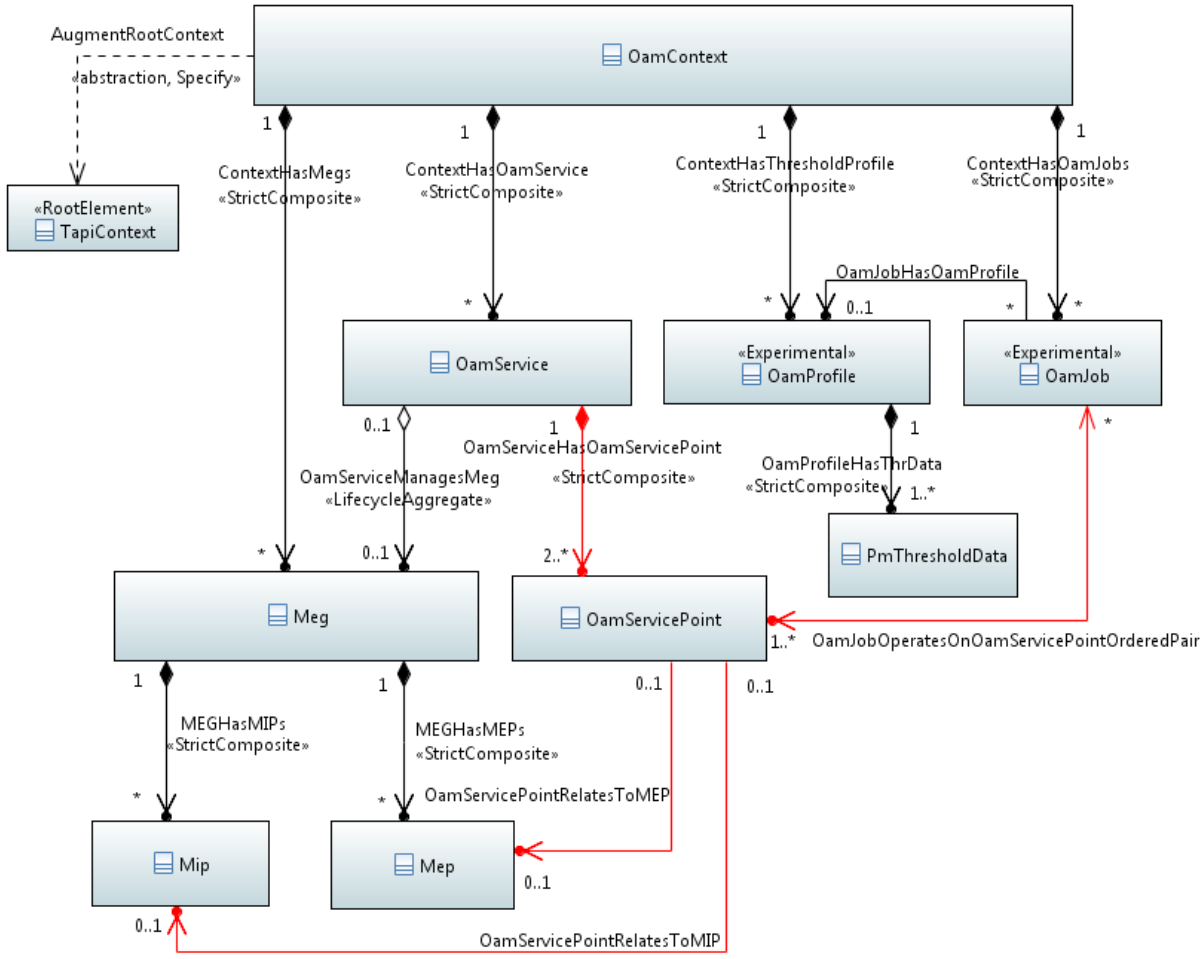


Figure 28 – *OamSkeleton* Diagram

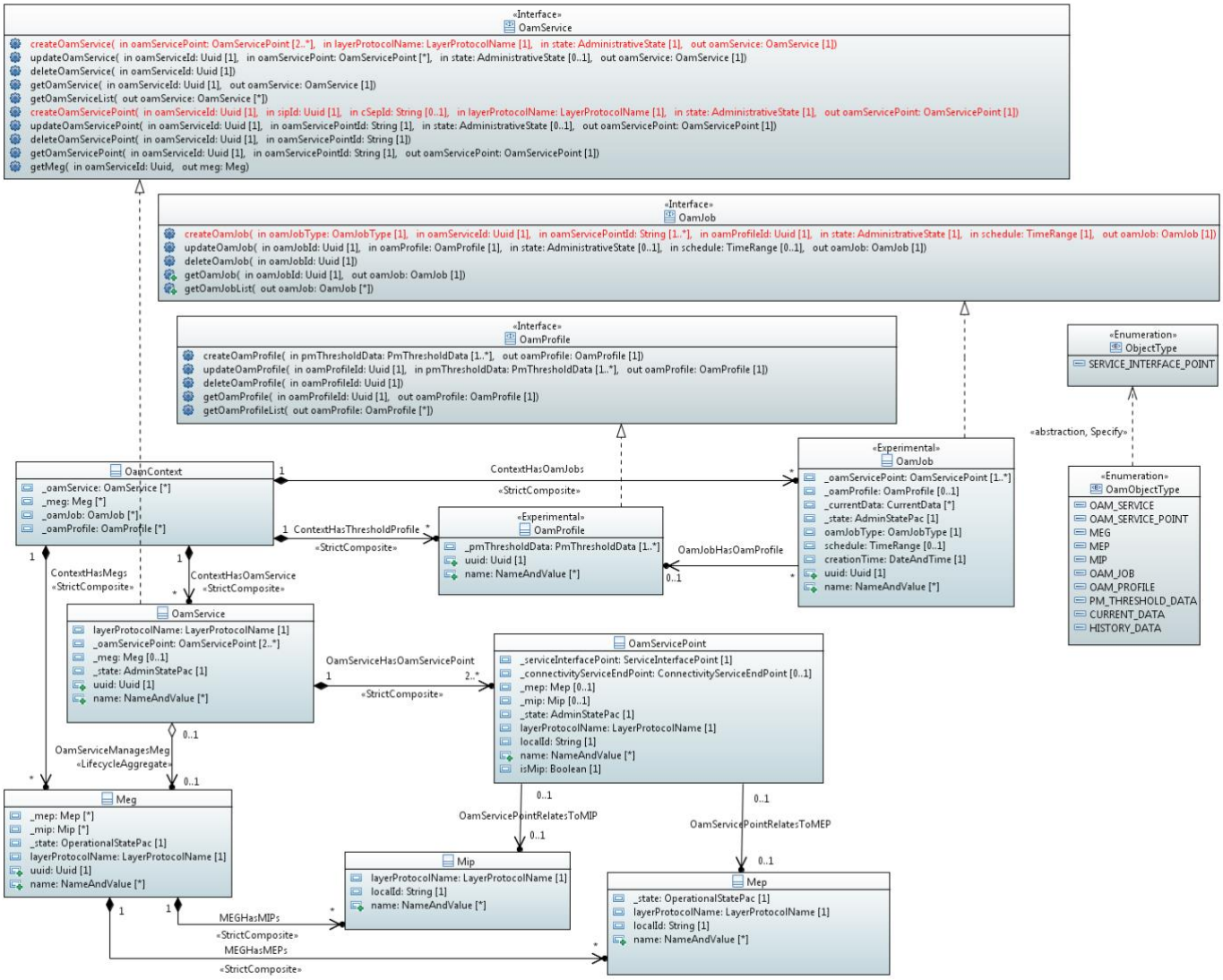


Figure 29 – *OamDetails* Diagram

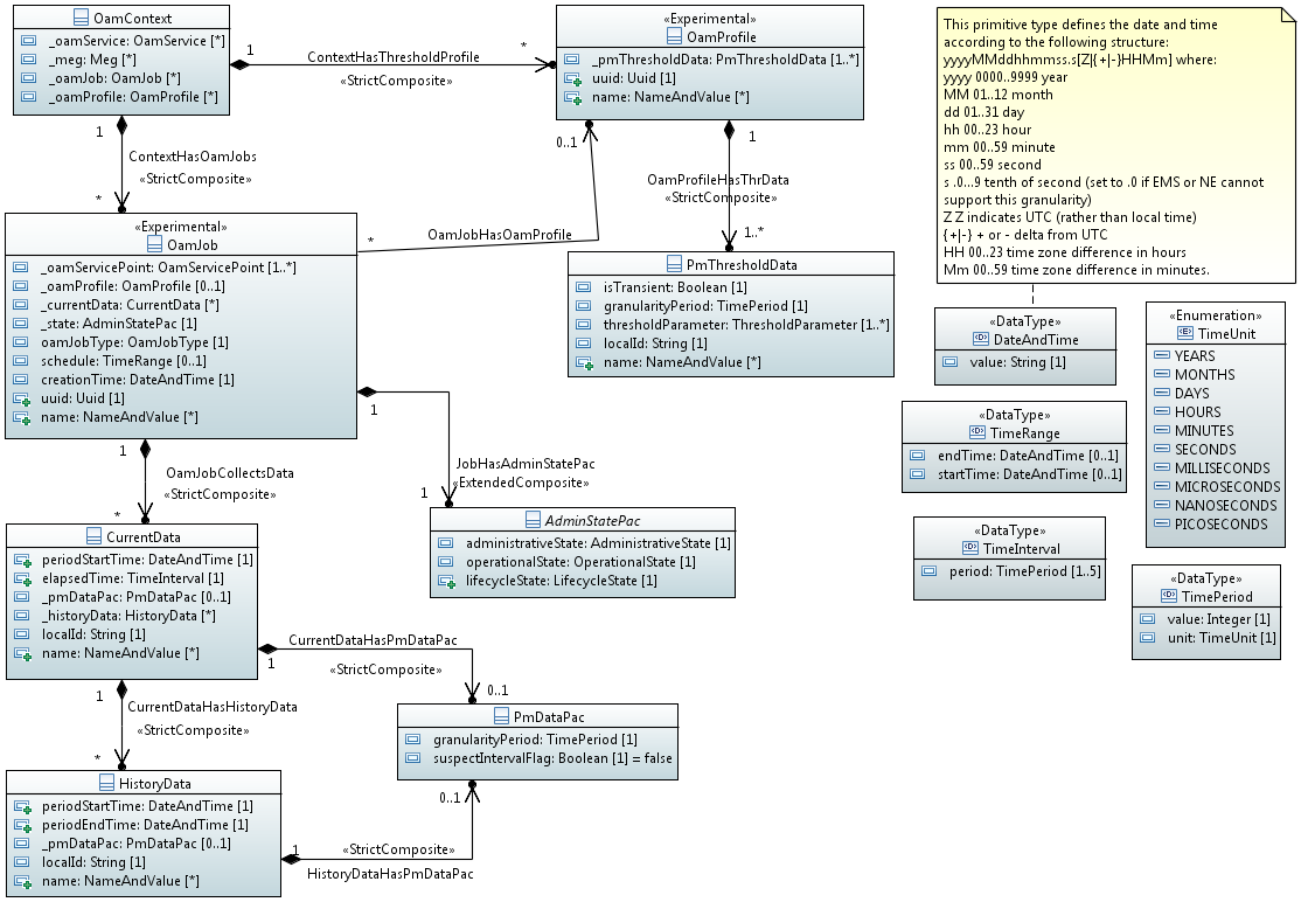


Figure 30 – *OamJobDetails* Diagram

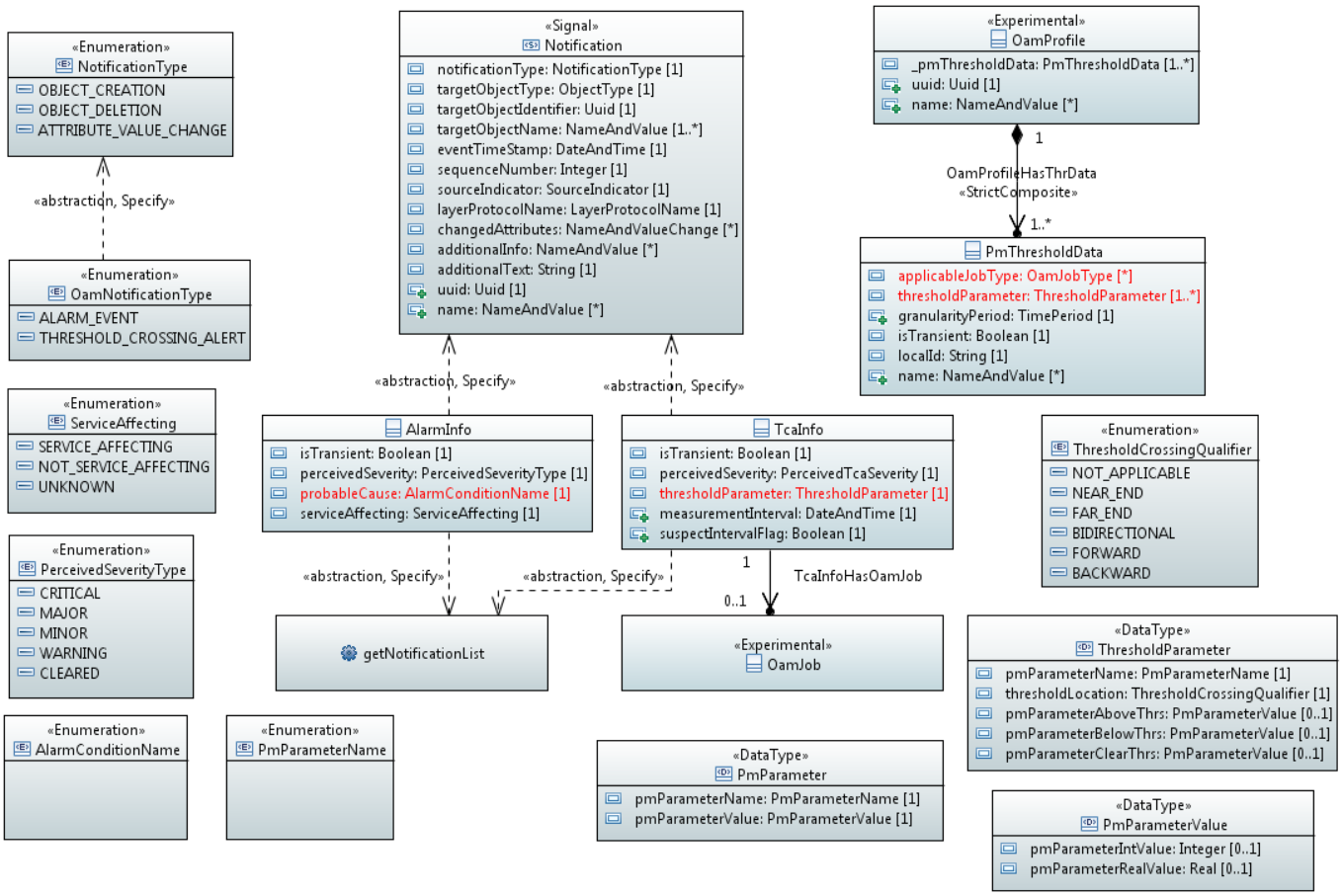


Figure 31 – *AlarmTcaDetails* Diagram

B.2 OAM Ethernet Model

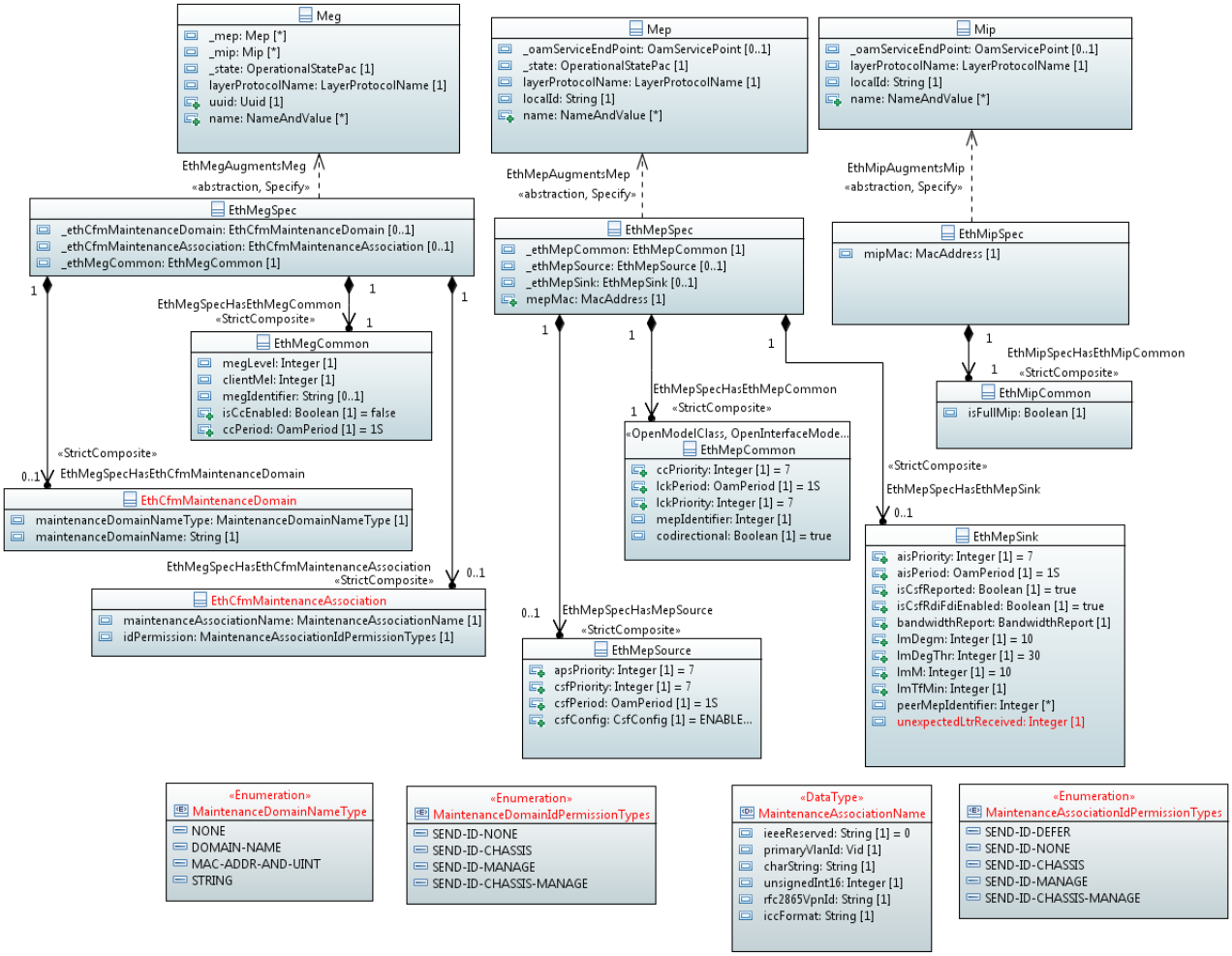


Figure 32 – *EthSpecOamResource* Diagram

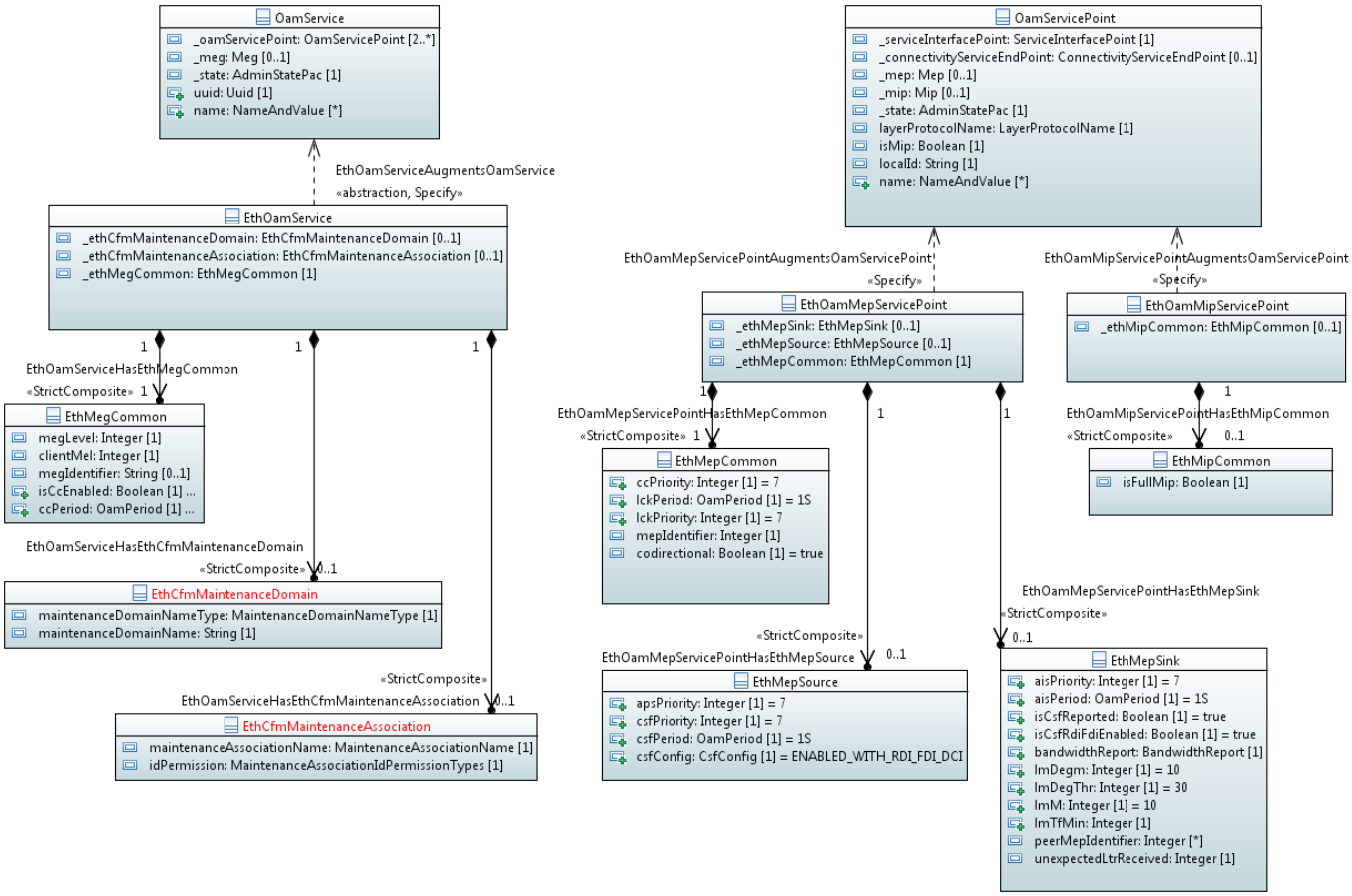


