MEF Standard

MEF 72.1

Resource Model - Subscriber & Operator Layer 1

January 2021

Disclaimer

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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.

- Fujitsu Network Communications
- Nokia
- TATA Communications

2 Abstract

This Standard describes the MEF Resource Model (MRM), specifically for Layer 1 Connectivity related management features.

This Standard supersedes and replaces MEF 72 (Network Resource Model - Subscriber Layer 1 [10]).

Lifecycle Service Orchestration Reference Architecture (LSO RA, MEF 55 [6]) 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.

Ethernet Connectivity Information Model (MEF 59 [7]), Subscriber Layer 1 Information Model (MEF 72 [10]) and Ethernet OAM Information Model (MEF 83 [11]) 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 [7] the management features related to Layer 1 Connectivity, as defined by

- *Subscriber Layer 1 Service Attributes Technical Specification* (MEF 63 [8]), and
- *Operator Layer 1 Service Attributes and Services* (MEF 64 [9]).

This model can be used as the basis for LSO RA PRESTO Interface Profiles defining APIs for the Layer 1 management.

The MRM structure is based on current and developing best network management solutions by ITU-T, ONF and 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 [3], ONF TR-512 [14], ONF TR-527 [15], TM Forum MTNM [19] and MTOSI [20].

This document normatively includes the content of the following Papyrus [17] and UML files as if they were contained within this document (pull request **#57**, commit **c814697,** GitHub Repository [13], [12]):

- NRM_L1.di / .notation / .uml
- MEF_Types.di / .notation / .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 4 [4], MEF 7.3 [5], MEF 55 [6], TMF GB922 [18] 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
Connection	A *Connection* represents an enabled (provisioned) potential for forwarding (including all circuit/packet forms) between two or more *Node Edge Points* of a *Node*. The bounding *Node* of a *Connection* may be explicit or be conceptually implicit. *Connection* is a container for provisioned connectivity that tracks the state of the allocated resources and is distinct from the *Connectivity Service* request.	ONF TR-527 [15]
CEP	*Connection End Point*	ONF TR-527 [15]
Connection End Point	The *Connection End Point* encapsulates information related to a *Connection* at the ingress/egress points of every *Node* that the *Connection* traverses in a *Topology*. Thus they represent the ingress/egress port functions (including termination, encapsulation, processing, mapping, etc) of the *Connection*.	ONF TR-527 [15]
Connectivity Service	A *Connectivity Service* represents an “intent-like” request for connectivity between two or more *Service Interface Points*. *Connectivity Service* is a container for connectivity request details and is distinct from *Connection* that realizes the request.	ONF TR-527 [15]
Connectivity Service End Point	The *Connectivity Service End Point* encapsulates information related to a *Connectivity Service* at the ingress/egress points of that *Connectivity Service.*	ONF TR-527 [15]
Context	The *Context* provides a scope of control, naming and information exchange between particular instances of SOF & ICM.	ONF TR-527 [15]
CS	*Connectivity Service*	ONF TR-527 [15]
CSEP	*Connectivity Service End Point*	ONF TR-527 [15]
DSR	Digital Signal Rate	This Standard

Term	Definition	Reference
Digital Signal Rate	Generic term indicating Layer 1 coding functions. Examples are 10GBASE-W, 100GBASE-R, FC-400, FC-800, STM-16, OC-192, etc. as defined by MEF 63 [8].	This Standard
ICM	Infrastructure Control and Management	MEF 55 [6]
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 [6]
INNI	Internal Network-to-Network Interface	MEF 4 [1] MEF 55 [6]
Internal Network-to-Network Interface	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 [6]
Link	A *Link* is an abstract representation of the effective adjacency between two or more *Nodes* (specifically *Node Edge Points*) in a *Topology*.	ONF TR-527 [15]
LSO	Lifecycle Service Orchestration	MEF 55 [6]
LSO RA	Lifecycle Service Orchestration Reference Architecture	MEF 55 [6]
Lifecycle Service Orchestration	Open and interoperable automation of management operations over the entire lifecycle of MEF Connectivity Services[1]. This includes fulfillment, control, performance, assurance, usage, security, analytics and policy capabilities, over all the network domains that require coordinated management and control in order to deliver the service.	MEF 55 [6]
Lifecycle Service Orchestration Reference Architecture	A layered abstraction architecture that characterizes the management and control domains and entities, and the interfaces among them, to enable cooperative orchestration of Connectivity Services.	MEF 55 [6]
MRM	MEF Resource Model	This Standard
NEP	*Node Edge Point*	ONF TR-527 [15]
Node	The *Node* is an abstract representation of the forwarding capabilities of a particular set of Network Resources. It is described in terms of the aggregation of a set of ports (*Node Edge Point*) belonging to those Network Resources and the potential to enable forwarding of information between those edge ports.	ONF TR-527 [15]

[1] There is an expectation that MEF 55 definition of Connectivity Services will be generalized beyond L2 and L3.

Term	Definition	Reference
Node Edge Point	The *Node Edge Point* represents the ingress-egress edge-port functions that access the forwarding capabilities provided by the *Node*. Hence it provides an encapsulation of addressing, mapping, termination, adaptation and OAM functions of one or more transport layers (including circuit and packet forms) performed at the entry and exit points of the *Node*.	ONF TR-527 [15]
Product Instance	Specific implementation of a Product Offering dedicated to the benefit of a party.	TMF GB922 [18]
Product Offering	An externally facing representation of a Service and/or Resource procurable by the Customer.	TMF GB922 [18]
Product Specification	The detailed description of product characteristics and behavior used in the definition of Product Offerings.	TMF GB922 [18]
Resource	A physical or non-physical component (or some combination of these) within a Service Provider's infrastructure or inventory.	TMF GB922 [18]
Service	Represents the Customer experience of a Product Instance that has been realized within the Service Provider's and / or Partners' infrastructure.	TMF GB922 [18]
Service Component	A segment or element of a Service that is managed independently by the Service Provider.	MEF 55 [6]
Service Interface Point	A *Service Interface Point* represents the network-interface-facing aspects of the edge-port functions that access the forwarding capabilities provided by the *Node*. Hence it provides a limited, simplified view of interest to external clients (e.g. shared addressing, capacity, re-source availability, etc.), that enable the clients to request connectivity without the need to understand the provider network internals.	ONF TR-527 [15]
Service Orchestration Functionality	The set of service management layer functionality supporting an agile framework to streamline and automate the service lifecycle in a sustainable fashion for coordinated management supporting design, fulfillment, control, testing, problem management, quality management, usage measurements, security management, analytics, and policy-based management capabilities providing coordinated end-to-end management and control of MEF Connectivity Services[1].	MEF 55 [6]
SIP	*Service Interface Point*	ONF TR-527 [15]
SOF	Service Orchestration Functionality	MEF 55 [6]

Term	Definition	Reference
TAPI or T-API	Transport API Information Model	ONF TR-527 [15] ONF TAPI IM [16]
Topology	The *Topology* is an abstract representation of the topological aspects of a particular set of Network Resources. It is described in terms of the underlying topological network of *Nodes* and *Links* that enable the forwarding capabilities of that particular set of Network Resources.	ONF TR-527 [15]
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 [1], RFC 8174 [2]) 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 Numerical Prefix Conventions

This document uses the prefix notation to indicate multiplier values as shown in Table 2.

Decimal		Binary	
Symbol	**Value**	**Symbol**	**Value**
k	10^3	Ki	2^{10}
M	10^6	Mi	2^{20}
G	10^9	Gi	2^{30}
T	10^{12}	Ti	2^{40}
P	10^{15}	Pi	2^{50}
E	10^{18}	Ei	2^{60}
Z	10^{21}	Zi	2^{70}
Y	10^{24}	Yi	2^{80}

Table 2 – Numerical Prefix Conventions

6 Introduction

The scope of this Standard is a protocol neutral definition of the information, i.e., the attributes (or properties), of the network resource management objects modeling the Layer 1 Connectivity features according to the requirements defined by MEF 63 [8] and MEF 64 [9].

Similarly to MEF 59 [7] and MEF 83 [11], the MRM for L1 reuses and extends the definitions of the ONF Transport API Information Model (TAPI IM [15], [16]), which is derived from the ONF Core Information Model ([14]).

The ONF Core IM is a common information model for network/transport technologies which:

- Defines a consistent set of fundamental concepts and the relationship among them, leveraging years of management standards evolution in TMF and ITU-T. These concepts are capable of representing both legacy management and SDN/NFV concepts/scenarios, while allowing for consistent management in hybrid environments.
- Is comprised of a stable core model (which is itself modular for scalability) and technology-specific model extensions that can be added in a timely manner without destabilizing the core.
- Forms part of a tooling chain, enabling context and technology specific interfaces (like TAPI) in different languages to be generated from a key set of definitions.

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.

Similarly to the ONF Core IM, the TAPI model is structured into a technology agnostic core and a number of technology specific augmentations, see Figure 1.

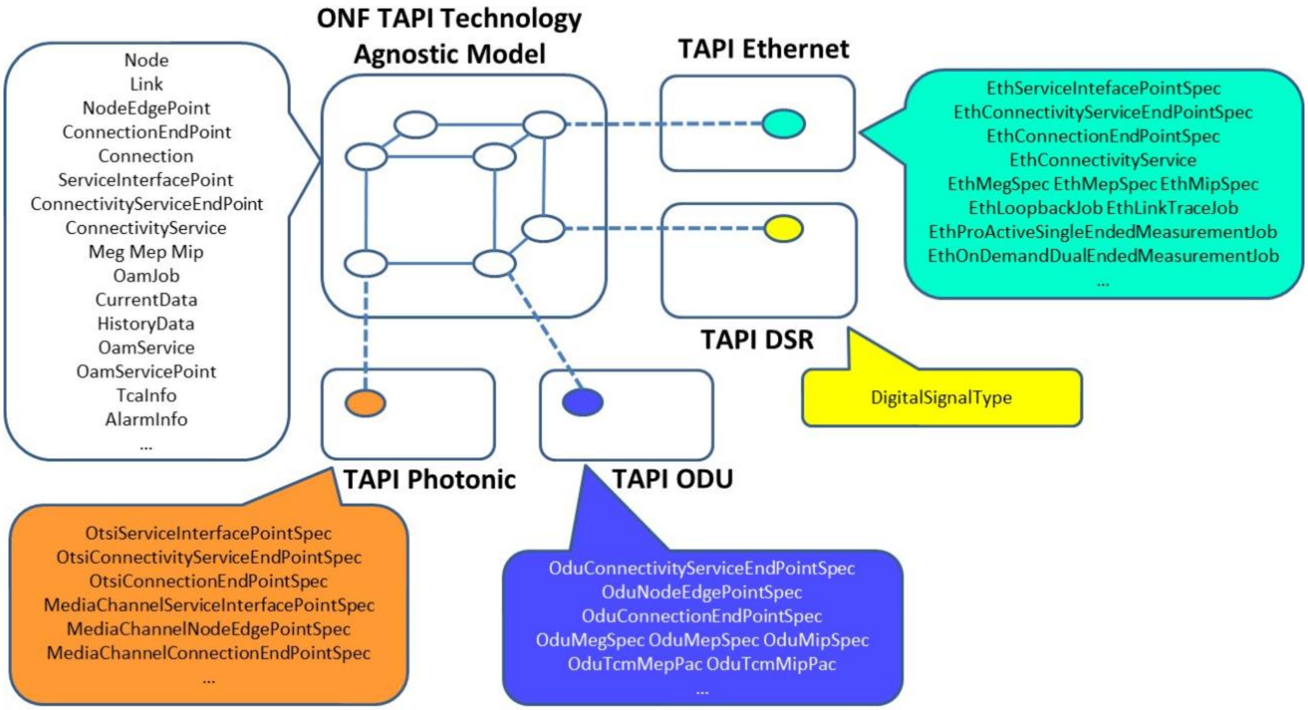

Figure 1 – Federation of technology agnostic and technology specific models

The model capabilities are extended through the augmentation approach. The essential concept of augmentation is to enable an instance of a base class to be extended with a set of attributes that characterize the specific case of augmenting class.

Augmentation does not require that base class is aware of the extensions, which allows for easy incorporation of newer technology or a vendor specific feature. Thus, an implementation (if desired) can be developed against just the base/standard model (schema) and ignore the augmentations (e.g., vendor specific augmentations).

In this way, the augmentation approach is flexible and does not lead to a proliferation of specialized classes (which are difficult to maintain) and does not lock children to all modifications of parents. In other words, augmentation allows for a flexible federated relationship between models.

Figure 2 depicts the federation of ONF and MEF information models. The TAPI technology agnostic model is augmented by TAPI and MEF technology specific models.

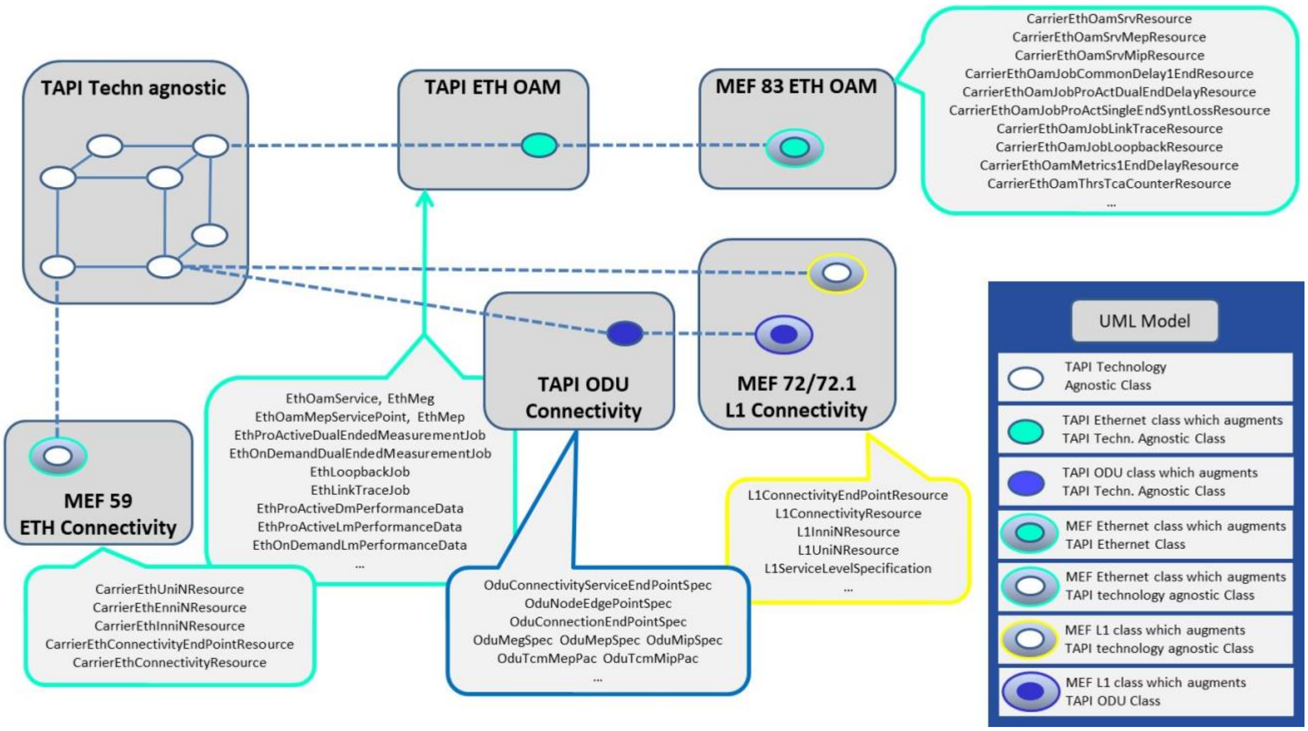

Figure 2 – MEF MRM extending ONF TAPI

Figure 2 shows that MEF 83 augments TAPI Ethernet specific model, while MEF 59 does not. This asymmetry is mainly due to the ONF TAPI different state-of-art at the time of MEF 59 development. MEF 83 has leveraged a more mature TAPI Ethernet model, and conversely the review process of MEF 83 included comments on TAPI OAM/Ethernet model, which was then accordingly enhanced in ONF, eventually allowing MEF approved and consistent reuse.

Figure 3 shows the imports from MEF General Common Model. A model is imported to reuse its definitions, e.g., the *L1UniPhysicalLayer* data type is used by the *l1UniPhysicalLayer* attribute of *L1UniNResource* class defined in this document, the *CosIdentifier* class is referenced by *CarrierEthConnectivityEndPointResource* class of MEF 59, etc.

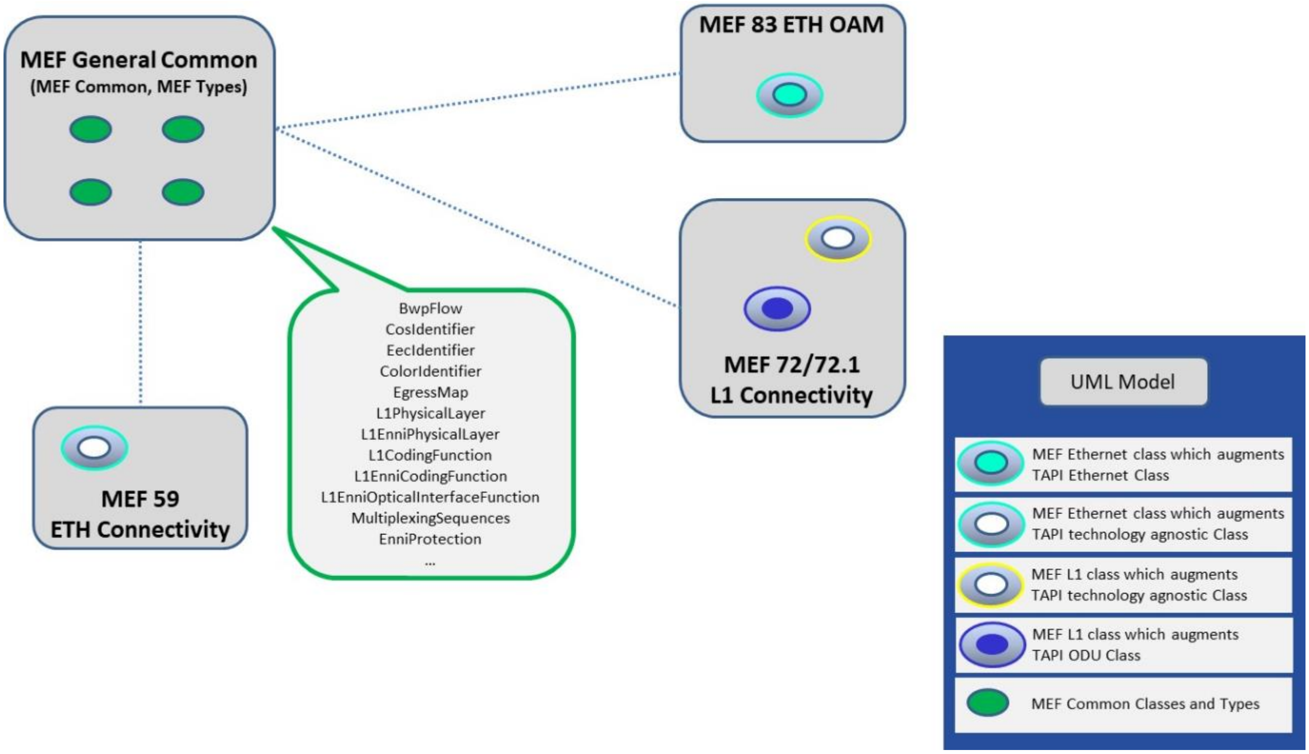

Figure 3 – MEF MRM importing MEF General Common Model

The MEF Resource Model is applicable to the PRESTO Interface Reference Point (MEF 55 [6]), see Figure 4.

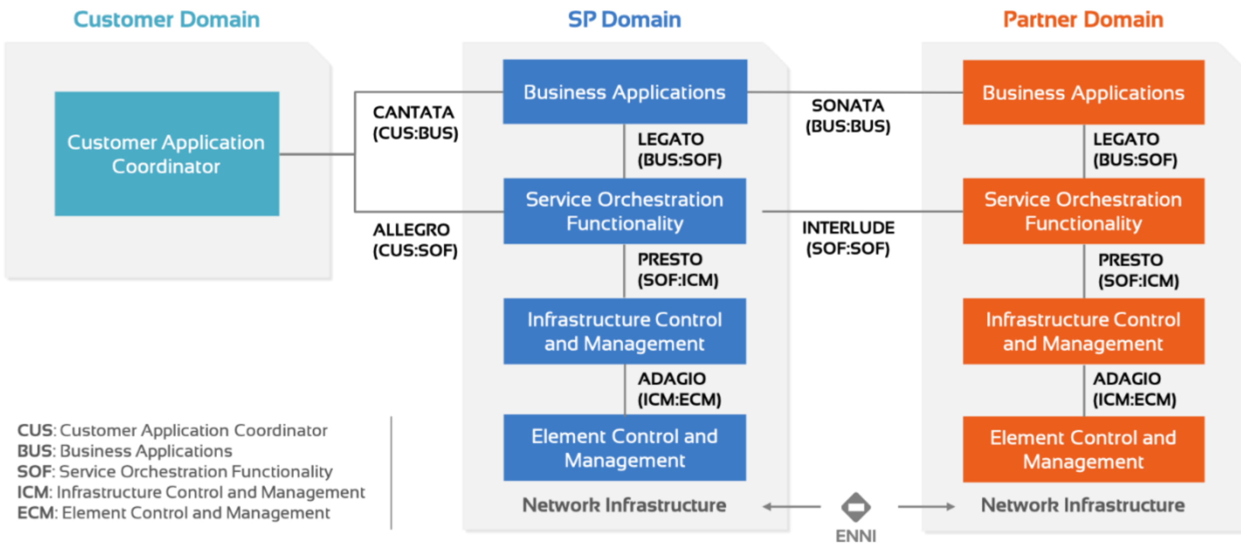

Figure 4 – MEF MRM positioning in LSO RA

The following sections of this document include:

- The overview of MRM IM Layer 1 classes (7)
- The data types and enumerations imported from MEF General Common model (8)
- The data types and enumerations imported from ONF TAPI Common model (9)
- The object classes imported from ONF TAPI ODU model (10)
- The ONF TAPI ODU enumerations used by TAPI ODU model (11)
- The Subscriber and Operator L1 Connectivity Resource model (12)
- The Layer 1 Service Level Specification (SLS) model (13)
- References (14)
- Appendix A lists the relevant network scenarios
- Appendix B shows some examples of ENNI Handoff Types

7 Network Resource Information Model Overview

This chapter shows the key examples of class instances and their augmentations.

Figure 5 shows the L1 *ConnectivityService* from UNI to UNI (Subscriber L1 Service). There is a *ConnectivityService* instance, which is ended by two *ConnectivityServiceEndPoint* instances, which are augmented by MEF specific *L1ConnectivityEndPointResource* classes.

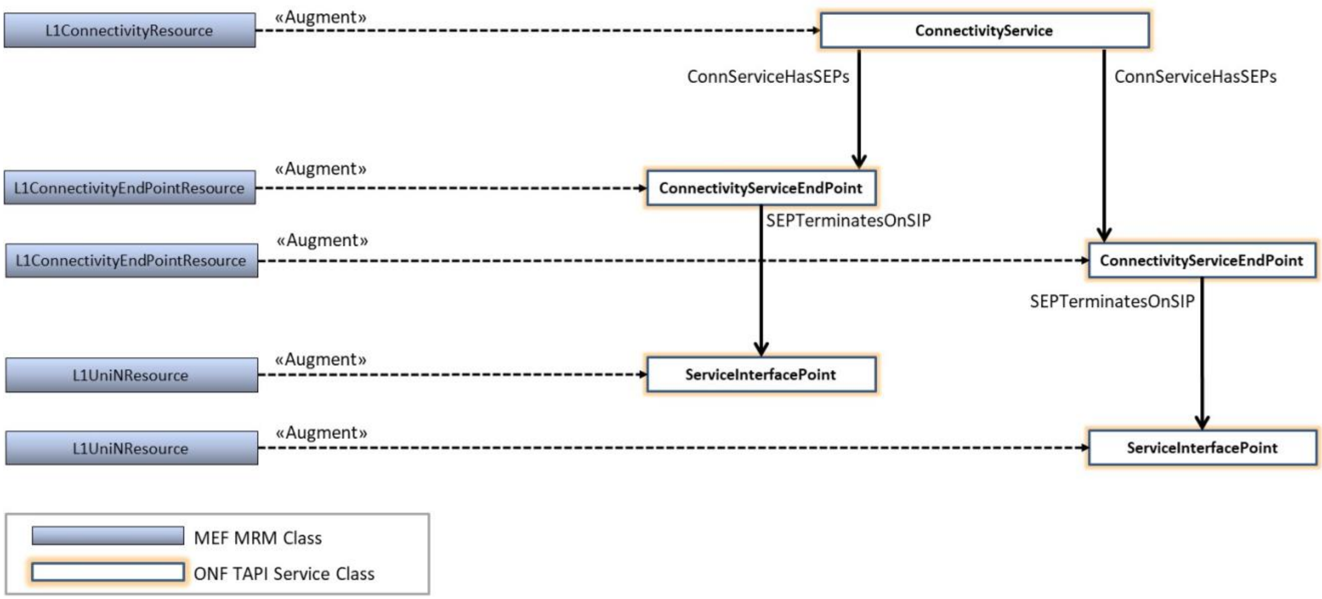

Figure 5 – Relationships with ONF TAPI: UNI to UNI

Figure 6 shows the L1 *ConnectivityService* from ENNI to ENNI (Operator L1 Transit Service). There is a *ConnectivityService* instance, which is ended by two *ConnectivityServiceEndPoint* instances, which are augmented by TAPI ODU specific *OduConnectivityServiceEndPointSpec* classes, which are further augmented by MEF specific *L1ConnectivityEndPointResource* classes.

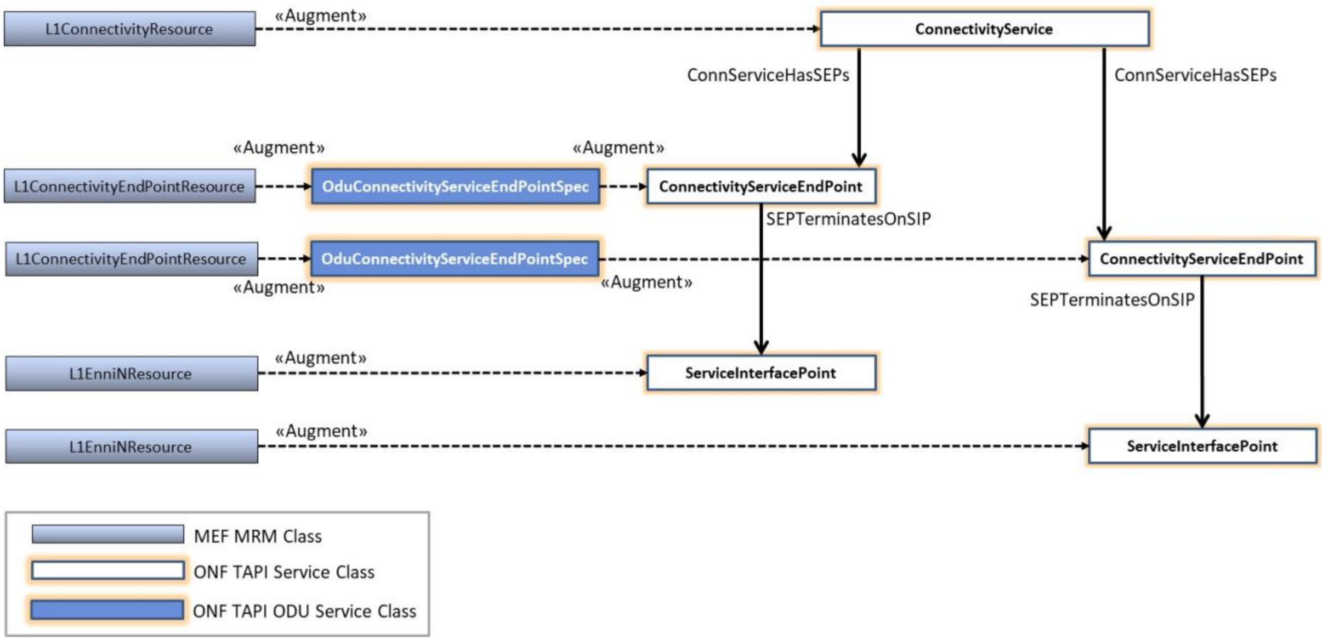

Figure 6 – Relationships with ONF TAPI: ENNI to ENNI

Figure 7 shows the L1 *ConnectivityService* from UNI to ENNI (Operator L1 Access Service). There is a *ConnectivityService* instance, which is ended by two[2] L1 *ConnectivityServiceEndPoint* instances:

- On UNI and ENNI side the *ConnectivityServiceEndPoint* instance is augmented by MEF specific *L1ConnectivityEndPointResource* class.
- On ENNI side the *ConnectivityServiceEndPoint* instance has a server *ConnectivityServiceEndPoint* instance, to represent the ODU provisioning parameters. Hence this server *ConnectivityServiceEndPoint* is augmented by TAPI ODU *OduConnectivityServiceEndPointSpec*.

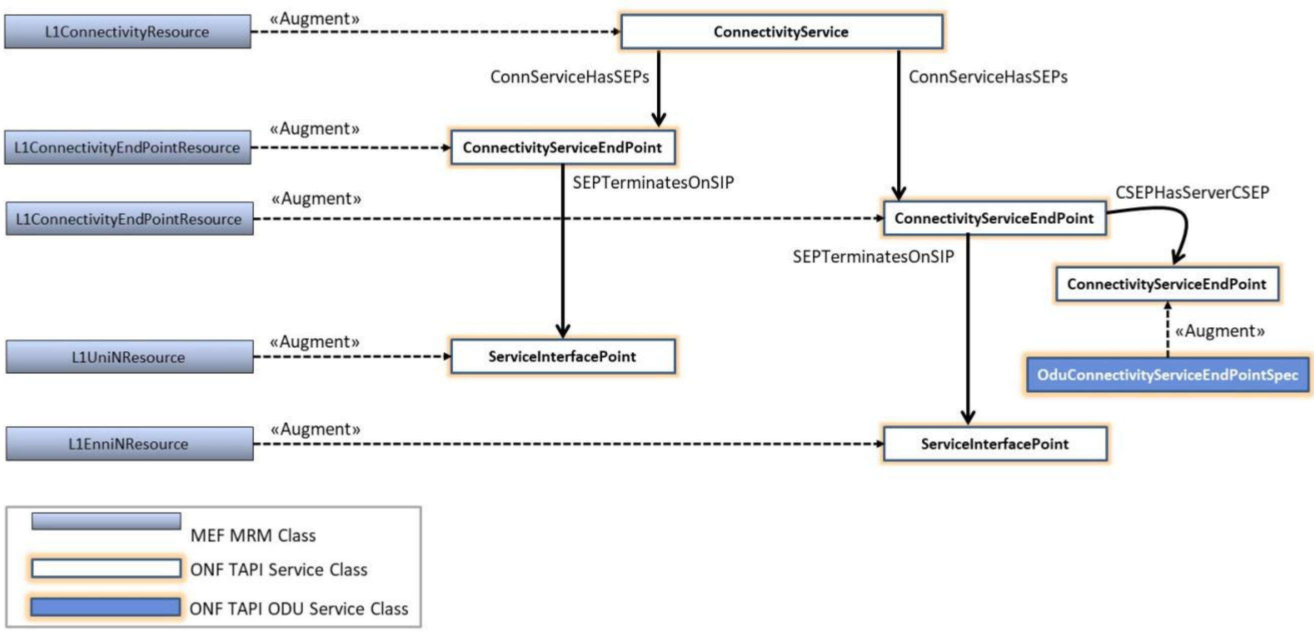

Figure 7 – Relationships with ONF TAPI: UNI to ENNI

Note that while INNI is not in the scope of MEF 63 and MEF 64, it is relevant for Resource network management when a Service Provider or an Operator is managing separate domains (e.g., vendor specific), see Figure 21 and Figure 22.

Figure 8 shows the L1 *ConnectivityService* from INNI to INNI (Operator L1 Internal Transit Service). Classes are structured similarly to ENNI to ENNI case, Figure 6.

[2] There can be more than two L1 *ConnectivityServiceEndPoint* instances in case of ENNI/INNI protection scheme.

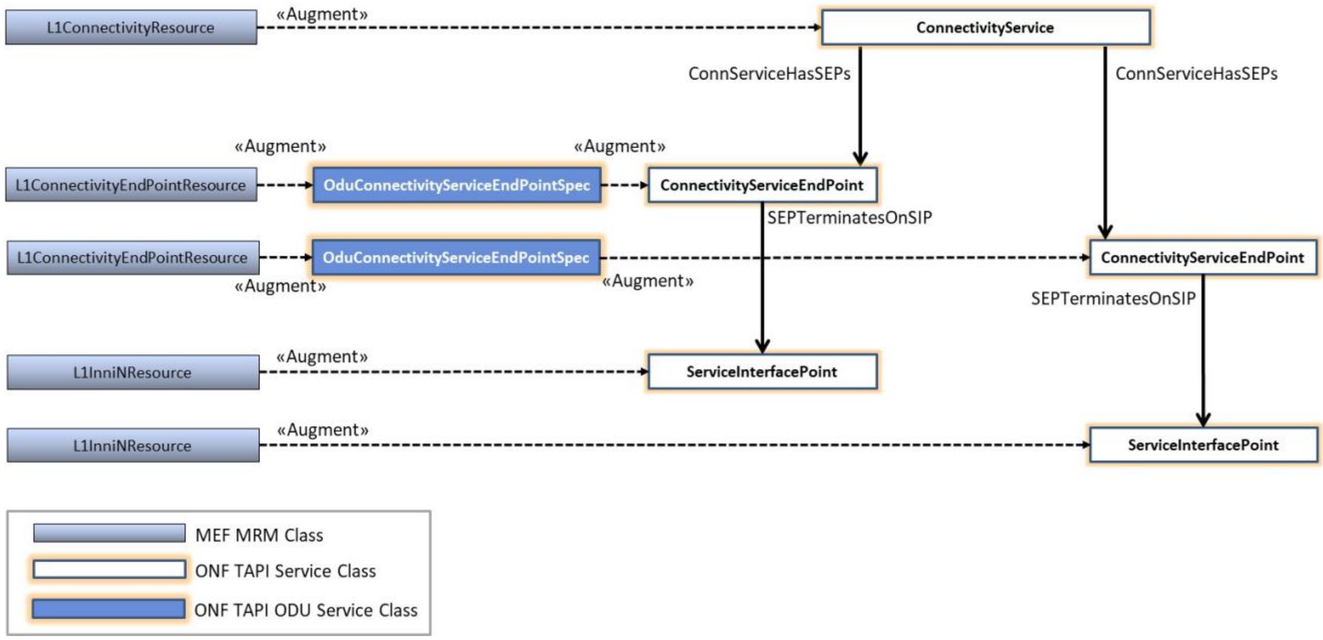

Figure 8 – Relationships with ONF TAPI: INNI to INNI

Figure 9 shows the L1 *ConnectivityService* from UNI to INNI (Operator L1 Internal Access Service). Classes are structured similarly to UNI to ENNI case, Figure 7.

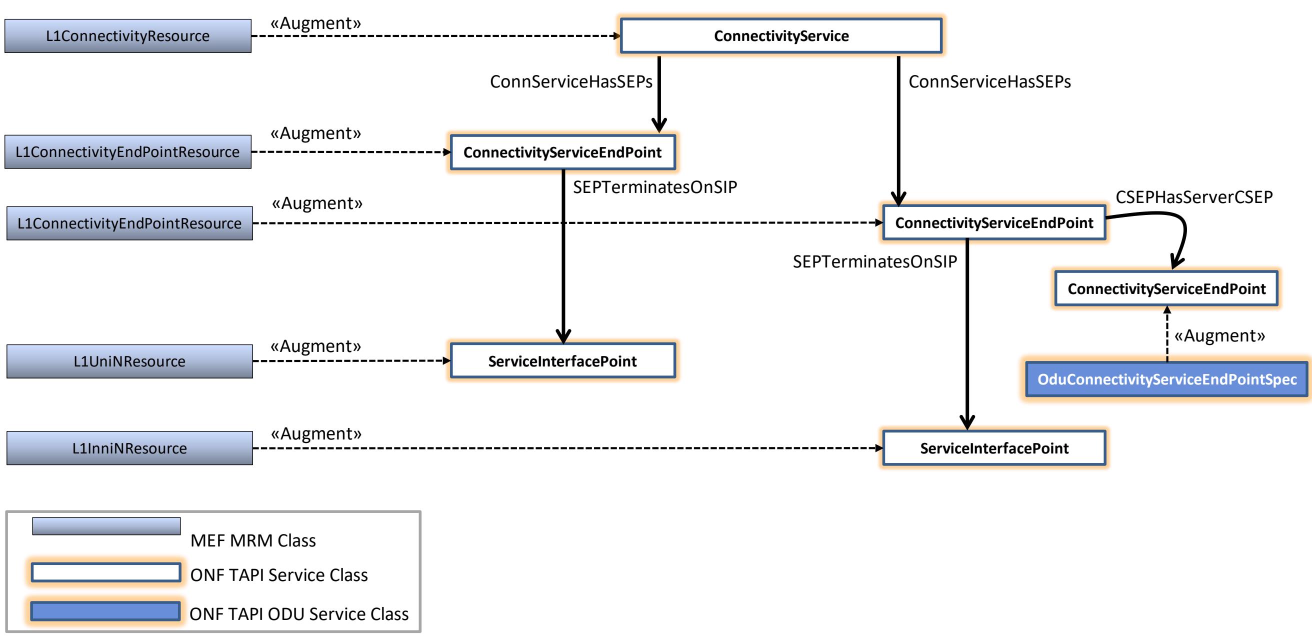

Figure 9 – Relationships with ONF TAPI: UNI to INNI

Figure 10 shows the L1 *ConnectivityService* from ENNI to INNI (Operator L1 Internal Access Service). Classes are structured similarly to ENNI to ENNI case, Figure 6.

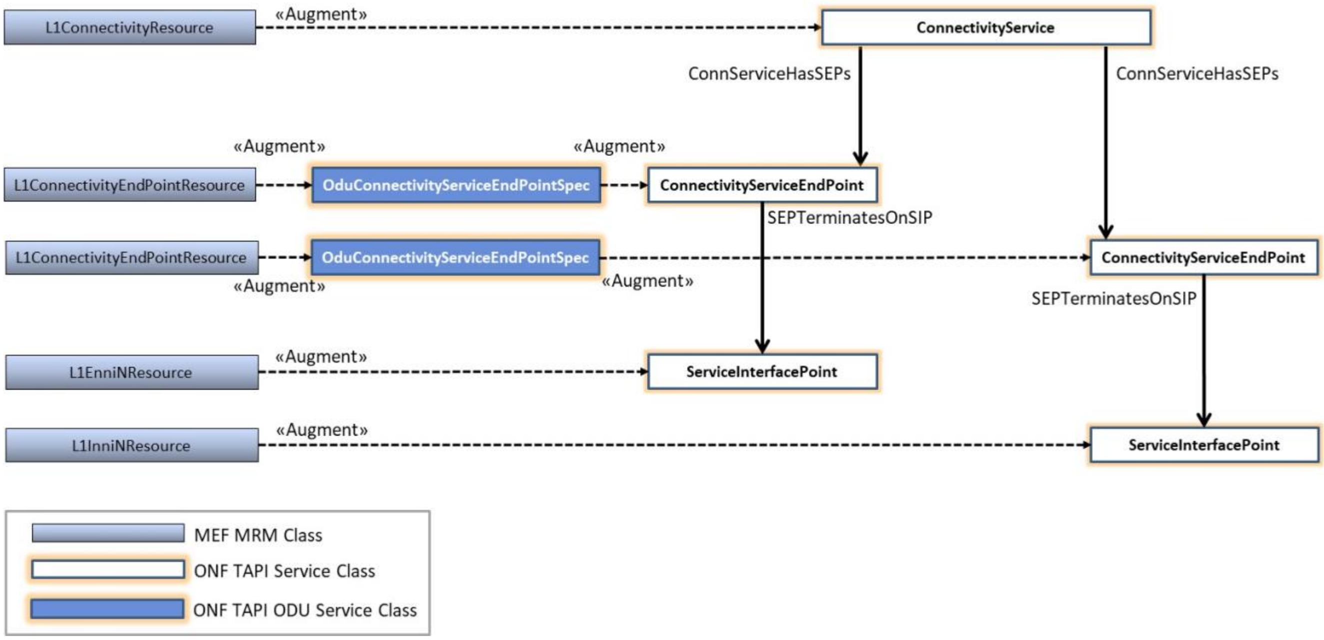

Figure 10 – Relationships with ONF TAPI: ENNI to INNI

Each *ConnectivityServiceEndPoint* instance is supported by one *ServiceInterfacePoint* instance, which is augmented either by the MEF specific *L1UniNResource* or by the *L1EnniNResource* or by the *L1InniNResource* classes.