Figure 33 – *EthSpecOamService* Diagram

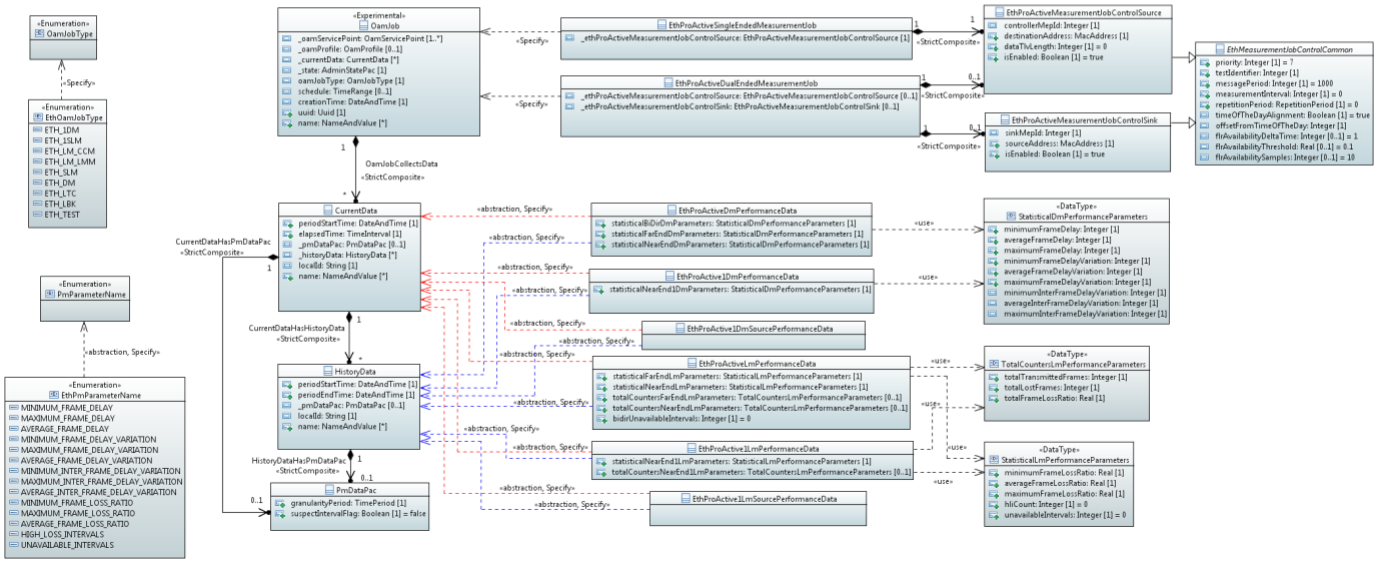


Figure 34 – *EthSpecJobsPmProActive* Diagram

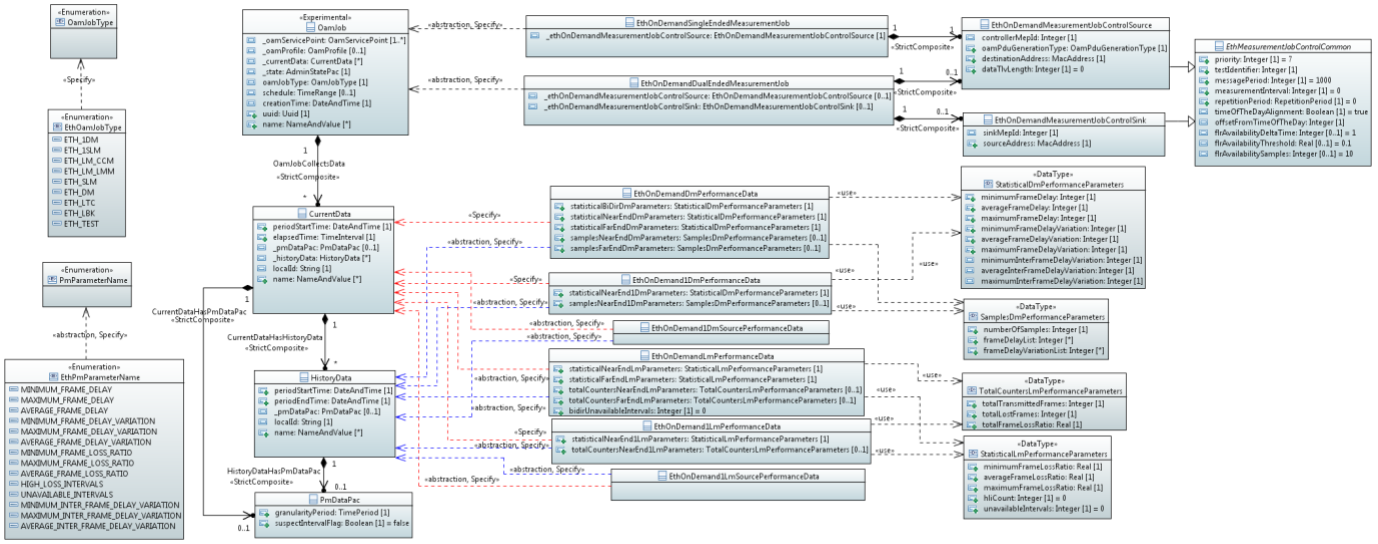


Figure 35 – *EthSpecJobsPmOnDemand* Diagram

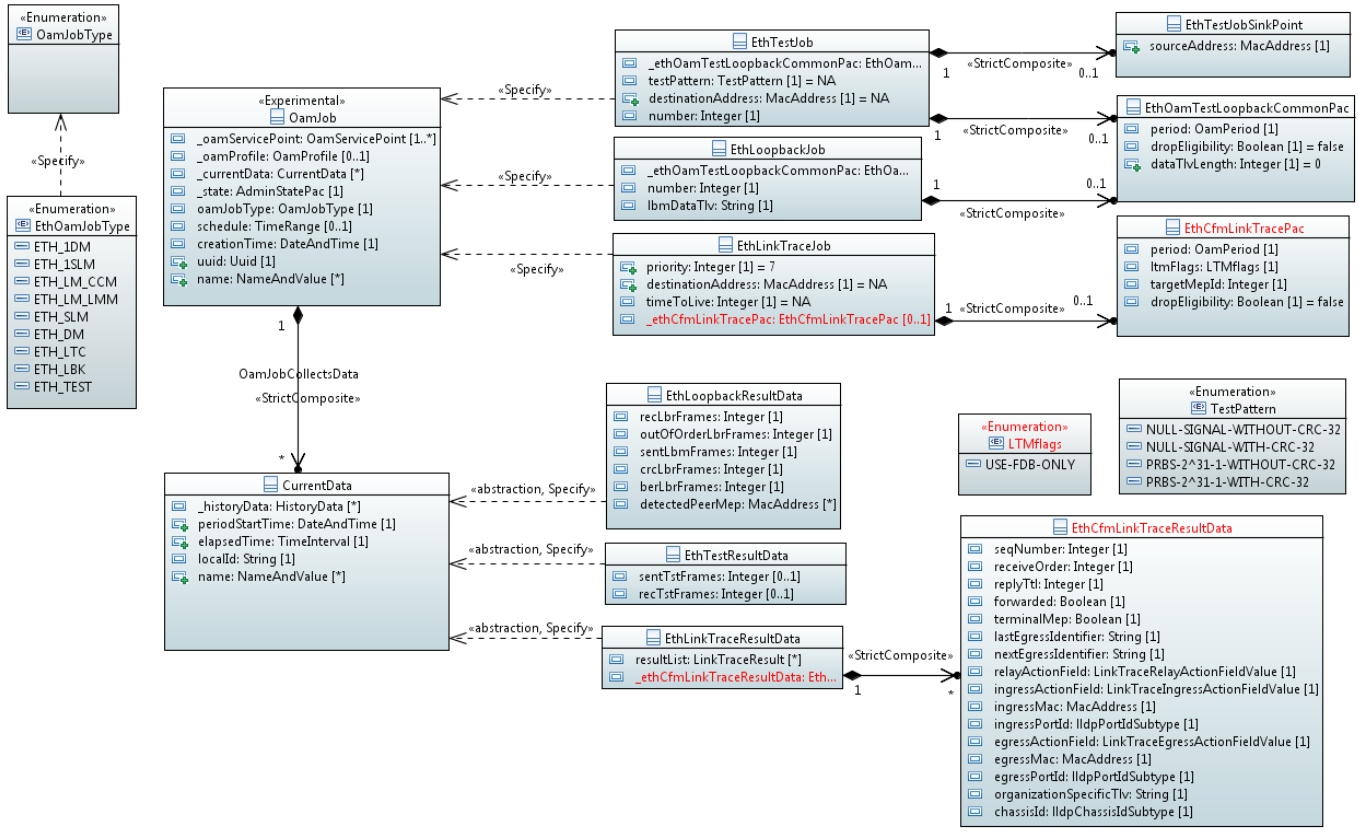


Figure 36 – *EthSpecJobsFm* Diagram

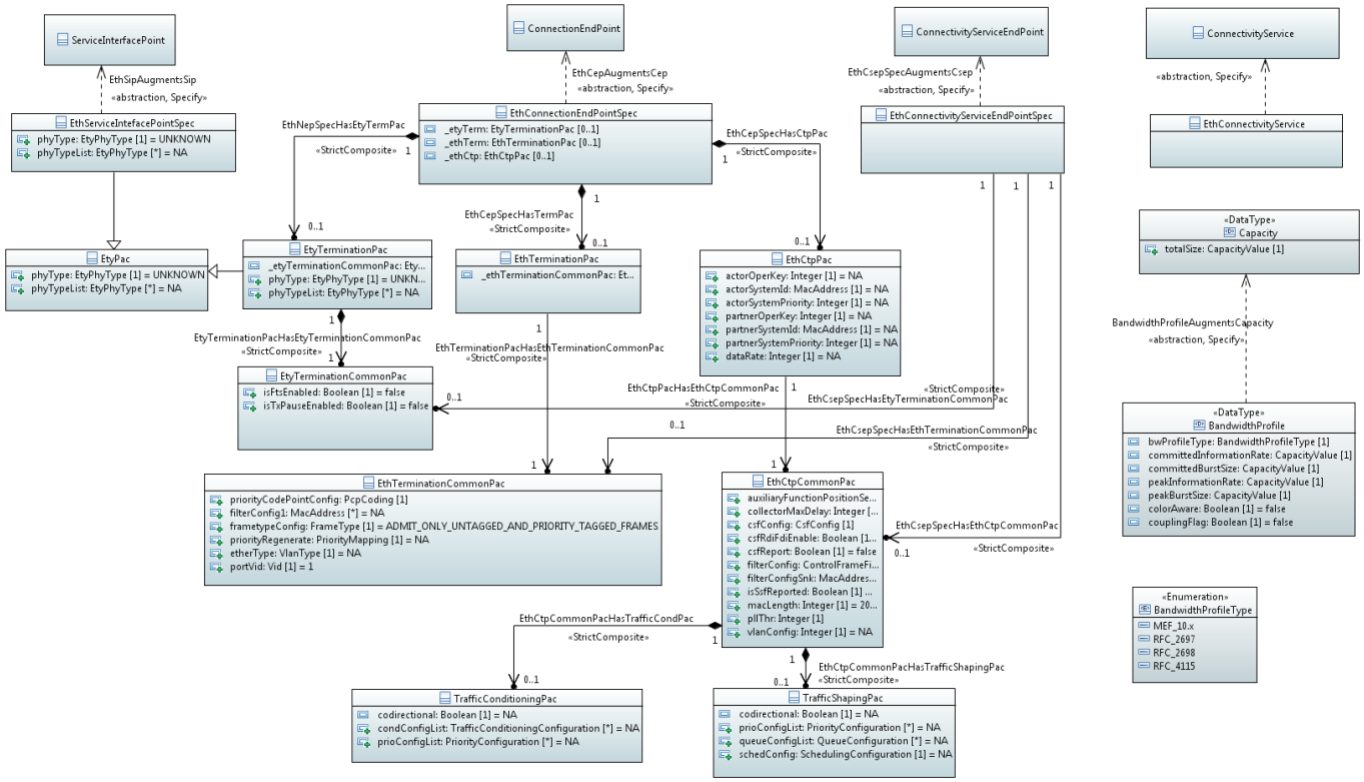


Figure 37 – *EthSpecConnectivity* Diagram

Appendix C PM Metrics detailed mapping with MEF 35.1 (Informative)

Conventions used in the "ONF-TAPI / NRM-OAM" column:

- All uppercase: the reference model:
  - "TAPI OAM" or "NRM OAM".
- Initial uppercase: the class, e.g.
  - "CurrentData".
- Initial lowercase: the PM metric attribute (*for reporting*) followed by all uppercase qualifier when applicable, e.g.
  - "fdr1BinThrs – FORWARD"
- Between brackets: all uppercase PM metric attribute (*for threshold configuration and notification*), followed by all uppercase qualifier, e.g.
  - "(BIN_FRAME_DELAY - BIDIRECTIONAL)"
  - "(MAXIMUM_FRAME_DELAY– BIDIRECTIONAL)"
- [ns] = nano second, 1x10e-9 seconds.
- In Single-Ended measurements, it is assumed that the:
  - FORWARD and FAR_END qualifiers are equivalent.
  - BACKWARD and NEAR_END qualifiers are equivalent.
- In Dual-Ended measurements (and in case of TX counters), it is assumed that the:
  - FORWARD and NEAR_END qualifiers are equivalent.
  - BACKWARD and FAR_END qualifiers are equivalent.