The MEF specific L1 classes are described below:

- The *L1ConnectivityResource* represents at resource level either the
  - Subscriber Layer 1 UNI to UNI connectivity, or the
  - Operator Layer 1 UNI to ENNI or ENNI to ENNI connectivity.

  The *L1ConnectivityResource* could also represent the
  - Operator Layer 1 UNI to INNI connectivity, or the
  - Operator Layer 1 ENNI to INNI connectivity, or optionally the
  - Operator Layer 1 INNI to INNI connectivity.

  The *L1ConnectivityResource* augments the TAPI *ConnectivityService* class, which represents the request for connectivity between two or more TAPI *ConnectivityServiceEndPoint*. More detailed connection and routing information are modeled by different constructs of TAPI.

- The *L1ConnectivityEndPointResource* class models the service end point. It may optionally augment the TAPI *OduConnectivityServiceEndPointSpec*, which augments the *ConnectivityServiceEndPoint*.

The relationship between *L1ConnectivityResource* and its two (or more[3]) *L1ConnectivityEndPointResource* is modeled through the relationship between *ConnectivityService* and *ConnectivityServiceEndPoint* of TAPI model.

- The *L1UniNResource* class represents the UNI-N management functions related to the layer 1, including the additional information which is Operator specific. The physical layer at UNIs is optical. The *L1UniNResource* augments the TAPI *ServiceInterfacePoint*.

- The *L1EnniNResource* class represents the ENNI-N management functions related to the layer 1. The physical layer at ENNIs is optical. The *L1EnniNResource* augments the TAPI *ServiceInterfacePoint*.

- The *L1InniNResource* class represents the INNI-N management functions related to the layer 1. The physical layer considered in this Standard[4] at INNIs is optical. The *L1InniNResource* augments the TAPI *ServiceInterfacePoint*.

  The relationship between *L1ConnectivityEndPointResource* and its *L1UniNResource*[5] or its *L1EnniNResource or L1InniNResource* is modeled through the relationship between *ConnectivityServiceEndPoint* and *ServiceInterfacePoint* of TAPI model.

Some notes on model and diagrams:

- At a resource management level, from a strict technical viewpoint the UNI / ENNI / INNI distinction could be ignored. In fact, assuming that the Controller knows the UNI / ENNI / INNI administrative roles of the managed physical interfaces, it can then provision the interfaces accordingly. Nevertheless it was recognized that the distinction is useful also at a resource level for clarity and general consistency across all LSO RA Interface Reference Points.
- MEF 64 only prescribes protection at ENNI. This implies that the provisioning of protection within a PRESTO management domain is not in the scope of this Standard.
- Some of the UML diagrams are very dense. To view them either zoom (sometimes to 400%) or open the corresponding UML diagram via Papyrus [17] (for each figure with a UML diagram the UML model diagram name is provided under the figure in italic font).

[3] A L1 Service has only point-to-point topology, but in case of protection scheme at ENNI/INNI there can be more end points.
[4] INNI is not in the scope of MEF 63 and MEF 64.
[5] A UNI can support at most one instance of a Subscriber L1 Service, while an ENNI/INNI can support more than one instance of an Operator L1 Service.

8 MEF General Common Model: Data Types and Enumerations

This section details the data types and enumerations imported from MEF General Common Model / MEF-Types [12] that are used by the L1 Connectivity Resource model.

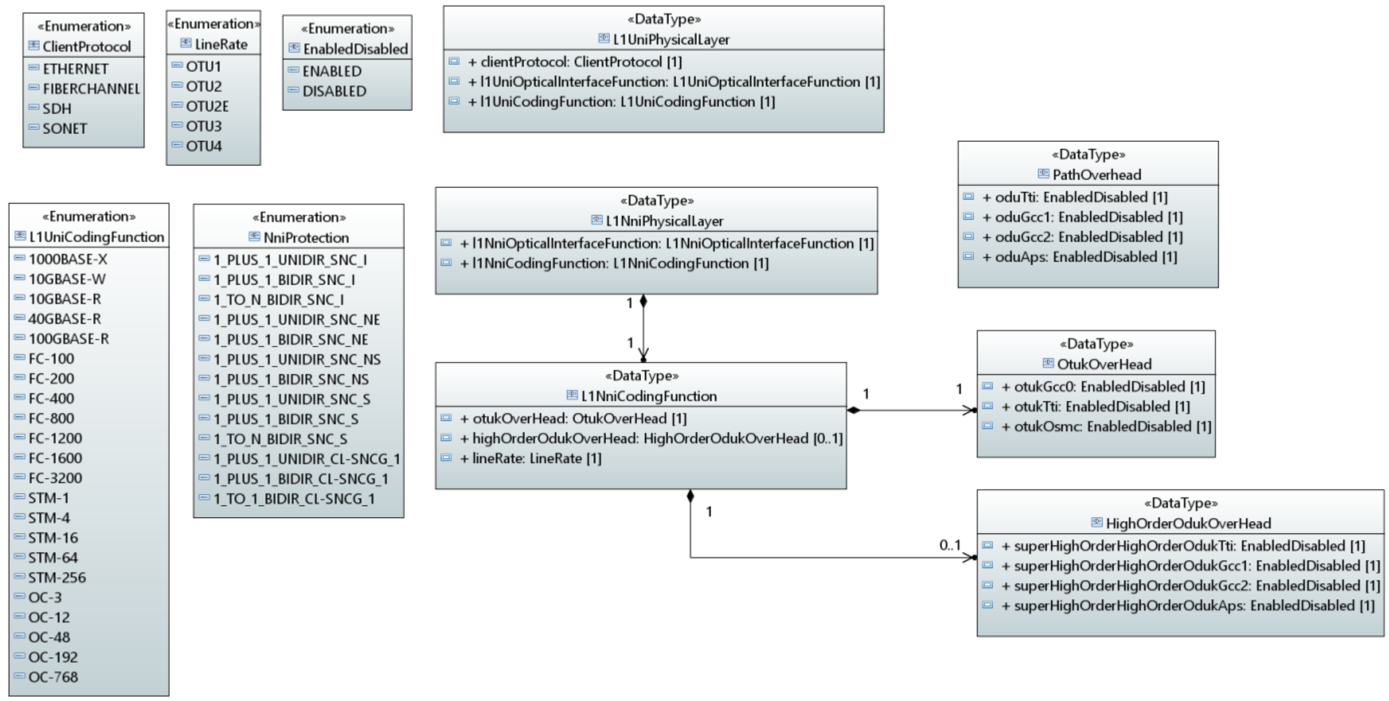

Figure 11 – *L1Service_DataTypes* Diagram

8.1 ClientProtocol

MEF 63: Enumeration representing Client Protocol of L1 Physical Layer.

Contains Enumeration Literals:

- ETHERNET:
  - Representing Ethernet is used as client protocol for UNI.
- FIBERCHANNEL:
  - Representing Fiber Channel is used as client protocol for UNI.
- SDH:
  - Representing Synchronous Digital Hierarchy(SDH) is used as client protocol for UNI.
- SONET:
  - Representing Synchronous Optical Networking(SONET) is used as client protocol for UNI.

8.2 EnabledDisabled

Enumeration used to indicate state as ENABLED OR DISABLED.

Contains Enumeration Literals:

- ENABLED:
    - Enumeration representing an ENABLED state.
- DISABLED:
    - Enumeration representing a DISABLED state.

8.3 NniProtection

MEF 64: Enumeration representing the protection protocol deployed at ENNI for the ODU container exchanged by the Operator. The enumeration value is either None or One of the rows as specified in G.873.1 Section 8.5, Table 8-1. This enumeration can apply also to INNI.

Contains Enumeration Literals:

- 1_PLUS_1_UNIDIR_SNC_I:
    - The 1st row of the table.
- 1_PLUS_1_BIDIR_SNC_I:
    - The 2nd row of the table.
- 1_TO_N_BIDIR_SNC_I:
    - The 3 rd row of the table.
- 1_PLUS_1_UNIDIR_SNC_NE:
    - The 4th row of the table.
- 1_PLUS_1_BIDIR_SNC_NE:
    - The 5th row of the table.
- 1_PLUS_1_UNIDIR_SNC_NS:
    - The 6th row of the table.
- 1_PLUS_1_BIDIR_SNC_NS:
    - The 7th row of the table.
- 1_PLUS_1_UNIDIR_SNC_S:
    - The 8th row of the table.
- 1_PLUS_1_BIDIR_SNC_S:
    - The 9th row of the table.
- 1_TO_N_BIDIR_SNC_S:
    - The 10th row of the table.
- 1_PLUS_1_UNIDIR_CL-SNCG_1:
    - The 11th row of the table.
- 1_PLUS_1_BIDIR_CL-SNCG_1:
    - The 12th row of the table.
- 1_TO_1_BIDIR_CL-SNCG_1:
    - The 13th row of the table.

8.4 HighOrderOdukOverHead

MEF 64: The value of HO ODUk OH is either None or List of overhead values corresponding to the terminated HO ODUk.

Attribute Name	Type	Mult.	Access	Description
superHighOrderHighOrderOdukTti	EnabledDisabled	1	RW	Super High Order/High Order ODUk Trail Trace Identifier.

superHighOrderHighOrderOdukGcc1	EnabledDisabled	1	RW	Super High Order/High Order ODUk General Communications Channel 1.
superHighOrderHighOrderOdukGcc2	EnabledDisabled	1	RW	Super High Order/High Order ODUk General Communications Channel 2.
superHighOrderHighOrderOdukAps	EnabledDisabled	1	RW	Super High Order/High Order ODUk Automatic Protection Switching.

8.5 L1UniCodingFunction

MEF 63 Coding Function <c>, functionality which encodes bits for transmission and the corresponding decode upon reception.

Contains Enumeration Literals:

- 1000BASE-X:
  - IEEE Std 802.3: PCS clause 36 coding function
- 10GBASE-W:
  - IEEE Std 802.3: PCS clause 49 and WIS clause 50 coding function (WAN PHY)
- 10GBASE-R:
  - IEEE Std 802.3: PCS clause 49 coding function (LAN PHY)
- 40GBASE-R:
  - IEEE Std 802.3: PCS clause 82 coding function
- 100GBASE-R:
  - IEEE Std 802.3: PCS clause 82 coding function
- FC-100:
  - ANSI INCITS 424-2007[R2012], February 2007: FC-FS-2 clause 5 FC-1 8B/10B coding function (1.0625 Gb/s)
- FC-200:
  - ANSI INCITS 424-2007[R2012], February 2007: FC-FS-2 clause 5 FC-1 8B/10B coding function (2.125 Gb/s)
- FC-400:
  - ANSI INCITS 424-2007[R2012], February 2007: FC-FS-2 clause 5 FC-1 8B/10B coding function (4.250 Gb/s)
- FC-800:
  - ANSI INCITS 424-2007[R2012], February 2007: FC-FS-2 clause 5 FC-1 8B/10B coding function (8.500 Gb/s)
- FC-1200:
  - ANSI INCITS 364-2003, November 2003: FC-10GFC clause 13 FC-1 coding function (10.51875 Gb/s)
- FC-1600:
  - ANSI INCITS 470-2011, December 2011: FC-FS-3 clause 5 FC-1 64B/66B coding function (14.025 Gb/s)
- FC-3200:

  - ANSI INCITS 488-2016, December 2016: FC-FS-4 clause 5 FC-1 64B/66B coding function plus 256B/257B transcoding and FEC encoding (28.05 Gb/s)
- STM-1:
  - ITU-T G.707/Y.1322 January 2007: framer, N=1
- STM-4:
  - ITU-T G.707/Y.1322 January 2007: framer, N=4
- STM-16:
  - ITU-T G.707/Y.1322 January 2007: framer, N=16
- STM-64:
  - ITU-T G.707/Y.1322 January 2007: framer, N=64
- STM-256:
  - ITU-T G.707/Y.1322 January 2007: framer, N=256
- OC-3:
  - Telcordia GR-253-CORE Issue 5, October 2009: framer, N=3
- OC-12:
  - Telcordia GR-253-CORE Issue 5, October 2009: framer, N=12
- OC-48:
  - Telcordia GR-253-CORE Issue 5, October 2009: framer, N=48
- OC-192:
  - Telcordia GR-253-CORE Issue 5, October 2009: framer, N=192
- OC-768:
  - Telcordia GR-253-CORE Issue 5, October 2009: framer, N=768

8.6 L1NniCodingFunction

MEF 64: ENNI Coding function is a 3-tuple of the <k, OTUk OH, HO ODUk OH>. k is an index representing the physical layer line rate. OTUk OH is a list of overhead values corresponding to the terminated OTUk. HO ODUk OH is either None or List where the value represents the overhead values corresponding to the terminated HO ODUk. This data type can apply also to INNI.

Attribute Name	Type	Mult.	Access	Description
otukOverHead	OtukOverHead	1	RW	A list of overhead values corresponding to the terminated OTUk.
highOrderOdukOverHead	HighOrderOdukOverHead	0..1	RW	The overhead values corresponding to the terminated HO ODUk (or SHO ODUk), where each entry in the list has the value Disabled or Enabled.
lineRate	LineRate	1	RW	Line rate representing the OTLk.4/OTUk physical layer line rate.

8.7 L1NniPhysicalLayer

MEF 64: The value of ENNI List of Physical Layer Common Attribute is a list of 2-tuples <c, o>. The <c> specifies the ENNI Coding Function and <o> specifies the wavelength structure, span loss, fiber type and other aspects of the physical layer. Reference MEF 64 Section 8.1.2 ENNI List of Physical Layer Common Attribute. This data type can apply also to INNI.

Attribute Name	Type	Mult.	Access	Description
l1NniOpticalInterfaceFunction	L1NniOpticalInterfaceFunction	1	RW	Pointer to ENNI/INNI Optical Interface Function.
l1NniCodingFunction	L1NniCodingFunction	1	RW	Pointer to ENNI/INNI Coding Function.

8.8 L1UniPhysicalLayer

The Physical Layer Service Attribute specifies the Client Protocol, the Coding Function and the Optical Interface Function. Reference MEF 63 Section 8.1.2 Physical Layer Service Attribute.

Attribute Name	Type	Mult.	Access	Description
clientProtocol	ClientProtocol	1	RW	The Client Protocol must be one of the following values: Ethernet, Fiber Channel, SDH or SONET. Reference MEF 63 Section 8.1.2.
l1UniOpticalInterfaceFunction	L1UniOpticalInterfaceFunction	1	RW	Optical Interface Function value. Reference MEF 63 Section 8.1.2.
l1UniCodingFunction	L1UniCodingFunction	1	RW	The coding function value. Reference MEF 63 Section 8.1.2.

8.9 LineRate

Enumeration representing physical line rate.

Contains Enumeration Literals:

- OTU1:
  - Enumeration representing when k=1.
- OTU2:
  - Enumeration representing when k=2.
- OTU2E:
  - Enumeration representing when k=2e.
- OTU3:
  - Enumeration representing when k=3.
- OTU4:
  - Enumeration representing when k=4.

8.10 OtukOverHead

MEF 64: *<OTUk OH>* is a list of overhead values corresponding to the terminated OTUk, where each entry in the list has the value *Disabled* or *Enabled*.

Attribute Name	Type	Mult.	Access	Description
otukTti	EnabledDisabled	1	RW	OTUk Trail Trace Identifier
otukGcc0	EnabledDisabled	1	RW	OTUk General Communications Channel.

otukOsmc	EnabledDisabled	1	RW	OTUk OTN Synchronization Messaging Channel.

8.11 PathOverhead

An ODU path is the connectivity between the locations where the path overhead is terminated. The value of the Operator Path Overhead Service Attribute is either None or List. When the value of the Operator Path Overhead Service Attribute is List, the entries are the overhead values corresponding to each of the SHO/HO/LO ODU paths carried across an ENNI which is terminated in an Operator's network. When there is no ODU path terminated in an Operator's network, the value of the Operator Path Overhead Service Attribute is None, i.e., the attribute is not present. Reference MEF 64 Section 8.2.3 Operator Path Overhead Service Attribute. This data type can apply also to INNI.

Attribute Name	Type	Mult.	Access	Description
oduTti	EnabledDisabled	1	RW	Overhead value, corresponding to each of the SHO/HO/LO ODU paths carried across an ENNI, ODU TTI is enabled or disabled.
oduGcc1	EnabledDisabled	1	RW	Overhead value, corresponding to each of the SHO/HO/LO ODU paths carried across an ENNI, ODU GCC1 is enabled or disabled.
oduGcc2	EnabledDisabled	1	RW	Overhead value, corresponding to each of the SHO/HO/LO ODU paths carried across an ENNI, ODU GCC2 is enabled or disabled.
oduAps	EnabledDisabled	1	RW	Overhead value, corresponding to each of the SHO/HO/LO ODU paths carried across an ENNI, ODU APS is enabled or disabled.

8.12 L1UniOpticalInterfaceFunction

MEF 63 Optical Interface Function <o>, functionality which converts encoded electrical bits into an optical signal(s) and the corresponding conversion into electrical format upon reception.

Contains Enumeration Literals:

Note: This enumeration is empty because it is augmented by the following enumerations.