  See Appendix E for further clarifications.

C.1 Single-Ended Delay Data Set

Data	Description	ONF-TAPI / NRM-OAM
Start Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled start time of the Measurement Interval.	TAPI OAM CurrentData periodStartTime HistoryData periodStartTime
End Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled end time of the Measurement Interval.	TAPI OAM HistoryData periodEndTime
Measurement Interval elapsed time	A 32-bit counter of the number of seconds of the Measurement Interval as calculated by the NE. Note: this may differ from the difference between the start and end times if measurements started or stopped part way through the Measurement Interval, or if there was a shift in the time-of-day clock. Some of these conditions will result in the Suspect Flag being set.	TAPI OAM CurrentData elapsedTime HistoryData periodEndTime
SOAM PM Frames Sent	A 32-bit counter reflecting the number of SOAM PM Frames sent.	NRM OAM CarrierEthOamMetricsControllerCommonPacResource soamPmFramesTx (TCA not foreseen)
SOAM PM Frames Received	A 32-bit counter reflecting the number of SOAM PM Frames received.	NRM OAM CarrierEthOamMetricsSinkCommonPacResource soamPmFramesRx (TCA not foreseen)
Two-way FD counter per configured FD Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of FD measurements that fall within the configured range.	NRM OAM CarrierEthOamMetrics1EndDelayResource fd2Bin (BIN_FRAME_DELAY - BIDIRECTIONAL)
Mean Two-way FD	A 32-bit integer reflecting the average (arithmetic mean) Two-way FD measurement in microseconds.	TAPI OAM StatisticalDmPerformanceParameters averageFrameDelay – BIDIRECTIONAL [ns] (TCA not foreseen)

Data	Description	ONF-TAPI / NRM-OAM
Minimum Two-way FD	A 32-bit integer reflecting the minimum Two-way FD measurement in microseconds.	TAPI OAM StatisticalDmPerformanceParameters minimumFrameDelay - BIDIRECTIONAL [ns] (TCA not foreseen)
Maximum Two-way FD	A 32-bit integer reflecting the maximum Two-way FD measurement in microseconds.	TAPI OAM StatisticalDmPerformanceParameters maximumFrameDelay - BIDIRECTIONAL [ns] (MAXIMUM_FRAME_DELAY– BIDIRECTIONAL)
One-way IFDV counter in the Forward direction per configured IFDV Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of IFDV measurements (i.e., each instance of $\|D_i – D_j\|$ in the Forward direction) that fall within a configured bin.	NRM OAM CarrierEthOamMetrics1EndDelayResource ifdv1FwBin (BIN_INTER_FRAME_DELAY_VARIATION - FORWARD)
Mean One-way IFDV in the Forward direction	A 32-bit integer reflecting the average (arithmetic mean) One-way IFDV measurement in the Forward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters averageInterFrameDelayVariation – FORWARD or FAR_END [ns] (TCA not foreseen)
Maximum One-way IFDV in the Forward direction	A 32-bit integer reflecting the maximum One-way IFDV measurement in the Forward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters maximumInterFrameDelayVariation– FORWARD or FAR_END [ns] (MAXIMUM_INTER_FRAME_DELAY_VARIATION - FORWARD or FAR_END)
One-way IFDV counter in the Backward direction per configured IFDV Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of IFDV measurements in the Backward direction that fall within a configured bin.	NRM OAM CarrierEthOamMetrics1EndDelayResource ifdv1BkBin (BIN_INTER_FRAME_DELAY_VARIATION - BACKWARD)
Mean One-way IFDV in the Backward direction	A 32-bit integer reflecting the average (arithmetic mean) One-way IFDV measurement in the Backward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters averageInterFrameDelayVariation – BACKWARD or NEAR_END [ns] (TCA not foreseen)
Maximum One-way IFDV in the Backward direction	A 32-bit integer reflecting the maximum One-way IFDV measurement in the Backward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters maximumInterFrameDelayVariation– BACKWARD or NEAR_END [ns] (MAXIMUM_INTER_FRAME_DELAY_VARIATION - BACKWARD or NEAR_END)

Data	Description	ONF-TAPI / NRM-OAM
One-way FDR counter in the Forward direction per configured FDR Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of FDR measurements in the Forward direction that fall within a configured bin.	NRM OAM CarrierEthOamMetrics1EndDelayResource fdr1FwBin (BIN_FRAME_DELAY_RANGE – FORWARD)
Mean One-way FDR in the Forward direction	A 32-bit integer reflecting the average (arithmetic mean) One-way FDR measurement in the Forward direction in microseconds.	NRM OAM CarrierEthOamMetrics1EndDelayResource fdr1FwMean (TCA not foreseen)
Maximum One-way FDR in the Forward direction	A 32-bit integer reflecting the maximum One-way FDR measurement in the Forward direction in microseconds.	NRM OAM CarrierEthOamMetrics1EndDelayResource fdr1FwMax (MAXIMUM_FRAME_DELAY_RANGE – FORWARD)
One-way FDR counter in the Backward direction per configured FDR Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of FDR measurements in the Backward direction that fall within a configured bin.	NRM OAM CarrierEthOamMetrics1EndDelayResource fdr1BkBin (BIN_FRAME_DELAY_RANGE – BACKWARD)
Mean One-way FDR in the Backward direction	A 32-bit integer reflecting the average (arithmetic mean) One-way FDR measurement in the Backward direction in microseconds.	NRM OAM CarrierEthOamMetrics1EndDelayResource fdr1BkMean (TCA not foreseen)
Maximum One-way FDR in the Backward direction	A 32-bit integer reflecting the maximum One-way FDR measurement in the Backward direction in microseconds.	NRM OAM CarrierEthOamMetrics1EndDelayResource fdr1BkMax (MAXIMUM_FRAME_DELAY_RANGE – BACKWARD)
Minimum One-way FD in the Forward direction	A 32-bit integer reflecting the minimum One-way FD measurement in the Forward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters minimumFrameDelay - FORWARD or FAR_END [ns] (TCA not foreseen)
Minimum One-way FD in the Backward direction	A 32-bit integer reflecting the minimum One-way FD measurement in the Backward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters minimumFrameDelay - BACKWARD or NEAR_END [ns] (TCA not foreseen)

Table 2 – MEF 35.1 Table 9 - Mandatory Single-Ended Delay Data Set

Data	Description	ONF-TAPI / NRM-OAM
One-way FD counter in the Forward direction per configured FD Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of One-way FD measurements in the Forward direction that fall within the configured bin.	NRM OAM CarrierEthOamMetricsFdSynchResource fd1FwBin (BIN_FRAME_DELAY – FORWARD)
Mean One-way FD in the Forward direction	A 32-bit integer reflecting the average (arithmetic mean) One-way FD measurement in the Forward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters averageFrameDelay - FORWARD or FAR_END [ns] (TCA not foreseen)
Maximum One-way FD in the Forward direction	A 32-bit integer reflecting the maximum One-way FD measurement in the Forward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters maximumFrameDelay - FORWARD or FAR_END [ns] (MAXIMUM_FRAME_DELAY - FORWARD or FAR_END)
One-way FD counter in the Backward direction per configured FD Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of One-way FD measurements in the Backward direction that fall within the configured bin	NRM OAM CarrierEthOamMetricsFdSynchResource fd1BkBin (BIN_FRAME_DELAY – BACKWARD)
Mean One-way FD in the Backward direction	A 32-bit integer reflecting the average (arithmetic mean) One-way FD measurement in the Backward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters averageFrameDelay - BACKWARD or NEAR_END [ns] (TCA not foreseen)
Maximum One-way FD in the Backward direction	A 32-bit integer reflecting the maximum One-way FD measurement in the Backward direction in microseconds.	TAPI OAM StatisticalDmPerformanceParameters maximumFrameDelay - BACKWARD or NEAR_END [ns] (MAXIMUM_FRAME_DELAY - BACKWARD or NEAR_END)

Table 3 – MEF 35.1 Table 10 - Mandatory Single-Ended Delay Data Set with Clock Synchronization

C.2 Single-Ended Synthetic Loss Data Set

Data	Description	ONF-TAPI / NRM-OAM
Start Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled start time of the Measurement Interval.	TAPI OAM CurrentData periodStartTime HistoryData periodStartTime
End Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled end time of the Measurement Interval.	TAPI OAM HistoryData periodEndTime
Measurement Interval elapsed time	A 32-bit counter of the number of seconds of the Measurement Interval as calculated by the NE. Note: this may differ from the difference between the start and end times if measurements started or stopped part way through the Measurement Interval, or if there was a shift in the time-of-day clock. Some of these conditions will result in the Suspect Flag being set.	TAPI OAM CurrentData elapsedTime HistoryData periodEndTime
SOAM PM Frames Sent[1]	A 32-bit counter reflecting the number of SOAM PM Frames sent.	NRM OAM CarrierEthOamMetricsControllerCommonPacResource soamPmFramesTx (TCA not foreseen)
SOAM PM Frames Received[1]	A 32-bit counter reflecting the number of SOAM PM Frames received.	NRM OAM CarrierEthOamMetricsSinkCommonPacResource soamPmFramesRx (TCA not foreseen)

[1] For Single-Ended Synthetic Loss, SOAM PM Frames Sent is equal to Tx frame count in the Forward Direction and SOAM PM Frames Received is equal to Rx frame count in the Backward Direction. Both fields are specified so as to retain consistency with other PM Functions.

Data	Description	ONF-TAPI / NRM-OAM
Tx frame count in the Forward direction[1]	A 32-bit counter reflecting the number of SLM frames transmitted in the Forward direction.	TAPI OAM TotalCountersLmPerformanceParameters totalTransmittedFrames - FORWARD or NEAR_END (TCA not foreseen)
Rx frame count in the Forward direction	A 32-bit counter reflecting the number of SLM frames received in the Forward direction.	NRM OAM CarrierEthOamMetrics1EndSynthLossResource slmFramesFwRx (TCA not foreseen)
Tx frame count in the Backward direction	A 32-bit counter reflecting the number of SLR frames transmitted in the Backward direction.	TAPI OAM TotalCountersLmPerformanceParameters totalTransmittedFrames - BACKWARD or FAR_END (TCA not foreseen)
Rx frame count in the Backward direction[1]	A 32-bit counter reflecting the number of SLR frames received in the Backward direction.	NRM OAM CarrierEthOamMetrics1EndSynthLossResource slrFramesBkRx (TCA not foreseen)
Count of Δt intervals evaluated as Available in the Forward direction	A 32-bit counter reflecting the number of Δt intervals evaluated as Available in the Forward direction (i.e., for which $A_{<Controller, Responder>}(\Delta t) = 1$).	NRM OAM CarrierEthOamMetrics1EndSynthLossResource availableIntervalsFw (TCA not foreseen)
Count of Δt intervals evaluated as Available in the Backward direction	A 32-bit counter reflecting the number of Δt intervals evaluated as Available in the Backward direction (i.e., for which $A_{<Responder, Controller>}(\Delta t) = 1$).	NRM OAM CarrierEthOamMetrics1EndSynthLossResource availableIntervalsBw (TCA not foreseen)
Count of Δt intervals evaluated as Unavailable in the Forward direction	A 32-bit counter reflecting the number of Δt intervals evaluated as Unavailable in the Forward direction (i.e., for which $A_{<Controller, Responder>}(\Delta t) = 0$).	TAPI OAM StatisticalLmPerformanceParameters unavailableIntervals - FORWARD or FAR_END (TCA not foreseen)

Data	Description	ONF-TAPI / NRM-OAM
Count of Δt intervals evaluated as Unavailable in the Backward direction	A 32-bit counter reflecting the number of Δt intervals evaluated as Unavailable in the Backward direction (i.e., for which $A_{<\text{Responder, Controller}>}(\Delta t) = 0$).	TAPI OAM StatisticalLmPerformanceParameters unavailableIntervals - BACKWARD or NEAR_END (TCA not foreseen)
Count of HLIs in the Forward direction	Count of HLIs in the Forward direction during the Measurement Interval.	TAPI OAM StatisticalLmPerformanceParameters hliCount - FORWARD or FAR_END (HIGH_LOSS_INTERVALS - FORWARD or FAR_END)
Count of HLIs in the Backward direction	Count of HLIs in the Backward direction during the Measurement Interval.	TAPI OAM StatisticalLmPerformanceParameters hliCount - BACKWARD or NEAR_END (HIGH_LOSS_INTERVALS - BACKWARD or NEAR_END)
Count of CHLIs in the Forward direction	Count of CHLIs in the Forward direction during the Measurement Interval.	NRM OAM CarrierEthOamMetrics1EndSynthLossResource ChliCountFw (CONSECUTIVE_HIGH_LOSS_INTERVALS – FORWARD)
Count of CHLIs in the Backward direction	Count of CHLIs in the Backward direction during the Measurement Interval.	NRM OAM CarrierEthOamMetrics1EndSynthLossResource chliCountBw (CONSECUTIVE_HIGH_LOSS_INTERVALS – BACKWARD)

Table 4 – MEF 35.1 Table 12 - Mandatory Single-Ended Synthetic Loss Data Set

Data	Description	ONF-TAPI / NRM-OAM
Minimum One-way Availability flr in the Forward direction	The minimum One-way Availability flr measurement during this Measurement Interval.	TAPI OAM StatisticalLmPerformanceParameters minimumFrameLossRatio - FORWARD or FAR_END (TCA not foreseen)
Maximum One-way Availability flr in the Forward direction	The maximum One-way Availability flr measurement during this Measurement Interval.	TAPI OAM StatisticalLmPerformanceParameters maximumFrameLossRatio - FORWARD or FAR_END (TCA not foreseen)
Mean One-way Availability flr in the Forward direction	The average (arithmetic mean) One-way Availability flr measurement during this Measurement Interval.	TAPI OAM StatisticalLmPerformanceParameters averageFrameLossRatio - FORWARD or FAR_END (TCA not foreseen)
Minimum One-way Availability flr in the Backward direction	The minimum One-way Availability flr measurement during this Measurement Interval.	TAPI OAM StatisticalLmPerformanceParameters minimumFrameLossRatio - BACKWARD or NEAR_END (TCA not foreseen)
Maximum One-way Availability flr in the Backward direction	The maximum One-way Availability flr measurement during this Measurement Interval.	TAPI OAM StatisticalLmPerformanceParameters maximumFrameLossRatio - BACKWARD or NEAR_END (TCA not foreseen)
Mean One-way Availability flr in the Backward direction	The average (arithmetic mean) One-way Availability flr measurement during this Measurement Interval.	TAPI OAM StatisticalLmPerformanceParameters averageFrameLossRatio - BACKWARD or NEAR_END (TCA not foreseen)

Table 5 – MEF 35.1 Table 13 - Optional Single-Ended Synthetic Loss Data Set

C.3 Dual-Ended Delay Data Set

Data	Description	MEP	ONF-TAPI / NRM-OAM
Start Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled start time of the Measurement Interval.	Both	TAPI OAM CurrentData periodStartTime HistoryData periodStartTime
End Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled end time of the Measurement Interval.	Both	TAPI OAM HistoryData periodEndTime
Measurement Interval elapsed time	A 32-bit counter of the number of seconds of the Measurement Interval as calculated by the NE. Note: this may differ from the difference between the start and end times if measurements started or stopped part way through the Measurement Interval, or if there was a shift in the time-of-day clock. Some of these conditions will result in the Suspect Flag being set.	Both	TAPI OAM CurrentData elapsedTime HistoryData periodEndTime

Data	Description	MEP	ONF-TAPI / NRM-OAM
SOAM PM Frames Sent	A 32-bit counter reflecting the number of SOAM PM Frames sent.	Controller	NRM OAM CarrierEthOamMetricsControllerCommonPacResource {when *augments* EthProActive1DmSourcePerformanceData/ EthOnDemand1DmSourcePerformanceData} soamPmFramesTx (TCA not foreseen)
SOAM PM Frames Received	A 32-bit counter reflecting the number of SOAM PM Frames received.	Sink	NRM OAM CarrierEthOamMetricsSinkCommonPacResource soamPmFramesRx (TCA not foreseen)
One-way IFDV counter per configured IFDV Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of IFDV measurements that fall within the configured bin.	Sink	NRM OAM CarrierEthOamMetrics2EndDelayResource ifdv1Bin (BIN_INTER_FRAME_DELAY_VARIATION - FORWARD)
Mean One-way IFDV	A 32-bit integer reflecting the average (arithmetic mean) One-way IFDV measurement in microseconds.	Sink	TAPI OAM StatisticalDmPerformanceParameters averageInterFrameDelayVariation – FORWARD or NEAR_END [ns] (TCA not foreseen)
Maximum One-way IFDV	A 32-bit integer reflecting the maximum One-way IFDV measurement in microseconds.	Sink	TAPI OAM StatisticalDmPerformanceParameters maximumInterFrameDelayVariation– FORWARD or NEAR_END [ns] (MAXIMUM_INTER_FRAME_DELAY_VARIATION - FORWARD or NEAR_END)
One-way FDR counter per configured FDR Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of FDR measurements that fall within a configured bin.	Sink	NRM OAM CarrierEthOamMetrics2EndDelayResource fdr1Bin (BIN_FRAME_DELAY_RANGE – FORWARD)

Data	Description	MEP	ONF-TAPI / NRM-OAM
Mean One-way FDR	A 32-bit integer reflecting the average (arithmetic mean) One-way FDR measurement in microseconds.	Sink	NRM OAM CarrierEthOamMetrics2EndDelayResource fdr1Mean (TCA not foreseen)
Maximum One-way FDR	A 32-bit integer reflecting the maximum One-way FDR measurement in microseconds.	Sink	NRM OAM CarrierEthOamMetrics2EndDelayResource fdr1Max (MAXIMUM_FRAME_DELAY_RANGE – FORWARD)
Minimum One-way FD	A 32-bit integer reflecting the minimum One-way FD measurement in microseconds.	Sink	TAPI OAM StatisticalDmPerformanceParameters minimumFrameDelay - FORWARD or NEAR_END [ns] (TCA not foreseen)