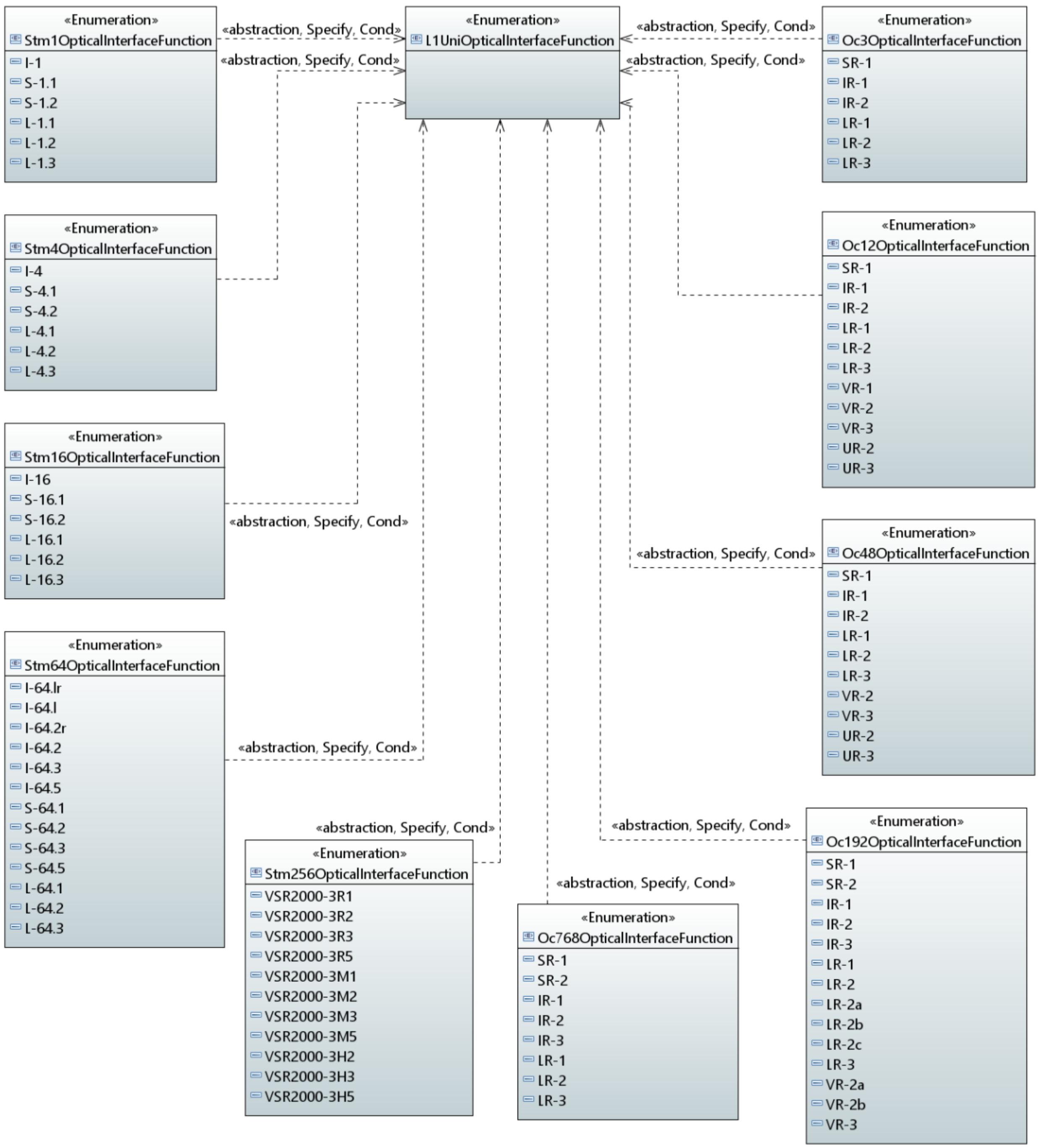

Figure 12 – *L1_Interface_Function_SDH_SONET* Diagram

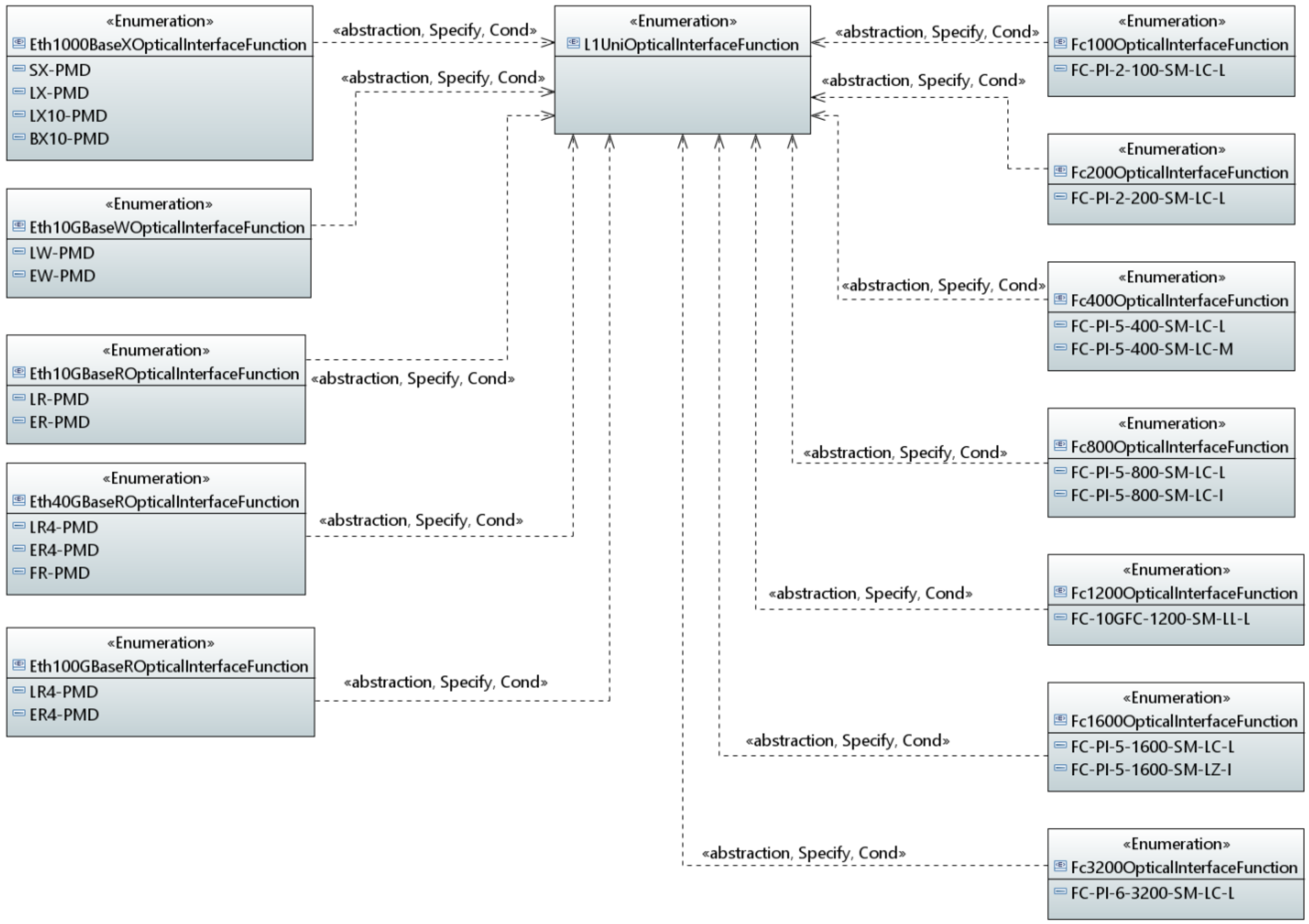

Figure 13 – *L1_Interface_Function_ETH_FC* Diagram

8.12.1 Stm1OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ITU-T G.707/Y.1322, January 2007: framer, N=1

Contains Enumeration Literals:

- I-1:
  - ITU-T G.957, March 2006: I-1
- S-1.1:
  - ITU-T G.957, March 2006: S-1.1
- S-1.2:
  - ITU-T G.957, March 2006: S-1.2
- L-1.1:
  - ITU-T G.957, March 2006: L-1.1
- L-1.2:
  - ITU-T G.957, March 2006: L-1.2
- L-1.3:
  - ITU-T G.957, March 2006: L-1.3

8.12.2 Stm4OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ITU-T G.707/Y.1322, January 2007: framer, N=4

Contains Enumeration Literals:

- I-4:
  - ITU-T G.957, March 2006: I-4
- S-4.1:
  - ITU-T G.957, March 2006: S-4.1
- S-4.2:
  - ITU-T G.957, March 2006: S-4.2
- L-4.1:
  - ITU-T G.957, March 2006: L-4.1
- L-4.2:
  - ITU-T G.957, March 2006: L-4.2
- L-4.3:
  - ITU-T G.957, March 2006: L-4.3

8.12.3 Stm16OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ITU-T G.707/Y.1322, January 2007: framer, N=16

Contains Enumeration Literals:

- I-16:
  - ITU-T G.957, March 2006: I-16
- S-16.1:
  - ITU-T G.957, March 2006: S-16.1
- S-16.2:
  - ITU-T G.957, March 2006: S-16.2
- L-16.1:
  - ITU-T G.957, March 2006: L-16.1
- L-16.2:
  - ITU-T G.957, March 2006: L-16.2
- L-16.3:
  - ITU-T G.957, March 2006: L-16.3

8.12.4 Stm64OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ITU-T G.707/Y.1322, January 2007: framer, N=64

Contains Enumeration Literals:

- I-64.lr:
  - ITU-T G.957, March 2006: I-64.lr
- I-64.l:

    - ITU-T G.957, March 2006: I-64.l
- I-64.2r:
    - ITU-T G.957, March 2006: I-64.2r
- I-64.2:
    - ITU-T G.957, March 2006: I-64.2
- I-64.3:
    - ITU-T G.957, March 2006: I-64.3
- I-64.5:
    - ITU-T G.957, March 2006: I-64.5
- S-64.1:
    - ITU-T G.957, March 2006: S-64.1
- S-64.2:
    - ITU-T G.957, March 2006: S-64.2
- S-64.3:
    - ITU-T G.957, March 2006: S-64.3
- S-64.5:
    - ITU-T G.957, March 2006: S-64.5
- L-64.1:
    - ITU-T G.957, March 2006: L-64.1
- L-64.2:
    - ITU-T G.957, March 2006: L-64.2
- L-64.3:
    - ITU-T G.957, March 2006: L-64.3

8.12.5 Stm256OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ITU-T G.707/Y.1322, January 2007: framer, N=256

Contains Enumeration Literals:

- VSR2000-3R1:
    - ITU-T G.693, November 2009: VSR2000-3R1
- VSR2000-3R2:
    - ITU-T G.693, November 2009: VSR2000-3R2
- VSR2000-3R3:
    - ITU-T G.693, November 2009: VSR2000-3R3
- VSR2000-3R5:
    - ITU-T G.693, November 2009: VSR2000-3R5
- VSR2000-3M1:
    - ITU-T G.693, November 2009: VSR2000-3M1
- VSR2000-3M2:
    - ITU-T G.693, November 2009: VSR2000-3M2
- VSR2000-3M3:
    - ITU-T G.693, November 2009: VSR2000-3M3
- VSR2000-3M5:
    - ITU-T G.693, November 2009: VSR2000-3M5

- VSR2000-3H2:
  - ITU-T G.693, November 2009: VSR2000-3H2
- VSR2000-3H3:
  - ITU-T G.693, November 2009: VSR2000-3H3
- VSR2000-3H5:
  - ITU-T G.693, November 2009: VSR2000-3H5

8.12.6 Oc3OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: Telcordia GR-253-CORE Issue 5, October 2009: framer, N=3

Contains Enumeration Literals:

- SR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: SR-1
- IR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-1
- IR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-2
- LR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-1
- LR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-2
- LR-3:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-3

8.12.7 Oc12OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: Telcordia GR-253-CORE Issue 5, October 2009: framer, N=12

Contains Enumeration Literals:

- SR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: SR-1
- IR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-1
- IR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-2
- LR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-1
- LR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-2
- LR-3:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-3
- VR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: VR-1

- VR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: VR-2
- VR-3:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: VR-3
- UR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: UR-2
- UR-3:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: UR-3

8.12.8 Oc48OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: Telcordia GR-253-CORE Issue 5, October 2009: framer, N=48

Contains Enumeration Literals:

- SR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: SR-1
- IR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-1
- IR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-2
- LR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-1
- LR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-2
- LR-3:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-3
- VR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: VR-2
- VR-3:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: VR-3
- UR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: UR-2
- UR-3:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: UR-3

8.12.9 Oc192OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: Telcordia GR-253-CORE Issue 5, October 2009: framer, N=192

Contains Enumeration Literals:

- SR-1:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: SR-1
- SR-2:
  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: SR-2

- IR-1:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-1
- IR-2:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-2
- IR-3:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-3
- LR-1:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-1
- LR-2:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-2
- LR-2a:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-2a
- LR-2b:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-2b
- LR-2c:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-2c
- LR-3:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-3
- VR-2a:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: VR-2a
- VR-2b:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: VR-2b
- VR-3:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: VR-3

8.12.10 Oc768OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: Telcordia GR-253-CORE Issue 5, October 2009: framer, N=768

Contains Enumeration Literals:

- SR-1:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: SR-1
- SR-2:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: SR-2
- IR-1:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-1
- IR-2:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-2
- IR-3:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: IR-3
- LR-1:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-1
- LR-2:
    - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-2
- LR-3:

  - Telcordia GR-253-CORE, Issue 5, October 2009, clause 4.1: LR-3

8.12.11 Eth1000BaseXOpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: IEEE Std 802.3: 1000BASE-X PCS clause 36 coding function

Contains Enumeration Literals:

- SX-PMD:
  - IEEE Std 802.3: clause 38
- LX-PMD:
  - IEEE Std 802.3: clause 38
- LX10-PMD:
  - IEEE Std 802.3: clause 59
- BX10-PMD:
  - IEEE Std 802.3: clause 59

8.12.12 Eth10GBaseWOpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: IEEE Std 802.3: 10GBASE-W (WAN PHY) PCS clause 49 and WIS clause 50 coding function

Contains Enumeration Literals:

- LW-PMD:
  - IEEE Std 802.3: clause 52
- EW-PMD:
  - IEEE Std 802.3: clause 52

8.12.13 Eth10GBaseROpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: IEEE Std 802.3: 10GBASE-R (LAN PHY) PCS clause 49 coding function

Contains Enumeration Literals:

- LR-PMD:
  - IEEE Std 802.3: clause 52
- ER-PMD:
  - IEEE Std 802.3: clause 52

8.12.14 Eth40GBaseROpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: IEEE Std 802.3: 40GBASE-R PCS clause 82 coding function

Contains Enumeration Literals:

- LR4-PMD:

    - IEEE Std 802.3: clause 87
- ER4-PMD:
    - IEEE Std 802.3: clause 87
- FR-PMD:
    - IEEE Std 802.3: clause 89

8.12.15 Eth100GBaseROpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: IEEE Std 802.3: 100GBASE-R PCS clause 82 coding function

Contains Enumeration Literals:

- LR4-PMD:
    - IEEE Std 802.3: clause 88
- ER4-PMD:
    - IEEE Std 802.3: clause 88

8.12.16 Fc100OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ANSI INCITS 424-2007[R2012], February 2007: FC-100 FC-FS-2 clause 5 FC-1 8B/10B coding function (1.0625 Gb/s)

Contains Enumeration Literals:

- FC-PI-2-100-SM-LC-L:
    - MEF 63: ANSI INCITS 404-2006, August 2006: FC-PI-2 clause 6.3 FC-0 100-SM-LC-L

8.12.17 Fc200OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ANSI INCITS 424-2007[R2012], February 2007: FC-200 FC-FS-2 clause 5 FC-1 8B/10B coding function (2.125 Gb/s)

Contains Enumeration Literals:

- FC-PI-2-200-SM-LC-L:
    - MEF 63: ANSI INCITS 404-2006, August 2006: FC-PI-2 clause 6.3 FC-0 200-SM-LC-L

8.12.18 Fc400OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ANSI INCITS 424-2007[R2012], February 2007: FC-400 FC-FS-2 clause 5 FC-1 8B/10B coding function (4.250 Gb/s)

Contains Enumeration Literals:

- FC-PI-5-400-SM-LC-L:

- MEF 63: ANSI INCITS 479-2011, November 2011: FC-PI-5 clause 6.3 FC-0: 400-SM-LC-L
- FC-PI-5-400-SM-LC-M:
  - MEF 63: ANSI INCITS 479-2011, November 2011: FC-PI-5 clause 6.3 FC-0: 400-SM-LC-M

8.12.19 Fc800OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ANSI INCITS 424-2007[R2012], February 2007: FC-800 FC-FS-2 clause 5 FC-1 8B/10B coding function (8.500 Gb/s)

Contains Enumeration Literals:

- FC-PI-5-800-SM-LC-L:
  - MEF 63: ANSI INCITS 479-2011, November 2011: FC-PI-5 clause 6.3 FC-0: 800-SM-LC-L
- FC-PI-5-800-SM-LC-I:
  - MEF 63: ANSI INCITS 479-2011, November 2011: FC-PI-5 clause 6.3 FC-0: 800-SM-LC-I

8.12.20 Fc1200OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ANSI INCITS 364-2003, November 2003: FC-1200 (10.51875 Gb/s) FC-10GFC clause 13 FC-1 coding function (10.51875 Gb/s)

Contains Enumeration Literals:

- FC-10GFC-1200-SM-LL-L:
  - MEF 63: ANSI INCITS 364-2003, November 2003: FC-10GFC clause 6.4 FC-0: 1200-SM-LL-L

8.12.21 Fc1600OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ANSI INCITS 470-2011, December 2011: FC-FS-3 clause 5 FC-1 64B/66B coding function (14.025 Gb/s)

Contains Enumeration Literals:

- FC-PI-5-1600-SM-LC-L:
  - MEF 63: ANSI INCITS 479-2011, November 2011: FC-PI-5 clause 6.3 FC-0: 1600-SM-LC-L
- FC-PI-5-1600-SM-LZ-I:
  - MEF 63: ANSI INCITS 479-2011, November 2011: FC-PI-5 clause 6.3 FC-0: 1600-SM-LZ-I

8.12.22 Fc3200OpticalInterfaceFunction

This enumeration is the set of possible optical interface function values that correspond to the coding function: ANSI INCITS 488-2016, December 2016: FC-FS-4 clause 5 FC-1 64B/66B coding function plus 256B/257B transcoding and FEC encoding (28.05 Gb/s)

Contains Enumeration Literals:

- FC-PI-6-3200-SM-LC-L:
  - MEF 63: ANSI INCITS 512-2015, January 2015: FC-PI-6 clause 5.3 FC-0: 3200-SM-LC-L

8.13 L1NniOpticalInterfaceFunction

The value of <o> corresponding to the index <k> in the entry <c> MUST be one of the Optical Interface Function values in the enumeration values.

Contains Enumeration Literals:
Note: This enumeration is empty because it is augmented by the following enumerations.

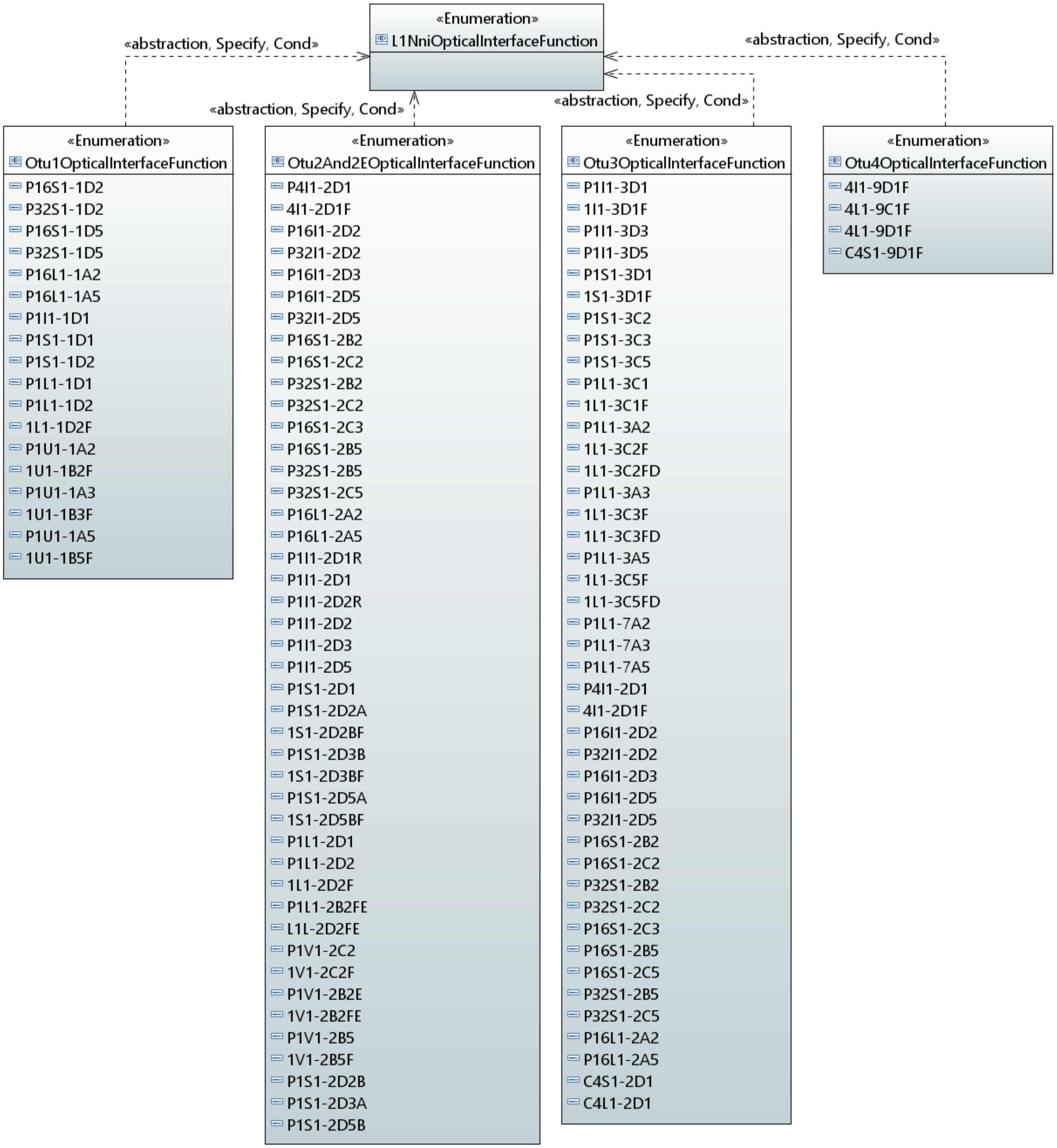

Figure 14 – *L1_NNI_Interface_Function* Diagram

8.13.1 Otu1OpticalInterfaceFunction

Enumeration values for l1EnniOpticalInterfaceFunction when Line Rate attribute equals to OTU1.

Contains Enumeration Literals:

- P16S1-1D2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P16S1-1D2
- P32S1-1D2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P32S1-1D2
- P16S1-1D5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.655 type Fiber, P16S1-1D5
- P32S1-1D5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.655 type Fiber, P32S1-1D5
- P16L1-1A2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P16L1-1A2
- P16L1-1A5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P16L1-1A5
- P1I1-1D1:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P1I1-1D1
- P1S1-1D1:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P1S1-1D1
- P1S1-1D2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P1S1-1D2
- P1L1-1D1:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P1L1-1D1
- P1L1-1D2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P1L1-1D2
- 1L1-1D2F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, 1L1-1D2F
- P1U1-1A2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, P1U1-1A2
- 1U1-1B2F:

    - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.652 type Fiber, 1U1-1B2F
- P1U1-1A3:
    - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.653 type Fiber, P1U1-1A3
- 1U1-1B3F:
    - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.653 type Fiber, 1U1-1B3F
- P1U1-1A5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.655 type Fiber, P1U1-1A5
- 1U1-1B5F:
    - G.959.1 July 2018: Optical tributary signal class NRZ 2.5G, ITU-T G.655 type Fiber, 1U1-1B5F

8.13.2 Otu2And2EOpticalInterfaceFunction

Enumeration values for l1EnniOpticalInterfaceFunction when Line Rate attribute equals to OTU2 or OTU2E.

Contains Enumeration Literals:

- P4I1-2D1:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P4I1-2D1
- 4I1-2D1F:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, 4I1-2D1F
- P16I1-2D2:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P16I1-2D2
- P32I1-2D2:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P32I1-2D2
- P16I1-2D3:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.653 type Fiber, P16I1-2D3
- P16I1-2D5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P16I1-2D5
- P32I1-2D5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P32I1-2D5
- P16S1-2B2:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P16S1-2B2
- P16S1-2C2:

    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P16S1-2C2
- P32S1-2B2:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P32S1-2B2
- P32S1-2C2:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P32S1-2C2
- P16S1-2C3:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.653 type Fiber, P16S1-2C3
- P16S1-2B5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P16S1-2B5
- P32S1-2B5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P32S1-2B5
- P32S1-2C5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P32S1-2C5
- P16L1-2A2:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P16L1-2A2
- P16L1-2A5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P16L1-2A5
- P1I1-2D1R:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1I1-2D1R
- P1I1-2D1:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1I1-2D1
- P1I1-2D2R:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1I1-2D2R
- P1I1-2D2:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1I1-2D2
- P1I1-2D3:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.653 type Fiber, P1I1-2D3
- P1I1-2D5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P1I1-2D5
- P1S1-2D1:

  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1S1-2D1
- P1S1-2D2A:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1S1-2D2A
- P1S1-2D2B:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1S1-2D2B
- 1S1-2D2BF:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, 1S1-2D2BF
- P1S1-2D3A:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.653 type Fiber, P1S1-2D3A
- P1S1-2D3B:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.653 type Fiber, P1S1-2D3B
- 1S1-2D3BF:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.653 type Fiber, 1S1-2D3BF
- P1S1-2D5A:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P1S1-2D5A
- P1S1-2D5B:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P1S1-2D5B
- 1S1-2D5BF:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, 1S1-2D5BF
- P1L1-2D1:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1L1-2D1
- P1L1-2D2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1L1-2D2
- 1L1-2D2F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, 1L1-2D2F
- P1L1-2B2FE:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1L1-2B2FE
- L1L-2D2FE:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, 1L1-2D2FE
- P1V1-2C2:

-
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1V1-2C2
- 1V1-2C2F:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, 1V1-2C2F
- P1V1-2B2E:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P1V1-2B2E
- 1V1-2B2FE:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, 1V1-2B2FE
- P1V1-2B5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P1V1-2B5
- 1V1-2B5F:
    - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, 1V1-2B5F

8.13.3 Otu3OpticalInterfaceFunction

Enumeration values for l1EnniOpticalInterfaceFunction when Line Rate attribute equals to OTU3.

Contains Enumeration Literals:

- P1I1-3D1:
    - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, P1I1-3D1
- 1I1-3D1F:
    - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, 1I1-3D1F
- P1I1-3D3:
    - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.653 type Fiber, P1I1-3D3
- P1I1-3D5:
    - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.655 type Fiber, P1I1-3D5
- P1S1-3D1:
    - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, P1S1-3D1
- 1S1-3D1F:
    - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, 1S1-3D1F
- P1S1-3C2:
    - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, P1S1-3C2
- P1S1-3C3:

  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.653 type Fiber, P1S1-3C3
- P1S1-3C5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.655 type Fiber, P1S1-3C5
- P1L1-3C1:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, P1L1-3C1
- 1L1-3C1F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, 1L1-3C1F
- P1L1-3A2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, P1L1-3A2
- 1L1-3C2F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, 1L1-3C2F
- 1L1-3C2FD:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, 1L1-3C2FD
- P1L1-3A3:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, P1L1-3A3
- 1L1-3C3F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, 1L1-3C3F
- 1L1-3C3FD:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.653 type Fiber, 1L1-3C3FD
- P1L1-3A5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.655 type Fiber, P1L1-3A5
- 1L1-3C5F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.655 type Fiber, 1L1-3C5F
- 1L1-3C5FD:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.655 type Fiber, 1L1-3C5FD
- P1L1-7A2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, P1L1-7A2
- P1L1-7A3:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.653 type Fiber, P1L1-7A3
- P1L1-7A5:

  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.655 type Fiber, P1L1-7A5
- P4I1-2D1:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, P4I1-2D1
- 4I1-2D1F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 40G, ITU-T G.652 type Fiber, 4I1-2D1F
- P16I1-2D2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P16I1-2D2
- P32I1-2D2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P32I1-2D2
- P16I1-2D3:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.653 type Fiber, P16I1-2D3
- P16I1-2D5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P16I1-2D5
- P32I1-2D5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P32I1-2D5
- P16S1-2B2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P16I1-2B2
- P16S1-2C2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P16S1-2C2
- P32S1-2B2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P32S1-2B2
- P32S1-2C2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P32S1-2C2
- P16S1-2C3:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.653 type Fiber, P16S1-2C3
- P16S1-2B5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P16S1-2B5
- P16S1-2C5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P16S1-2C5
- P32S1-2B5:

  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P32S1-2B5
- P32S1-2C5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P32S1-2C5
- P16L1-2A2:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, P16L1-2A2
- P16L1-2A5:
  - G.959.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.655 type Fiber, P16L1-2A5
- C4S1-2D1:
  - G.695.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, C4S1-2D1
- C4L1-2D1:
  - G.695.1 July 2018: Optical tributary signal class NRZ 10G, ITU-T G.652 type Fiber, C4L1-2D1

8.13.4 Otu4OpticalInterfaceFunction

Enumeration values for l1EnniOpticalInterfaceFunction when Line Rate attribute equals to OTU4.

Contains Enumeration Literals:

- 4I1-9D1F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 25G, ITU-T G.652 type Fiber, 4I1-9D1F
- 4L1-9C1F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 25G, ITU-T G.652 type Fiber, 4L1-9C1F
- 4L1-9D1F:
  - G.959.1 July 2018: Optical tributary signal class NRZ 25G, ITU-T G.652 type Fiber, 4L1-9D1F
- C4S1-9D1F:
  - G.695.1 July 2018: Optical tributary signal class NRZ 25G, ITU-T G.652 type Fiber, C4S1-9D1F

8.14 MultiplexingSequences

Contains Enumeration Literals:

Note: This enumeration is empty because it is augmented by the following enumerations.

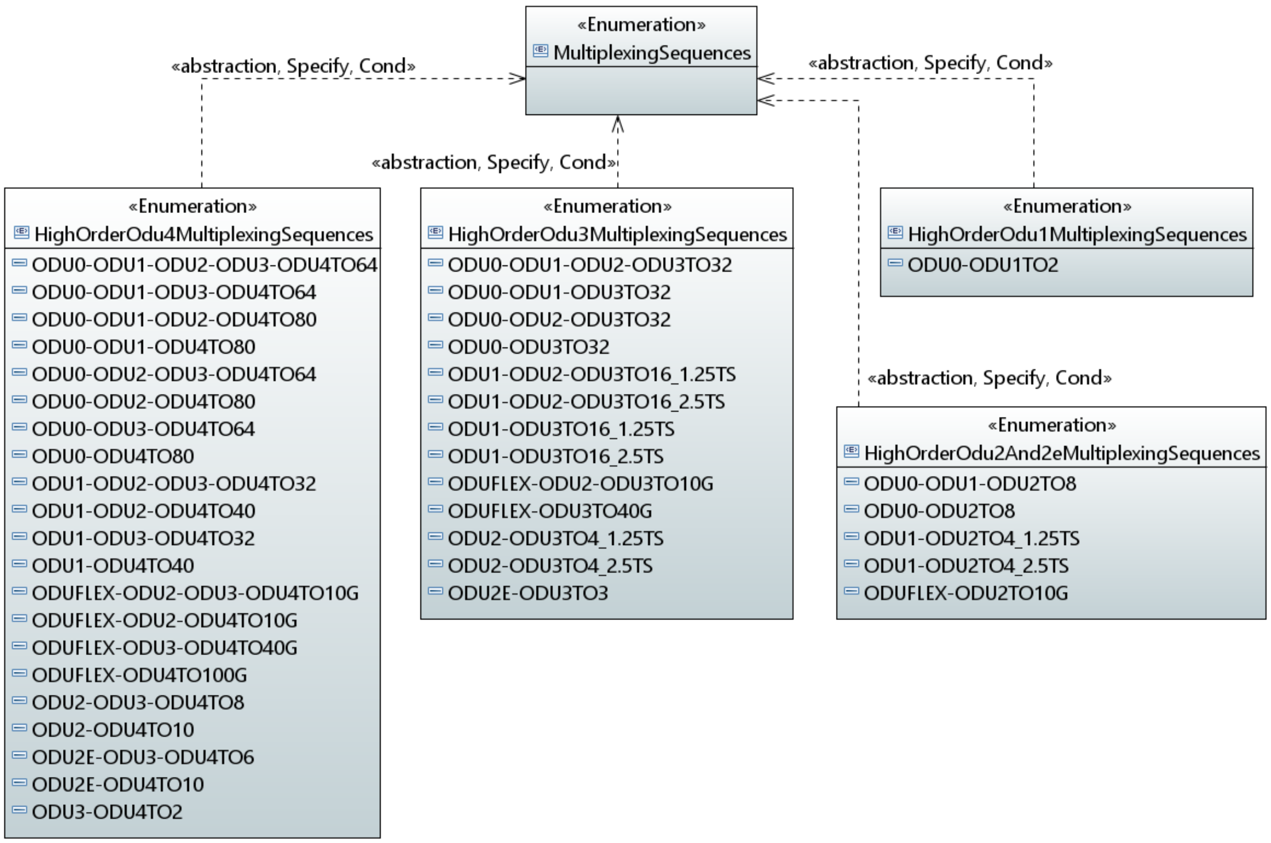

Figure 15 – *L1_ENNI_Multiplexing Sequences* Diagram

8.14.1 HighOrderOdu1MultiplexingSequences

Enumeration representing the available multiplexing sequences when Line Rate equals OTU1.

Contains Enumeration Literals:

- ODU0-ODU1TO2:
    - Up to 2 LO ODU0 can be multiplexed in that sequence of HO ODU1.

8.14.2 HighOrderOdu2And2eMultiplexingSequences

Enumeration representing the available multiplexing sequences when Line Rate equals OTU2 or OTU2E.

Contains Enumeration Literals:

- ODU0-ODU1-ODU2TO8:

  - Up to 8 LO ODU0 can be multiplexed in that sequence of HO ODU2.
- ODU0-ODU2TO8:
  - Up to 8 LO ODU0 can be multiplexed in that sequence of HO ODU2.
- ODU1-ODU2TO4_1.25TS:
  - Up to 4 LO ODU1 can be multiplexed in that sequence of HO ODU2 supports 1.25 Gb/s Tributary Slot.
- ODU1-ODU2TO4_2.5TS:
  - Up to 4 LO ODU1 can be multiplexed in that sequence of HO ODU2 supports 2.5 Gb/s Tributary Slot.
- ODUFLEX-ODU2TO10G:
  - LO ODUflex up to 10Gb/s can be multiplexed in this sequence to HO ODU2.

8.14.3 HighOrderOdu3MultiplexingSequences

Enumeration representing the available multiplexing sequences when Line Rate equals OTU3.

Contains Enumeration Literals:

- ODU0-ODU1-ODU2-ODU3TO32:
  - Up to 32 LO ODU0 can be multiplexed in that sequence of HO ODU3.
- ODU0-ODU1-ODU3TO32:
  - Up to 32 LO ODU0 can be multiplexed in that sequence of HO ODU3.
- ODU0-ODU2-ODU3TO32:
  - Up to 32 LO ODU0 can be multiplexed in that sequence of HO ODU3.
- ODU0-ODU3TO32:
  - Up to 32 LO ODU0 can be multiplexed in that sequence of HO ODU3.
- ODU1-ODU2-ODU3TO16_1.25TS:
  - Up to 16 LO ODU1 can be multiplexed in that sequence of HO ODU3 supports 1.25 Gb/s Tributary Slot.
- ODU1-ODU2-ODU3TO16_2.5TS:
  - Up to 16 LO ODU1 can be multiplexed in that sequence of HO ODU3 supports 2.5 Gb/s Tributary Slot.
- ODU1-ODU3TO16_1.25TS:
  - Up to 16 LO ODU1 can be multiplexed in that sequence of HO ODU3 supports 1.25 Gb/s Tributary Slot.
- ODU1-ODU3TO16_2.5TS:
  - Up to 16 LO ODU1 can be multiplexed in that sequence of HO ODU3 supports 2.5 Gb/s Tributary Slot.
- ODUFLEX-ODU2-ODU3TO10G:
  - LO ODUflex up to 10Gb/s can be multiplexed in this sequence to HO ODU3.
- ODUFLEX-ODU3TO40G:
  - LO ODUflex up to 40Gb/s can be multiplexed in this sequence to HO ODU3.
- ODU2-ODU3TO4_1.25TS:
  - Up to 4 LO ODU2 can be multiplexed in that sequence of HO ODU3 supports 1.25 Gb/s Tributary Slot.
- ODU2-ODU3TO4_2.5TS:

  - Up to 4 LO ODU2 can be multiplexed in that sequence of HO ODU3 supports 2.5 Gb/s Tributary Slot.
- ODU2E-ODU3TO3:
  - Up to 3 LO ODU2E can be multiplexed in that sequence of HO ODU3.

8.14.4 HighOrderOdu4MultiplexingSequences

Enumeration representing the available multiplexing sequences when Line Rate equals OTU4.

Contains Enumeration Literals:

- ODU0-ODU1-ODU2-ODU3-ODU4TO64:
  - Up to 64 LO ODU0 can be multiplexed in that sequence of HO ODU4.
- ODU0-ODU1-ODU3-ODU4TO64:
  - Up to 64 LO ODU0 can be multiplexed in that sequence of HO ODU4.
- ODU0-ODU1-ODU2-ODU4TO80:
  - Up to 80 LO ODU0 can be multiplexed in that sequence of HO ODU4.
- ODU0-ODU1-ODU4TO80:
  - Up to 80 LO ODU0 can be multiplexed in that sequence of HO ODU4.
- ODU0-ODU2-ODU3-ODU4TO64:
  - Up to 64 LO ODU0 can be multiplexed in that sequence of HO ODU4.
- ODU0-ODU2-ODU4TO80:
  - Up to 80 LO ODU0 can be multiplexed in that sequence of HO ODU4.
- ODU0-ODU3-ODU4TO64:
  - Up to 64 LO ODU0 can be multiplexed in that sequence of HO ODU4.
- ODU0-ODU4TO80:
  - Up to 80 LO ODU0 can be multiplexed in that sequence of HO ODU4.
- ODU1-ODU2-ODU3-ODU4TO32:
  - Up to 32 LO ODU1 can be multiplexed in that sequence of HO ODU4.
- ODU1-ODU2-ODU4TO40:
  - Up to 40 LO ODU1 can be multiplexed in that sequence of HO ODU4.
- ODU1-ODU3-ODU4TO32:
  - Up to 32 LO ODU1 can be multiplexed in that sequence of HO ODU4.
- ODU1-ODU4TO40:
  - Up to 40 LO ODU1 can be multiplexed in that sequence of HO ODU4.
- ODUFLEX-ODU2-ODU3-ODU4TO10G:
  - LO ODUflex up to 10Gb/s can be multiplexed in this sequence to HO ODU4.
- ODUFLEX-ODU2-ODU4TO10G:
  - LO ODUflex up to 10Gb/s can be multiplexed in this sequence to HO ODU4.
- ODUFLEX-ODU3-ODU4TO40G:
  - LO ODUflex up to 40Gb/s can be multiplexed in this sequence to HO ODU4.
- ODUFLEX-ODU4TO100G:
  - LO ODUflex up to 100Gb/s can be multiplexed in this sequence to HO ODU4.
- ODU2-ODU3-ODU4TO8:
  - Up to 8 LO ODU2 can be multiplexed in that sequence of HO ODU4.
- ODU2-ODU4TO10:
  - Up to 10 LO ODU2 can be multiplexed in that sequence of HO ODU4.

- ODU2E-ODU3-ODU4TO6:
    - Up to 6 LO ODU2E can be multiplexed in that sequence of HO ODU4.
- ODU2E-ODU4TO10:
    - Up to 10 LO ODU2E can be multiplexed in that sequence of HO ODU4.
- ODU3-ODU4TO2:
    - Up to 2 LO ODU3 can be multiplexed in that sequence of HO ODU4.

9 ONF TAPI Common: Data Types and Enumerations

This section details the data types and enumerations imported from ONF TAPI Common model [16] that are used by the L1 Connectivity Resource model.

9.1 DateAndTime

This primitive type defines the date and time according to the following structure:
yyyyMMddhhmmss.s[Z|{+|-}HHMm] where:

yyyy	0000..9999	year
MM	01..12	month
dd	01..31	day
hh	00..23	hour
mm	00..59	minute
ss	00..59	second
.s	.0...9	tenth of second (set to .0 if EMS or NE cannot support this granularity)
Z	Z	indicates UTC (rather than local time)
{+|-}	+ or -	delta from UTC
HH	00..23	time zone difference in hours
Mm	00..59	time zone difference in minutes.

Attribute Name	Type	Mult.	Access	Description
value	String	1	RW	The specific value of the universal id

9.2 TimePeriod

Attribute Name	Type	Mult.	Access	Description
value	Integer	1	RW	
unit	TimeUnit	1	RW	

9.3 TimeUnit

Contains Enumeration Literals:

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

10 ONF TAPI ODU: Connectivity Model

This section details the *OduConnectivityServiceEndPointSpec* object class, imported from ONF TAPI ODU model [16], which is augmented by the L1 Connectivity Resource model (12).

Figure 16 illustrates the TAPI ODU diagram representing the *OduConnectivityServiceEndPointSpec*, with attributes and associations with other object classes. Note that *OduCsepTtpPac* is not used in MEF L1 Connectivity Resource model.

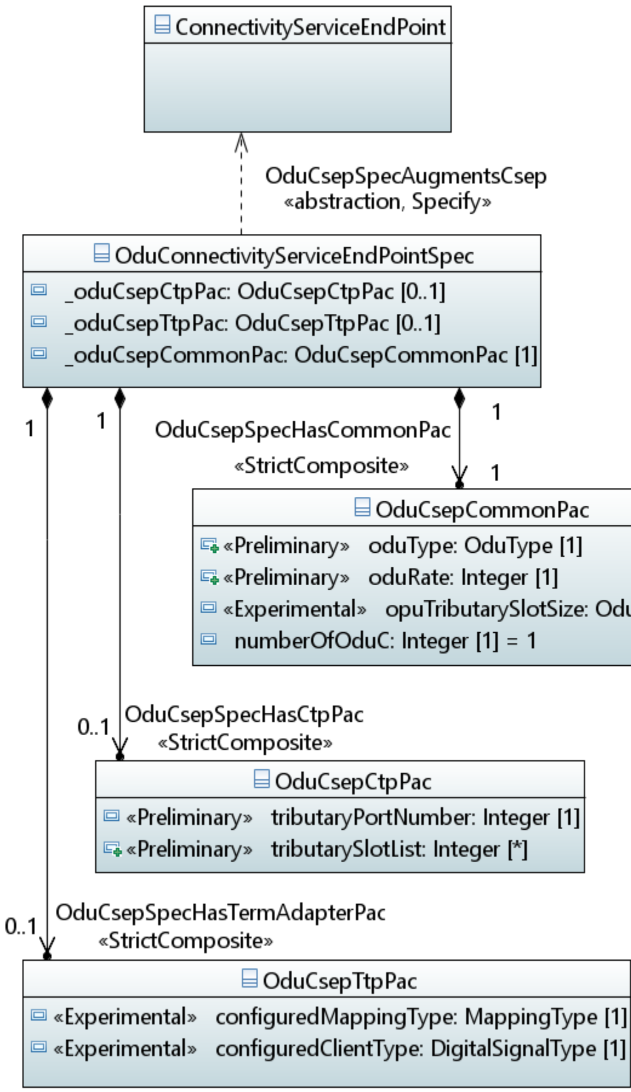

Figure 16 – *OduEndPointSpec* diagram

10.1 OduConnectivityServiceEndPointSpec

This class augments CSEP with ODU related parameters.