Table 6 – MEF 35.1 Table 14 - Mandatory Dual-Ended Delay Data Set

Data	Description	MEP	ONF-TAPI / NRM-OAM
One-way FD counter per configured FD Measurement Bin	A 32-bit counter per Measurement Bin that counts the number of One-way FD measurements that fall within the configured bin.	Sink	NRM OAM CarrierEthOamMetrics2FdSynchResource fd1Bin (BIN_FRAME_DELAY – FORWARD)
Mean One-way FD	A 32-bit integer reflecting the average (arithmetic mean) One-way FD measurement in microseconds.	Sink	TAPI OAM StatisticalDmPerformanceParameters averageFrameDelay - FORWARD or NEAR_END [ns] (TCA not foreseen)
Maximum One-way FD	A 32-bit integer reflecting the maximum One-way FD measurement in microseconds.	Sink	TAPI OAM StatisticalDmPerformanceParameters maximumFrameDelay - FORWARD or NEAR_END [ns] (MAXIMUM_FRAME_DELAY - FORWARD or NEAR_END)

Table 7 – MEF 35.1 Table 15 - Mandatory Dual-Ended Delay Data Set with Clock Synchronization

C.4 Single-Ended Service Loss Data Set

Data	Description	ONF-TAPI / NRM-OAM
Start Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled start time of the Measurement Interval.	TAPI OAM CurrentData periodStartTime HistoryData periodStartTime
End Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled end time of the Measurement Interval.	TAPI OAM HistoryData periodEndTime
Measurement Interval elapsed time	A 32-bit counter of the number of seconds of the Measurement Interval as calculated by the NE. Note: this may differ from the difference between the start and end times if measurements started or stopped part way through the Measurement Interval, or if there was a shift in the time-of-day clock. Some of these conditions will result in the Suspect Flag being set.	TAPI OAM CurrentData elapsedTime HistoryData periodEndTime
SOAM PM Frames Sent	A 32-bit counter reflecting the number of SOAM PM Frames sent (i.e., LMM frames transmitted).	NRM OAM CarrierEthOamMetricsControllerCommonPacResource soamPmFramesTx (TCA not foreseen)
SOAM PM Frames Received	A 32-bit counter reflecting the number of SOAM PM Frames received (i.e., LMR frames received).	NRM OAM CarrierEthOamMetricsSinkCommonPacResource soamPmFramesRx (TCA not foreseen)
Tx frame count in the Forward direction	A 64-bit counter reflecting the number of frames transmitted in the Forward direction.	TAPI OAM TotalCountersLmPerformanceParameters totalTransmittedFrames - FORWARD or NEAR_END (TCA not foreseen)

Data	Description	ONF-TAPI / NRM-OAM
Rx frame count in the Forward direction	A 64-bit counter reflecting the number of frames received in the Forward direction.	NRM OAM CarrierEthOamMetrics1EndLossResource AllFramesFwRx (TCA not foreseen)
Tx frame count in the Backward direction	A 64-bit counter reflecting the number of frames transmitted in the Backward direction.	TAPI OAM TotalCountersLmPerformanceParameters totalTransmittedFrames - BACKWARD or FAR_END (TCA not foreseen)
Rx frame count in the Backward direction	A 64-bit counter reflecting the number of frames received in the Backward direction.	NRM OAM CarrierEthOamMetrics1EndLossResource AllFramesBkRx (TCA not foreseen)

Table 8 – MEF 35.1 Table 16 - Mandatory Single-Ended Service Loss Data Set

C.5 Dual-Ended Synthetic Loss Data Set

Data	Description	MEP	ONF-TAPI / NRM-OAM
Start Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled start time of the Measurement Interval.	Both	TAPI OAM CurrentData periodStartTime HistoryData periodStartTime
End Time-of-day timestamp	A 64-bit timestamp of the time-of-day in UTC at the scheduled end time of the Measurement Interval.	Both	TAPI OAM HistoryData periodEndTime
Measurement Interval elapsed time	A 32-bit counter of the number of seconds of the Measurement Interval as calculated by the NE. Note: this may differ from the difference between the start and end times if measurements started or stopped part way through the Measurement Interval, or if there was a shift in the time-of-day clock. Some of these conditions will result in the Suspect Flag being set.	Both	TAPI OAM CurrentData elapsedTime HistoryData periodEndTime
Tx frame count	A 32-bit counter reflecting the number of 1SL frames transmitted.	Controller	NRM OAM CarrierEthOamMetricsControllerCommonPacResource {when *augments* EthProActive1LmSourcePerformanceData/ EthOnDemand1LmSourcePerformanceData} soamPmFramesTx (TCA not foreseen)

Data	Description	MEP	ONF-TAPI / NRM-OAM
Rx frame count	A 32-bit counter reflecting the number of 1SL frames received.	Sink	NRM OAM CarrierEthOamMetricsSinkCommonPacResource soamPmFramesRx (TCA not foreseen)
Count of Δt intervals evaluated as Available	A 32-bit counter reflecting the number of Δt intervals evaluated as Available (i.e., for which $A_{<Controller, Sink>}(\Delta t) = 1$).	Sink	NRM OAM CarrierEthOamMetrics2EndSynthLossResource availableIntervals (TCA not foreseen)
Count of Δt intervals evaluated as Unavailable	A 32-bit counter reflecting the number of Δt intervals evaluated as Unavailable (i.e., for which $A_{<Controller, Sink>}(\Delta t) = 0$).	Sink	TAPI OAM StatisticalLmPerformanceParameters unavailableIntervals - FORWARD or NEAR_END (TCA not foreseen)
Count of HLIs	Count of HLIs during the Measurement Interval.	Sink	TAPI OAM StatisticalLmPerformanceParameters hliCount - FORWARD or NEAR_END (HIGH_LOSS_INTERVALS - FORWARD or NEAR_END)
Count of CHLIs	Count of CHLIs during the Measurement Interval.	Sink	NRM OAM CarrierEthOamMetrics2EndSynthLossResource chliCount (CONSECUTIVE_HIGH_LOSS_INTERVALS – FORWARD)

Table 9 – MEF 35.1 Table 18 - Mandatory Dual-Ended Synthetic Loss Data Set

Data	Description	MEP	NRM-OAM
Minimum One-way Availability flr	The minimum One-way Availability flr measurement during this Measurement Interval.	Sink	TAPI OAM StatisticalLmPerformanceParameters minimumFrameLossRatio - FORWARD or NEAR_END (TCA not foreseen)
Maximum One-way Availability flr	The maximum One-way Availability flr measurement during this Measurement Interval.	Sink	TAPI OAM StatisticalLmPerformanceParameters maximumFrameLossRatio - FORWARD or NEAR_END (TCA not foreseen)
Mean One-way Availability flr	The average (arithmetic mean) One-way Availability flr measurement during this Measurement Interval.	Sink	TAPI OAM StatisticalLmPerformanceParameters averageFrameLossRatio - FORWARD or NEAR_END (TCA not foreseen)

Table 10 – MEF 35.1 Table 19 - Optional Dual-Ended Synthetic Loss Data Set

Appendix D FM Metrics detailed mapping with MEF 30.1 (Informative)

D.1 Linktrace

From MEF 30.1:

The following requirements define the Linktrace information that is to be maintained.

- ***[R47]*** *An initiating MEP MUST be able to report the number of LTMs transmitted and the number of LTRs received.*

- ***[D65]*** *A responding MP SHOULD be able to report the number of LTMs received and the number of LTRs transmitted.*

Agreed that these metrics are not relevant at network level management / PRESTO IRP, because there will be just one LTM message trasmitted at Job creation time, and few LTRs received as result.

D.2 Loopback

From MEF 30.1:

The following requirements define the Loopback information that is to be maintained for each LB session that is sent to a Unicast address.

- ***[R44]*** *For an LB Session, the initiating MEP **MUST** be able to report the number of LBMs transmitted and the number of LBRs received.*
- ***[D59]*** *A responding MP **SHOULD** be able to report the aggregate number of LBMs received and the aggregate number of LBRs transmitted during a time period.*

Agreed that these metrics are not relevant at network level management / PRESTO IRP, because more related to detailed / singleton equipment management.

Supported metrics:

- ***[D57]*** *For an LB Session, the initiating MEP **SHOULD** be able to report the percentage of responses lost (timed out).*

    - NRM OAM, CarrierEthOamMetricsLoopbackResource, percentageOfLostResponses.

- ***[D58]*** *For an LB session, the round trip time (RTT) min/max/average statistics **SHOULD** be supported by the initiating MEP.*

    - NRM OAM, CarrierEthOamMetricsLoopbackResource, roundTripTimeMin, roundTripTimeMax, roundTripTimeAverage.