Attribute Name	Type	Mult.	Access	Description
_oduCsepCtpPac	OduCsepCtpPac	0..1	RW	Attributes related to adaptation function.
_oduCsepTtpPac	OduCsepTtpPac	0..1	RW	Attributes related to termination function.
_oduCsepCommonPac	OduCsepCommonPac	1	RW	Attributes common for both adaptation and termination functions.

10.2 OduCsepCommonPac

Attributes common to both adaptation and termination functions.

Attribute Name	Type	Mult.	Access	Description
oduType	OduType	1	RW	This attribute specifies the type of the ODU termination point.
oduRate	Integer	1	RW	This attribute indicates the rate of the ODU termination point in Kbits/s. This attribute is Set at create; i.e., once created it cannot be changed directly. In case of resizable ODU flex, its value can be changed via HAO (not directly on the attribute). This attribute indicates the rate of the ODU termination point. Valid values shall be consistent with the oduType configuration as shown in Table 7-2/G.709 v5. Setting this value for fixed-rate ODUk types (e.g., ODU0), is optional. The default value is derived from the configured oduType, as defined in Table 7-2/G.709 v5. Setting this value for ODUCn type is optional. The default value is derived from the configured n of the ODUCn as defined in Table 7-2/G.709 v5.
opuTributarySlotSize	OduSlotSize	1	RW	This attribute is applicable for ODU2 and ODU3 CTP only. It indicates the slot size of the ODU CTP.
numberOfOduC	Integer	1	RW	This attribute specifies the number of ODUC instances of the ODUCn.

10.3 OduCsepCtpPac

Attributes related to adaptation function.

Attribute Name	Type	Mult.	Access	Description
tributaryPortNumber	Integer	1	RW	This attribute identifies the tributary port number that is associated with the ODUk CTP. This attribute applies when the ODUk CTP is multiplexed into a server layer ODU TTP object. It will not apply if this ODUk CTP object is directly mapped into an OTUk TTP object (i.e. OTUk has no tributary slots). The upper bound of the integer allowed in this set is a function of the ODU server layer into which the ODUk CTP is multiplexed. In case the ODU server layer is an HO-ODUk, the upper bound is the maximum number of tributary slots within the HO-ODUk (see ITU-T Recommendation G.709 (v5) clause 19.4.1). Thus, for example, M=8/32/80 for ODU2/ODU3/ODU4 server layers (respectively) using 1.25G slot size. In case the ODU server layer is an ODUCn, the upper bound is M=10*n (see ITU-T Recommendation G.709 (v5) Clause 20.4.1).
tributarySlotList	Integer	0..*	RW	ITU-T G.875 (v5) This attribute contains a set of distinct (i.e. unique) integers (e.g. 2, 3, 5, 9, 15 representing the tributary slots TS#2, TS#3, TS#5, TS#9 and TS#15) which represents the resources occupied by the ODUk CTP (e.g. an ODUflex with a bit rate of 6.25G setup over an HO-ODUk). This attribute applies when the ODUk CTP is carried by a sever layer ODU TTP object. It will not apply if this ODUk CTP object is directly carried by an OTUk TTP object (i.e. OTUk has no tributary slots). The upper bound of the integer allowed in this set and its relationship with the tributary slots are a function of the ODU server layer to which the ODUk CTP is carried over. In case the ODU server layer is an HO-ODUk, each entry in the list is an integer value (i) representing the tributary slot name TS#i and the upper bound is the maximum number of tributary slots within the HO-ODUk (see ITU-T Recommendation G.709 (v5) clause 19). Thus, for example, M=8/32/80 for ODU2/ODU3/ODU4 server layers (respectively) using 1.25G slot size. In case the ODU server layer is an ODUCn, each entry in the list is an integer value (P) representing the time slot name TS#A.B (e.g. 2, 3, 5, 9, 15, 34 representing the tributary slots TS#1.2, TS#1.3, TS#1.5, TS#1.9, TS#1.15, and TS#2.14) and the upper und is 20*n (see ITU-T Recommendation G.709 (v5) Clause 20.1). The mapping between P and A & B is: A = [P/20] + 1; B = P - (P/20]*20; where the square bracket represents the whole integer. Note that the value of this attribute can be changed only in the case of ODUflex and has to be through specific operations (i.e. not be changing the attribute tributarySlotList directly).

11 ONF TAPI ODU: Enumerations

This section details the enumerations imported from ONF TAPI ODU model [16].

11.1 OduSlotSize

Contains Enumeration Literals:

- 1G25:
- 2G5:

11.2 OduType

Contains Enumeration Literals:

- ODU0:
- ODU1:
- ODU2:
- ODU2E:
- ODU3:
- ODU4:
- ODU_FLEX:
- ODU_CN:

12 Subscriber and Operator L1 Connectivity Resource Model

This section details the Subscriber and Operator L1 Connectivity Resource object classes, attributes and relationships.

Some attributes defined by MEF 63 and MEF 64 have not been directly mapped by MRM L1 model because they are either redundant given the model structure or because they duplicate existing TAPI definitions:

- MEF 64: Operator L1VC End Point External Interface Type Service Attribute (*UNI* or *ENNI*): This information can be inferred from the specific MRM class augmenting TAPI SIP (*L1UniNResource* or *L1EnniNResource* or *L1InniNResource*).

- MEF 64: Operator L1VC End Point Map Service Attribute is redundant with respect to TAPI *OduType*, *opuTributarySlotSize* attributes of TAPI *OduCsepCommonPac* class and *tributarySlotList* attribute of TAPI *OduCsepCtpPac*.
    - TAPI *OduType* value range excludes ODU_CN when used in MEF.

Note that SIP *layer1UniId*, *layer1OperatorUniId*, *layer1OperatorPeeringIdentifier*, *layer1OperatorEnniIdentifier* and CSEP *layer1EndPointId*, *layer1OperatorVcEndPointIdentifier* may be not strictly necessary from a pure resource management perspective, while they could be useful when a Server Controller uses these IDs, e.g., signalling, fault-to-service correlation or local GUI.

Figure 17 illustrates the classes representing L1 Connectivity Resource, L1 Connectivity End Point, L1 UNI, ENNI and INNI.

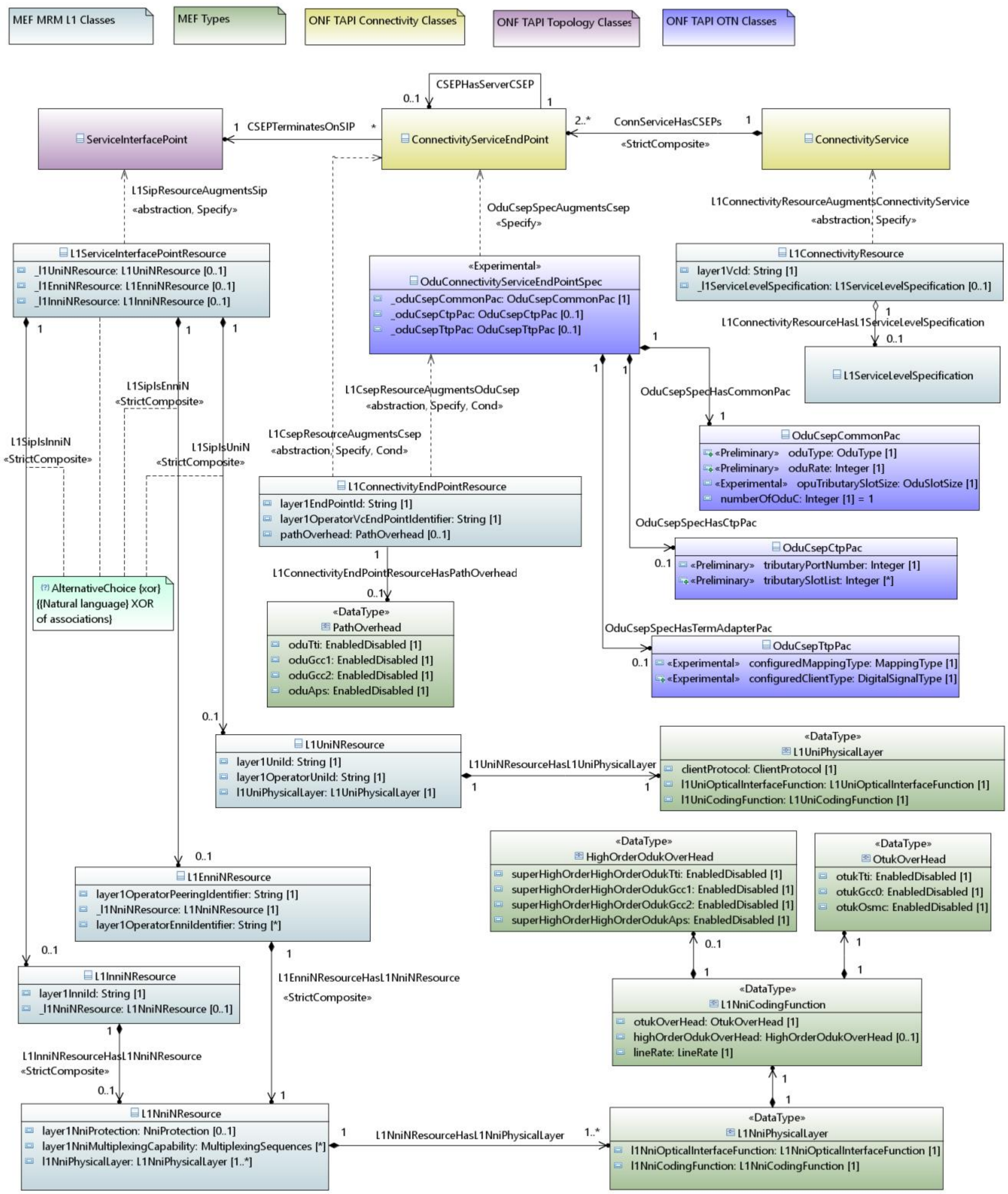

Figure 17 – *MRM_L1_Connectivity* Diagram

12.1 L1ConnectivityEndPointResource

This class augments ONF TAPI (ODU) CSEP with MEF L1 attributes. This class augments ONF TAPI ConnectivityServiceEndPoint when CSEP is directly referenced by ConnectivityService (ConnServiceHasCSEPs). This class augments ONF TAPI OduConnectivityServiceEndPointSpec when CSEP is the server of another CSEP (CSEPHasServerCSEP). In this case, the following constraints apply:

1) OduCsepCommonPac/oduType value range excludes ODU_CN,
2) OduCsepCommonPac/numberOfOduC is fixed to 1,
3) OduCsepTtpPac is not used.

MEF 63: Subscriber Layer 1 Virtual Connection End Point represents the logical attachment of a Subscriber Layer 1 Virtual Connection to a L1 UNI.
MEF 64: Operator Layer 1 Virtual Connection End Point is a logical entity at a given EI that is associated with L1CI passing over that EI. An Operator L1VC End Point represents the logical attachment of an Operator L1VC to an EI.
The MEF 64 "Operator L1VC End Point External Interface Type Service Attribute" is mapped by the supporting SIP type (L1UniNResource or L1EnniNResource or L1InniNResource).
The MEF 64 "Operator L1VC End Point Map Service Attribute" is mapped by TAPI oduType, opuTributarySlotSize attributes of TAPI OduCsepCommonPac class and tributarySlotList attribute of TAPI OduCsepCtpPac. TAPI oduType value range shall be restricted when used in MEF L1 Resource Model, see above. In this model, the L1ConnectivityEndPointResource can have a L1 INNI supporting SIP.

Attribute Name	Type	Mult.	Access	Description
layer1EndPointId	String	1	RW	This attribute represents the Subscriber L1VC End Point Identifier Service Attribute. MEF 63: The value of the Subscriber L1VC End Point ID Service Attribute is a string that is used to allow the Subscriber and Service Provider to uniquely identify the Subscriber L1VC End Point. [R36] The Subscriber L1VC End Point ID MUST be unique across all the Service Provider's Subscriber L1VC End Points. [R37] The Subscriber L1VC End Point ID MUST contain no more than 45 characters. [R38] The Subscriber L1VC End Point ID MUST be a non-null RFC 2579 DisplayString but not contain the characters 0x00 through 0x1f.
layer1OperatorVcEndPointIdentifier	String	1	RW	This attribute represents the Operator L1VC End Point Identifier Service Attribute. MEF 64: The value of the Operator L1VC End Point Identifier Service Attribute is a string that is used to allow the SP/SO and Operator to uniquely identify the Operator L1VC End Point. [R43] The value of the Operator L1VC End Point Identifier MUST be unique among all such identifiers for Operator L1VC End Points supported by the Operator network. [R44] The value of the Operator L1VC End Point Identifier MUST contain no more than 45 characters. [R45] The value of the Operator L1VC End Point Identifier MUST be a non-null RFC 2579 Display String but not contain the characters 0x00 through 0x1f.

Attribute Name	Type	Mult.	Access	Description
pathOverhead	PathOverhead	0..1	RW	MEF 64: The set of overhead entries for each ODU path directly supporting an access L1VC (LO ODU), i.e., one end is at UNI side. The SP/SO agrees with all access Operators supporting the LO ODU path to establish consistent values of the overhead entries. This attribute applies to LO ODU Connectivity End Points of an access L1 Connectivity Service. In case of LO-HO-SHO ODU stack, the attribute may apply also to the HO ODU path supporting the LO ODU path. The attribute is not present when there is no ODU path terminated in an Operator's network (mapping the value "None" of the MEF 64 Operator Path Overhead Service Attribute). In this model the attribute is applicable to both ENNI and INNI cases.

12.2 L1ConnectivityResource

This class augments ONF TAPI Connectivity Service with MEF L1 attributes.
MEF 63: A Subscriber Layer 1 Service is a connectivity service which delivers Layer 1 Characteristic Information that is specified using the Service Attributes in MEF 63 [8]. A fundamental aspect of a Subscriber L1 Service is the Subscriber L1 Virtual Connection (L1VC): An association of two Layer 1 Virtual Connection End Points that limits the transport of Layer 1 Characteristic Information between those Layer 1 Virtual Connection End Points. A Subscriber L1 Service has the following basic characteristics:

1) Topology: Only point-to-point.
2) UNI: Both UNIs have the same rate. The physical layer at both UNIs is optical.
3) Rate: Only full port speed of the UNIs.
4) Client protocol: Ethernet, Fibre Channel, SONET, SDH.
5) Transparency: The client protocol data (L1CI) is transported bit identical from the ingress UNI to egress UNI at the same frequency (aka timing transparent).
6) Performance metrics (SLS).

An instance of a Subscriber L1 Service has:

1) The same client protocol at both UNIs (i.e., one of: Ethernet, Fibre Channel, SONET, SDH).
2) The physical ports at both UNIs have the same rate and same coding function (e.g., 8B/10B).
3) The physical port at each UNI may have a different optical interface function (e.g., long reach or extended reach).
4) A single service instance per UNI (i.e., no service multiplexing).

MEF 64: An Operator Layer 1 Service is a connectivity service provided by an Operator to an L1 Super Operator or to a Service Provider that delivers Layer 1 Characteristic Information between two External Interfaces where at least one External Interface is an L1 ENNI, specified using the Service Attributes in MEF 64 [9]. A fundamental aspect of an Operator L1 Service is the Operator Layer 1 Virtual Connection (L1VC): An association of two Operator Layer 1 Virtual Connection End Points that limits the transport of Layer 1 Characteristic Information between those Operator Layer 1 Virtual Connection End Points where at least one of the Operator Layer 1 Virtual Connection End Points is at an L1 ENNI. An Operator Layer 1 Service has basic characteristics similar to a Subscriber L1 Service, adding the description of ENNI related attributes (MEF 64). In this model, the L1ConnectivityResource can have end points at an L1 INNI.

Attribute Name	Type	Mult.	Access	Description
layer1VcId	String	1	RW	This attribute represents the Subscriber or Operator L1VC ID Service Attribute. MEF 63: The value of the Subscriber L1VC ID Service Attribute is a string that is used to identify the Subscriber L1VC within the Service Provider network. It is subject to the following requirements. [R17] The Subscriber L1VC ID MUST be unique across all the Service Provider's Subscriber L1VCs. [R18] The Subscriber L1VC ID MUST contain no more than 45 characters. [R19] The Subscriber L1VC ID MUST be a non-null RFC 2579 DisplayString but not contain the characters 0x00 through 0x1f. MEF 64: The value of the Operator L1VC Identifier Service Attribute is a string that is used to allow the SP/SO and Operator to uniquely identify an Operator L1VC. [R26] The value of the Operator L1VC Identifier Service Attribute MUST be unique among all such identifiers for Operator L1VCs supported by the Operator Network. [R27] The value of the Operator L1VC Identifier Service Attribute MUST contain no more than 45 characters. [R28] The value of the Operator L1VC Identifier Service Attribute MUST be a non-null RFC 2579 DisplayString but not contain the characters 0x00 through 0x1f.
_l1ServiceLevelSpecification	L1ServiceLevelSpecification	0..1	RW	Reference to Service Level Specification attributes. MEF 63: The Subscriber L1VC Service Level Specification (SLS) Service Attribute is the technical specification of aspects of the service performance agreed to by the Service Provider and the Subscriber. MEF 64: The Operator L1VC Service Level Specification (SLS) Service Attribute is the technical specification of aspects of the service performance agreed to by the SP/SO and the Operator. MEF 63/MEF 64: For any given SLS, a given Performance Metric may or may not be specified.

12.3 L1EnniNResource

This class represents L1 ENNI related attributes.

Attribute Name	Type	Mult.	Access	Description
layer1OperatorPeeringIdentifier	String	1	RW	MEF 64: The ENNI Peering Identifier Common Attribute value is a string used to allow the Operators at the ENNI to uniquely identify the ENNI. It is subject to the following requirements: [R1] The value of the ENNI Peering Identifier Common Attribute MUST be unique across all ENNIs for each of the Operators. [R2] The value of the ENNI Peering Identifier Common Attribute MUST contain no more than 45 characters. [R3] The value of the ENNI Peering Identifier Common Attribute MUST be a non-null RFC 2579 DisplayString but not contain the characters 0x00 through 0x1f.
_l1NniNResource	L1NniNResource	1	RW	Reference to common attributes for L1 ENNI and INNI.

Attribute Name	Type	Mult.	Access	Description
layer1OperatorEnniIdentifier	String	0..*	RW	MEF 64: The Operator ENNI Identifier Service Attribute value is a string used to allow the SP/SO and Operator to uniquely identify the ENNI. For each instance of an ENNI, there are multiple sets of ENNI Identifier Service Attributes. The value for each ENNI Identifier Service Attribute in a set for an Operator network is specific to the SP/SO that is using the ENNI. [R9] The value of the Operator ENNI Identifier Service Attribute MUST be unique across all ENNIs supported by the Operator. [R10] The value of the Operator ENNI Identifier Service Attribute MUST contain no more than 45 characters. [R11] The value of the Operator ENNI Identifier Service Attribute MUST be a non-null RFC 2579 DisplayString but not contain the characters 0x00 through 0x1f.

12.4 L1InniNResource

This class represents L1 INNI related attributes.

Attribute Name	Type	Mult.	Access	Description
layer1InniId	String	1	RW	Unique identifier of the INNI-N
_l1NniNResource	L1NniNResource	0..1	RW	The L1 INNI SIP may or may not use MEF 64 ENNI parameters.

12.5 L1NniNResource

This class represents common attributes for L1 ENNI and INNI.

Attribute Name	Type	Mult.	Access	Description
layer1NniProtection	NniProtection	0..1	RW	MEF 64: The ENNI Protection Common Attribute value specifies the protection protocol deployed at the ENNI for the ODU container exchanged by the Operators (Section 7.3). The ENNI Protection Common Attribute value is either: • None, or • One of the rows as specified in G.873.1 Section 8.5, Table 8-1 [20]. In this model the attribute is applicable to both ENNI and INNI cases. Note that in case of ENNI context the attribute value is the result of an agreement between two Operators, while in case of INNI context it is up to the single Operator, e.g., managing the agreement between two Vendors. The layer1OperatorProtection attribute is not present to map the case when MEF 64 (8.1.3) ENNI Protection Common Attribute value is "None".

Attribute Name	Type	Mult.	Access	Description
layer1NniMultiplexingCapability	MultiplexingSequences	0..*	RW	MEF 64: The value of the Operator Multiplexing Capability List Service Attribute indicates the Operator's ability to multiplex a given LO ODUj into a HO ODUk (single-stage), or multiplex a given LO ODUi into a HO ODUj and into a SHO ODUk (two-stage), or more multiplexing stages. This information is used by the SP/SO to determine if an Operator can provide the required multiplexing to form the ODU container exchanged between Operators at an ENNI (Section 7.3). In this model the attribute is applicable to both ENNI and INNI cases. Note that in case of ENNI context the attribute value is the result of an agreement between two Operators, while in case of INNI context it is up to the single Operator, e.g., managing the agreement between two Vendors. MEF 64 (8.2.2) in case of "the value Null is used to indicate no multiplexing capability" then layer1OperatorMultiplexingCapability attribute is not present to represent the "no multiplexing capability" scenario.
l1NniPhysicalLayer	L1NniPhysicalLayer	1..*	RW	ENNI/INNI Common attributes. There is a protection scheme in case of more than one entry. MEF 64/8.1.2 ENNI List of Physical Layers Common Attribute / L1EnniCodingFunction: The value of (HO ODUk OH) is either None or List. When the value of (HO ODUk OH) is List, the ENNI is referred to as Type 3 and the entries are the overhead values corresponding to the terminated HO ODUk (or SHO ODUk), where each entry in the list has the value Disabled or Enabled. When the value of (HO ODUk OH) is None, the ENNI is referred to as either Type 1 or Type 2. This attribute applies to ODU container which is HO, i.e., when the server is OTU. In this model the attribute is applicable to both ENNI and INNI cases. Note that in case of ENNI context the attribute value is the result of an agreement between two Operators, while in case of INNI context it is up to the single Operator, e.g., managing the agreement between two Vendors. Note that in case the HO ODU is not locally terminated on INNI/ENNI, then MEF 64/8.2.3 Operator Path Overhead Service Attribute applies, which augments TAPI ODU CSEP.

12.6 L1ServiceInterfacePointResource

This class augments ONF TAPI SIP with MEF L1 attributes.

Attribute Name	Type	Mult.	Access	Description
_l1UniNResource	L1UniNResource	0..1	RW	If the SIP is of UNI type, it refers to UNI related attributes.
_l1EnniNResource	L1EnniNResource	0..1	RW	If the SIP is of ENNI type, it refers to ENNI related attributes.
_l1InniNResource	L1InniNResource	0..1	RW	If the SIP is of INNI type, it refers to INNI related attributes.

12.7 L1UniNResource

This class represents L1 UNI related attributes.

Attribute Name	Type	Mult.	Access	Description
layer1UniId	String	1	RW	MEF 63: The value of the [Service Provider] UNI ID Service Attribute is a string that is used to allow the Subscriber and Service Provider to uniquely identify the UNI. It is subject to the following requirements. [R3] The UNI ID MUST be unique among all the Service Provider's UNIs. [R4] The UNI ID MUST contain no more than 45 characters. [R5] The UNI ID MUST be a non-null RFC 2579 DisplayString but not contain the characters 0x00 through 0x1f.
l1UniPhysicalLayer	L1UniPhysicalLayer	1	RW	MEF 63: The Physical Layer Service Attribute specifies the Client Protocol, the Coding Function and the Optical Interface Function used by the Service Provider for the physical link implementing the UNI.
layer1OperatorUniId	String	1	RW	MEF 64: The value of the Operator UNI Identifier Service Attribute is a string that is used to allow the SP/SO and Operator to uniquely identify the UNI. [R14] The value of the Operator UNI Identifier Service Attribute MUST be unique across all UNIs supported by the Operator. [R15] The value of the Operator UNI Identifier Service Attribute MUST contain no more than 45 characters. [R16] The value of the Operator UNI Identifier Service Attribute MUST be a non-null RFC 2579 DisplayString but not contain the characters 0x00 through 0x1f.

13 Layer 1 Service Level Specification (SLS)

This section details the L1 Service Level Specification (SLS) object classes, attributes and relationships used by the L1 Connectivity Resource model (12). Figure 18 illustrates the SLS diagram.

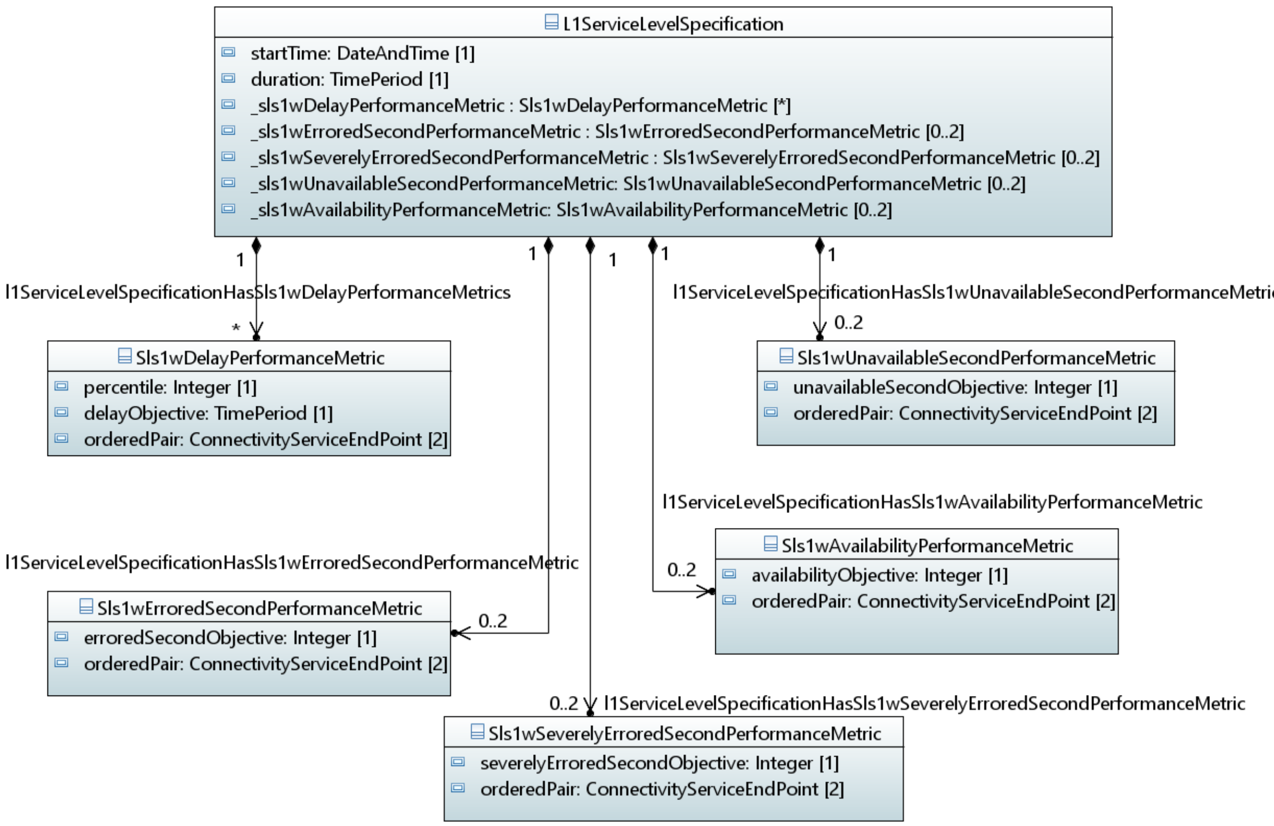

Figure 18 – *MRM_L1_SLS* Diagram

Note that the *orderedPair* attribute refers to TAPI *ConnectivityServiceEndPoint* object class, which description is not included in this Standard. See ONF TAPI Connectivity model [16] for further details.

13.1 L1ServiceLevelSpecification

This class represents the Service Level Specification that can be associated to a Subscriber or Operator L1 Connectivity Service.
MEF 63: The Subscriber L1VC Service Level Specification (SLS) Service Attribute is the technical specification of aspects of the service performance agreed to by the Service Provider and the Subscriber.
MEF 64: The Operator L1VC Service Level Specification (SLS) Service Attribute is the technical specification of aspects of the service performance agreed to by the SP/SO and the Operator.
MEF 63/MEF 64: For any given SLS, a given Performance Metric may or may not be specified. The value of the Subscriber/Operator L1VC SLS Service Attribute is either None or a 3-tuple of the form (t-s, T, PM). A Performance Metric is a quantitative characterization of L1CI delivery quality experienced by the Subscriber/SP/SO.

Attribute Name	Type	Mult.	Access	Description
startTime	DateAndTime	1	RW	MEF 63/MEF 64: t-start is a time that represents the date and time for the start of the SLS. [R22]/[R30} t-start MUST be specified to the nearest second.
duration	TimePeriod	1	RW	MEF 63/MEF 64: T is a duration that is used in conjunction with ts to specify a contiguous sequence of time intervals for determining when performance objectives are met. The units for T are not constrained. For example, a calendar month is an allowable value. Since the duration of a month varies it could be specified as, e.g. from midnight on the 10th of one month up to but not including midnight on the 10th of the following month. [R23]/[R31] T MUST contain an integer number of seconds.
_sls1wDelayPerformanceMetric	Sls1wDelayPerformanceMetric	0..*	RW	Reference to One-way Delay metric.
_sls1wErroredSecondPerformanceMetric	Sls1wErroredSecondPerformanceMetric	0..2	RW	Reference to One-way Errored Second metric.
_sls1wSeverelyErroredSecondPerformanceMetric	Sls1wSeverelyErroredSecondPerformanceMetric	0..2	RW	Reference to One-way Severely Errored Second metric.
_sls1wUnavailableSecondPerformanceMetric	Sls1wUnavailableSecondPerformanceMetric	0..2	RW	Reference to One-way Unavailable Second metric.
_sls1wAvailabilityPerformanceMetric	Sls1wAvailabilityPerformanceMetric	0..2	RW	Reference to One-way Availability metric.

13.2 Sls1wAvailabilityPerformanceMetric

MEF 63: Availability is defined as the percentage of Available Time over a given interval T-l which does not include Maintenance Interval Time (MIT).
MEF 64: Availability is defined as the number of seconds of Available Time divided by the sum of the number of seconds of Available Time plus the number of seconds of Unavailable Time expressed as a percentage over a given interval T-l.
MEF 63/MEF 64: [R35]/[R42] The SLS MUST define the One-way Availability Performance Metric Objective as met over T-l for a PM entry if and only if measured Availability PM >= availabilityObjective.

Attribute Name	Type	Mult.	Access	Description
availabilityObjective	Integer	1	RW	MEF 63/MEF 64: The value of the One-way Availability Performance Metric Objective, percentage > 0
orderedPair	ConnectivityServiceEndPoint	2	RW	MEF 63: Ordered pair of Subscriber L1VC EPs. MEF 64: Ordered pair of Operator L1VC End Points.

13.3 Sls1wDelayPerformanceMetric

MEF 63: The One-way Delay for the L1CI that ingresses at UNI 1 and that egresses at UNI 2 is defined as the time elapsed from the reception of the first bit of the ingress L1CI at UNI 1 until the reception of that first bit of the corresponding L1CI egressing at UNI 2.
MEF 64: The One-way Delay for the L1CI that ingresses at External Interface (EI) 1 and that egresses at EI 2 is defined as the time elapsed from the reception of the first bit of the ingress L1CI at EI 1 until the reception of that first bit of the corresponding L1CI egressing at EI 2 (Ordered pair of Operator L1VC End Points).
MEF 63/MEF 64: [R27]/[R34] The SLS MUST define the One-way Delay Performance Metric Objective as met during Available Time over T-l for a PM entry if and only if measured delay D <= delayObjective.

Attribute Name	Type	Mult.	Access	Description
percentile	Integer	1	RW	MEF 63: The Pd-percentile allows the One-way Delay Performance Metric Objective to be met although different delays may occur following a protection switch. To place an upper bound on any longer delays a second One-way Delay Performance Metric Objective for a higher Pd_percentile value (e.g., 100th) may be specified. MEF 64: Note that two One-way Delay Performance Metric Objectives D1 and D2 could be specified with corresponding parameters Pd1 and Pd2 respectively, where Pd2 > Pd1 (D2 being a longer delay objective associated with a higher percentile Pd2 (e.g., 100th) to bound potentially longer delays following a protection switch).
delayObjective	TimePeriod	1	RW	MEF 63/MEF 64: The value of the One-way Delay Performance Metric Objective, time units>0
orderedPair	ConnectivityServiceEndPoint	2	RW	MEF 63: Ordered pair of Subscriber L1VC EPs. MEF 64: Ordered pair of Operator L1VC End Points.

13.4 Sls1wErroredSecondPerformanceMetric

MEF 63/MEF 64: An errored second (ES) is defined as one second sigma-k in Available Time with at least one errored block (EB) and is not a SES. An EB is defined as a block in which one or more bits are in error (MEF 64: following Forward Error Correction). In this specification the L1CI corresponds to a block. [R29]/[R36] The SLS MUST define the One-way Errored Second Performance Metric Objective as met during Available Time over T-l for a PM entry if and only if measured Errored Second PM <= erroredSecondObjective.

Attribute Name	Type	Mult.	Access	Description
erroredSecondObjective	Integer	1	RW	MEF 63/MEF 64: The value of the One-way Errored Second Performance Metric Objective, integer >=0

Attribute Name	Type	Mult.	Access	Description
orderedPair	ConnectivityServiceEndPoint	2	RW	MEF 63: Ordered pair of Subscriber L1VC EPs. MEF 64: Ordered pair of Operator L1VC End Points.

13.5 Sls1wSeverelyErroredSecondPerformanceMetric

MEF 63/MEF 64: A Severely Errored Second (SES) is defined as: One second sigma-k which contains >= 15% errored L1CI (errored block, EB), or one second sigma-k which contains a defect (e.g., loss of signal), where MEF 63: a defect on ingress to (client protocol specific), or within the Service Provider's network (transport technology specific) may result in the insertion of a replacement signal (transport technology specific). Note that if a replacement signal is not inserted, a defect (such as a loss of signal) may propagate to the egress UNI. Note that a SES is not counted as a ES.
MEF 64: A defect may occur on ingress to an Operator's network or within the Operator's network and may result in the insertion of a replacement signal (transport technology specific). Note that a replacement signal itself represents a defect. Note that a SES is not counted as an ES.
MEF 63/MEF 64: [R31]/[R38] The SLS MUST define the One-way Severely Errored Second Performance Metric Objective as met during Available Time over T-l for a PM entry if and only if measured Severely Errored Second PM <= severelyErroredSecondObjective.

Attribute Name	Type	Mult.	Access	Description
severelyErroredSecondObjective	Integer	1	RW	MEF 63/MEF 64: The value of the One-way Severely Errored Second Performance Metric Objective, integer >=0
orderedPair	ConnectivityServiceEndPoint	2	RW	MEF 63: Ordered pair of Subscriber L1VC EPs. MEF 64: Ordered pair of Operator L1VC End Points.

13.6 Sls1wUnavailableSecondPerformanceMetric

MEF 63/MEF 64: An Unavailable Second (UAS) is defined as a second during Unavailable Time (UAT). [R33]/[R40] The SLS MUST define the One-way Unavailable Second Performance Metric Objective as met over T-l for a PM entry if and only if measured Unavailable Seconds PM <= unavailableSecondObjective.

Attribute Name	Type	Mult.	Access	Description
unavailableSecondObjective	Integer	1	RW	MEF 63/MEF 64: The value of the One-way Unavailable Second Performance Metric Objective, integer >=0
orderedPair	ConnectivityServiceEndPoint	2	RW	MEF 63: Ordered pair of Subscriber L1VC EPs. MEF 64: Ordered pair of Operator L1VC End Points.

14 References

[1] IETF RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, March 1997

[2] IETF RFC 8174, *Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words*, May 2017

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

[4] MEF 4, *Metro Ethernet Network Architecture Framework - Part 1: Generic Framework*, May 2004

[5] MEF 7.3, *Carrier Ethernet Service Information Model*, February 2017

[6] MEF 55, *Lifecycle Service Orchestration (LSO): Reference Architecture and Framework*, March 2016

[7] MEF 59, *Network Resource Management Information Model: Connectivity*, January 2018

[8] MEF 63, *Subscriber Layer 1 Service Attributes*, August 2018

[9] MEF 64, *Operator Layer 1 Service Attributes and Services*, February 2020

[10] MEF 72, *Network Resource Model - Subscriber Layer 1*, May 2019

[11] MEF 83, *Network Resource Model – OAM*, September 2019

[12] MEF Common Info Model GitHub repository: https://github.com/MEF-GIT/MEF-General-Common

[13] MEF MRM Info Model GitHub repository: https://github.com/MEF-GIT/Resources-Common-Model

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

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

[16] ONF Transport API (TAPI) Information Model, SDK 2.1.3 - “https://github.com/OpenNetworkingFoundation/TAPI/releases/tag/v2.1.3”, June 2020

[17] Papyrus UML Tool - Version 2019-09 “https://www.eclipse.org/papyrus/documentation.html” Copyright © 2019 The Eclipse Foundation. All Rights Reserved.

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

[19] TM Forum MTNM 4.5, July 2015

[20] TM Forum MTOSI 4.0, July 2015

Appendix A Examples of Network Scenarios (Informative)

The following depicts some network scenarios.