Appendix E PM Collection Scenarios (Informative)

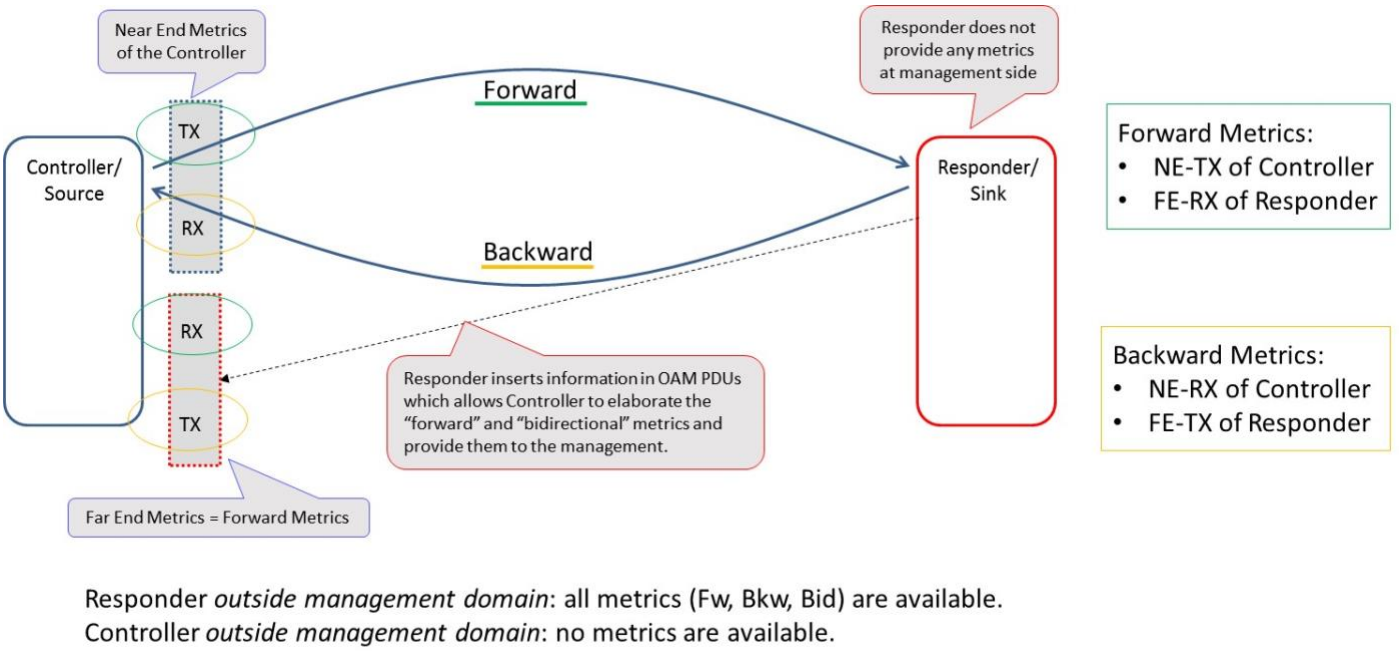


Figure 38 – Single Ended Measurement: Forward/Backward, Near/Far End

In case of Single Ended Mesurements, the Responder MEP may be located outside the managed domain where PM Measurement Job is managed, because there is neither need of provisioning nor PM Metrics collection on Responder MEP.

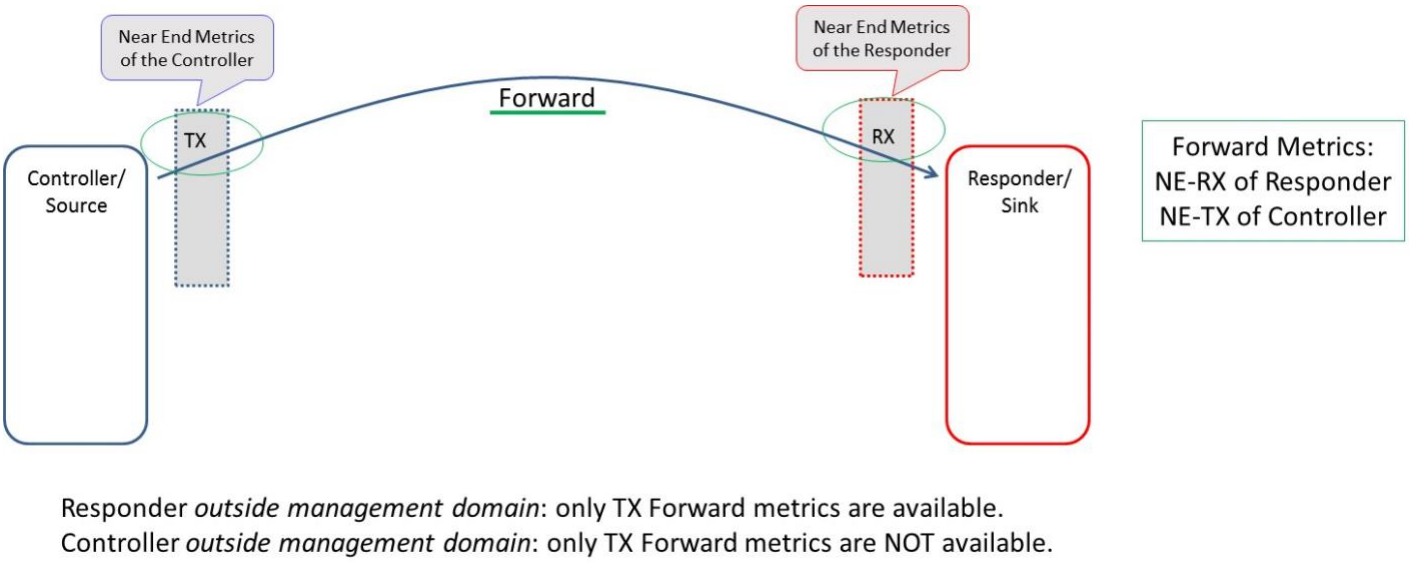


Figure 39 – Dual Ended Measurement: Forward / Near End

Note that in Dual ended measurement, "Forward" is "Near End" on Responder MEP.

In case of Dual Ended Mesurements there could be two possible PM Measurement Job provisioning scenarios:

- Both Controller/Source and Responder/Sink MEPs are located in the same management domain: only one PM Job is provisioned, the Agent shall distribute provisioning to proper devices.
- Controller/Source and Responder/Sink MEPs are located in distinct management domains:
    - Two PM Jobs shall be provisioned, each one addressing the proper MEP.
    - Two PM Data collections will be performed, with partial/side view of metrics.

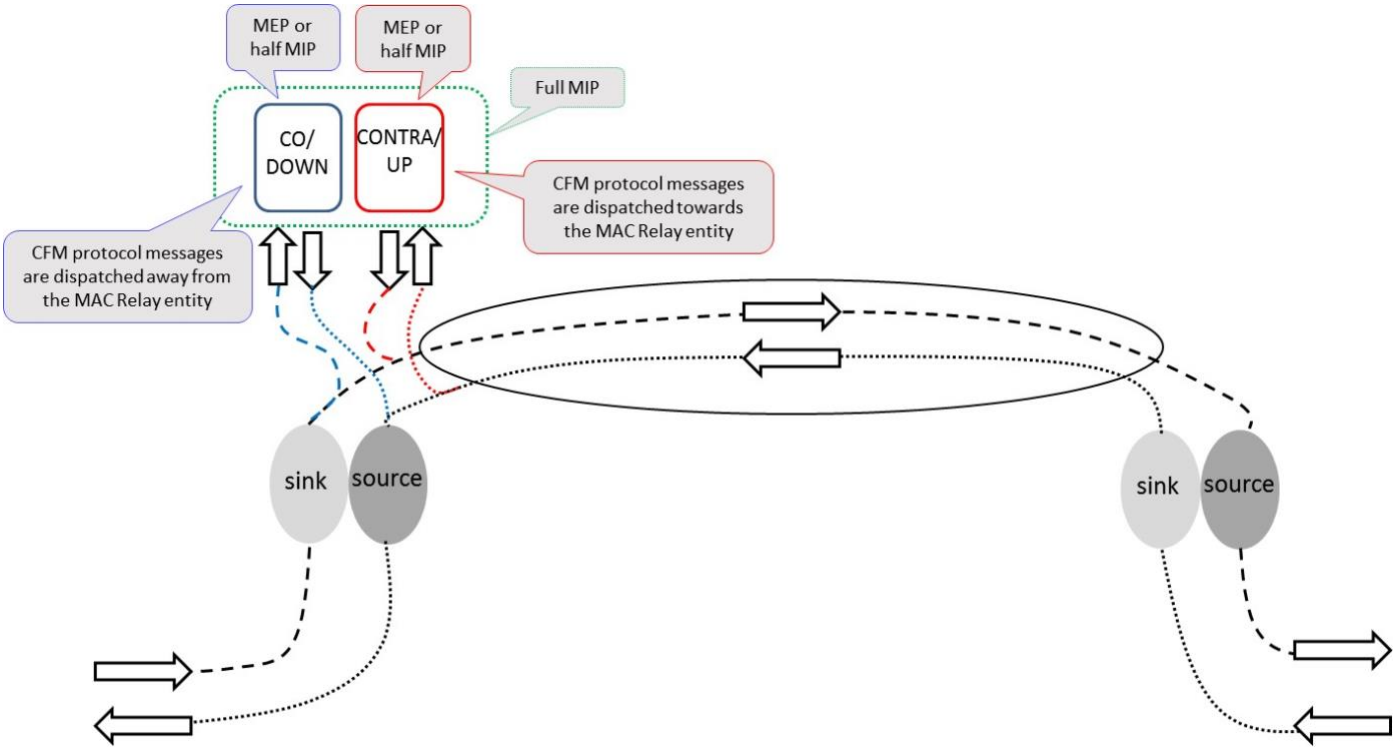


Figure 40 – Down/Up Codirectional/Contradirectional Measurement