1) UNI to UNI:

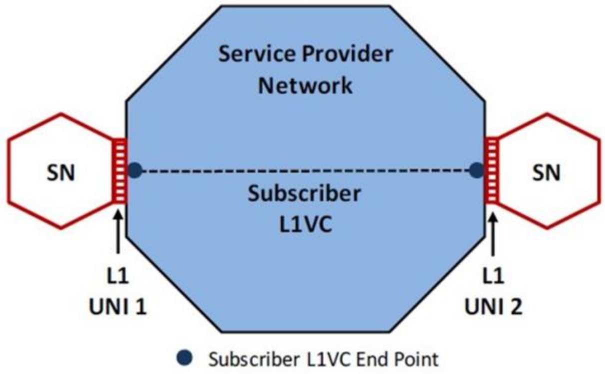

Figure 19 – Subscriber Layer 1 Virtual Connection

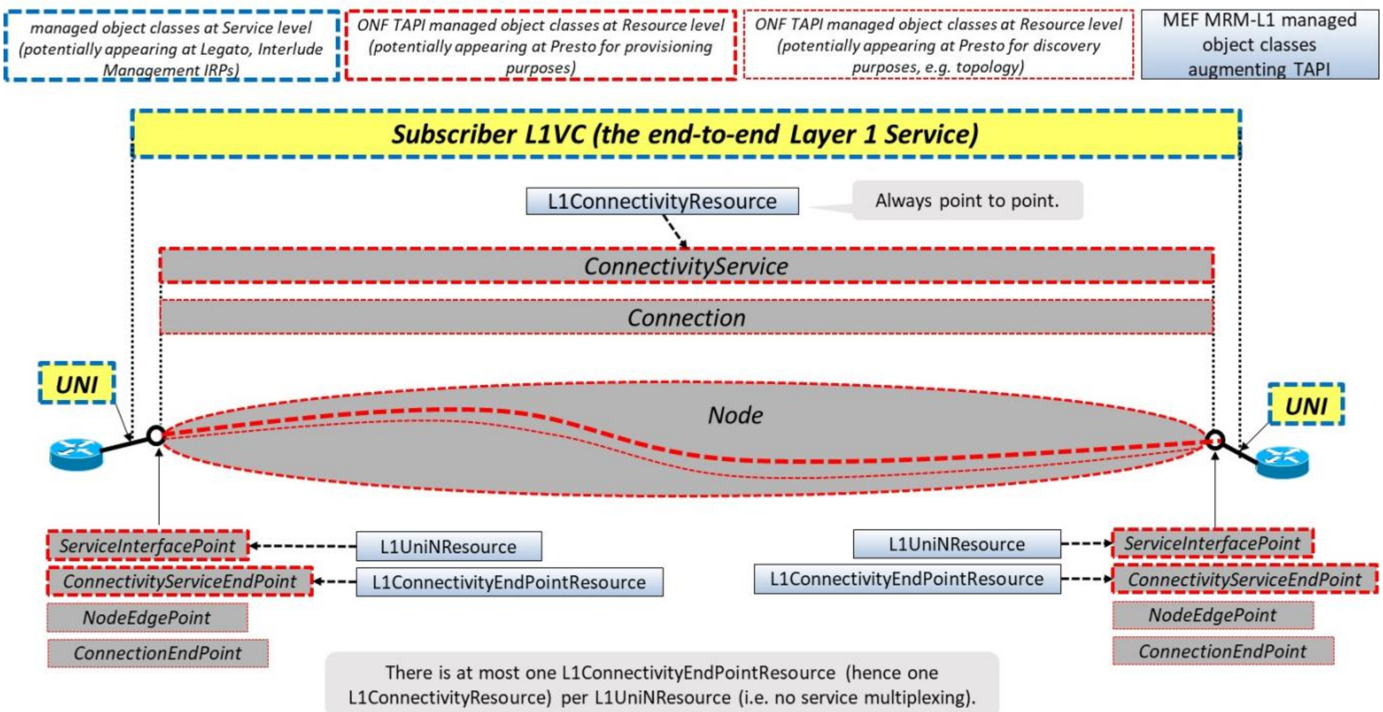

Figure 20 – Single Provider: single domain

2) UNI to INNI:

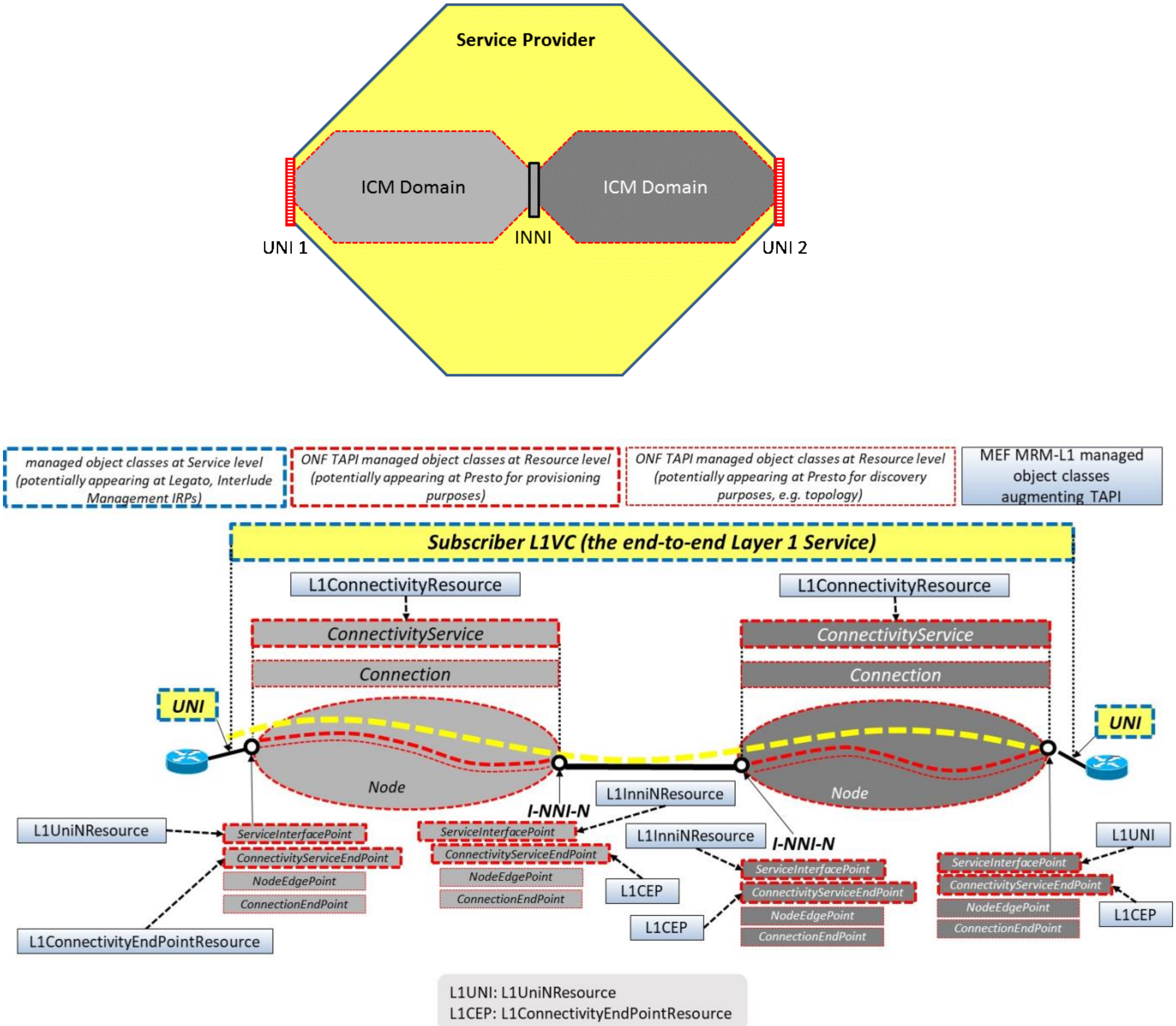

Figure 21 – Single Provider: separately managed domains

3) UNI to ENNI:

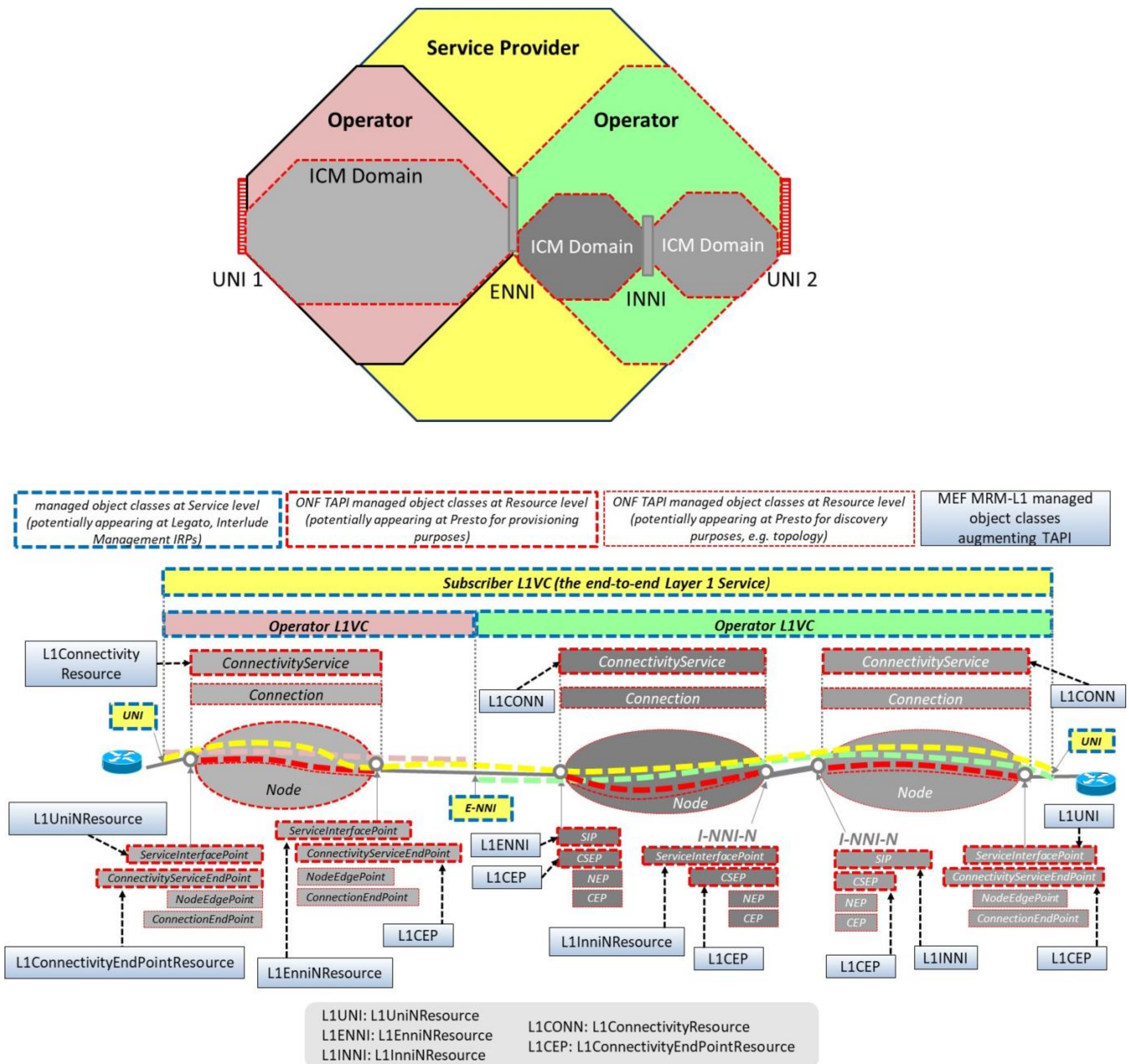

Figure 22 – Different Operators, separately managed domains

Figure 22 shows how a LEGATO Operator L1VC (green) is *decomposed-per-managed-domain* into two PRESTO L1CONN (L1 Connectivity Services). This is to be intended as a further recursion of Subscriber/Operator pattern. In other words, the PRESTO L1CONN is a *decomposition-per-managed-domain* of the LEGATO Operator L1VC, which itself is a *decomposition-per-managed-operator-domain* of the LEGATO Subscriber L1VC. The SOF shall manage these decompositions.

Appendix B Examples of ENNI Handoff types (Informative)

The following depicts some handoff scenarios using ONF TAPI graphic conventions.

- Note that from a resource management perspective, all scenarios also apply to replacing ENNI with INNI.
- Note that the OTU layer rate is not shown because it is considered *encapsulated* together with ODU rate.

B.1 ENNI Handoff Type 1 – Access

Figure 23 illustrates the case of a 100GigE client mapped into a LO ODU4 which is handed off at an ENNI where there is no multiplexing on either side (ENNI Type 1).

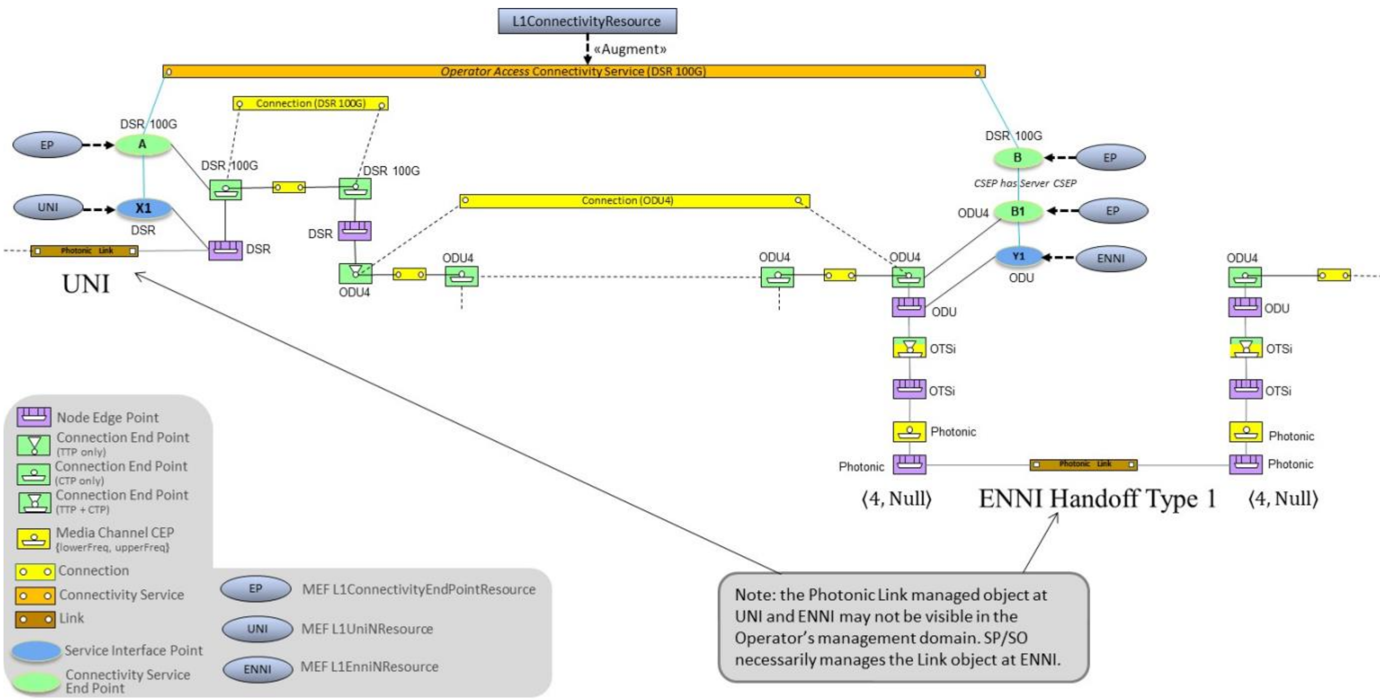

Figure 23 – ENNI Handoff Type 1 – Access

Figure 24 adds to Figure 23 the representation of TAPI *Nodes*. The *Node* is an abstract representation of the forwarding capabilities of a particular set of Network Resources. It is described in terms of the aggregation of a set of ports (*Node Edge Point*) belonging to those Network Resources and the potential to enable forwarding of information between those edge ports.

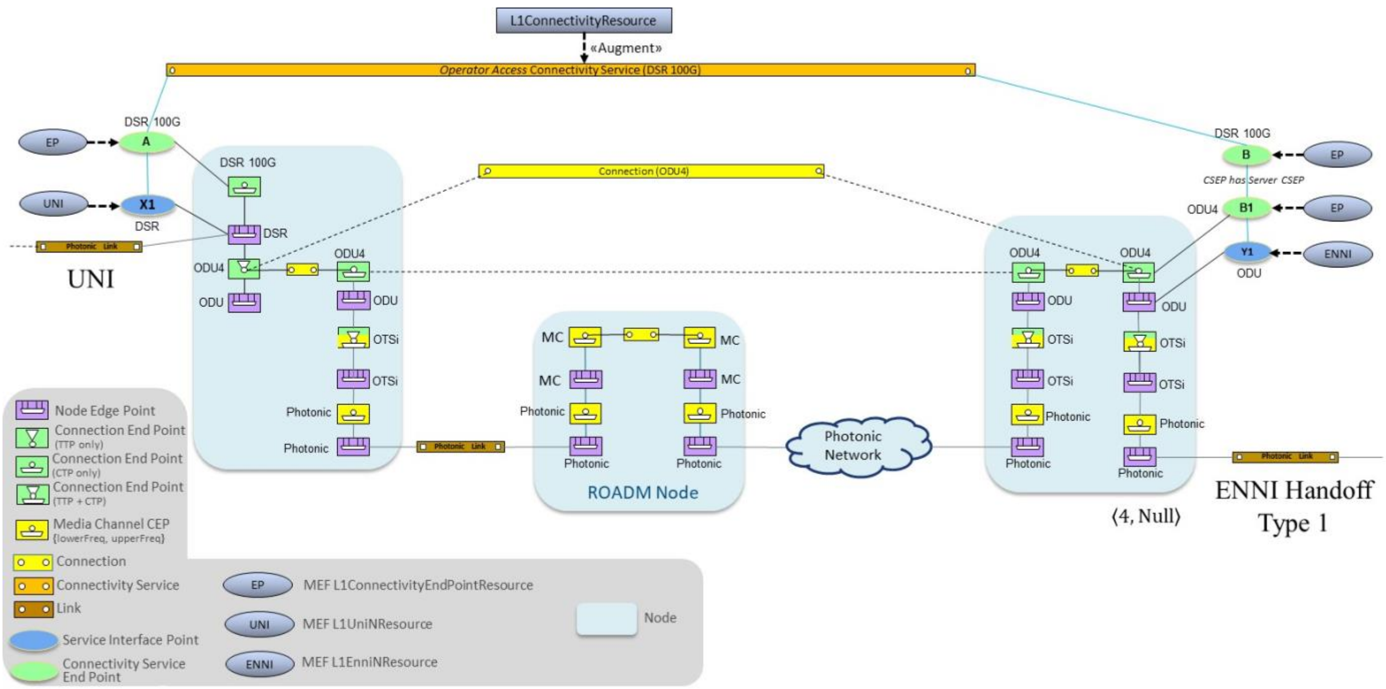

Figure 24 – ENNI Handoff Type 1 – Access, with *Nodes*

Figure 25 adds to Figure 23 the *OtukOverHead* and *PathOverhead* attributes.

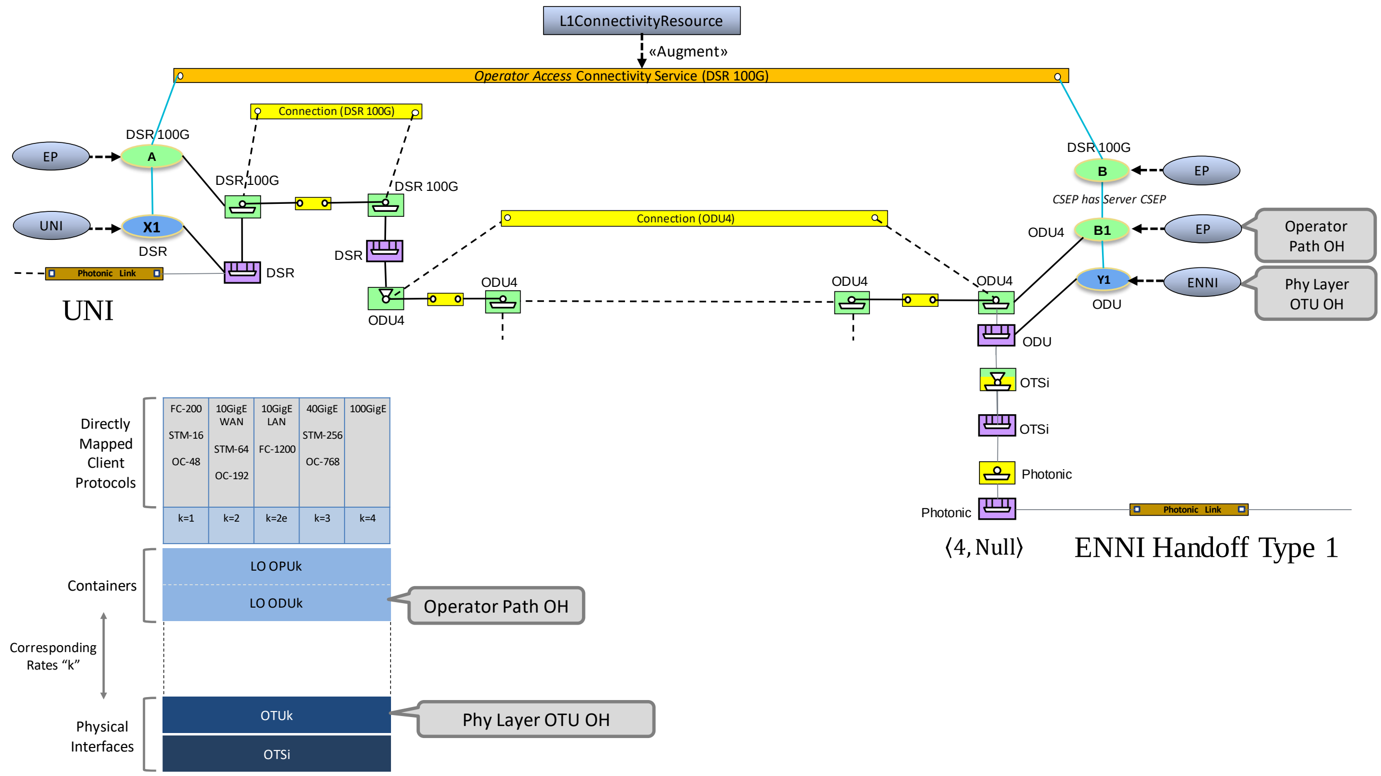

Figure 25 – ENNI Handoff Type 1 – Access, with OTU/ODU parameters

Figure 26 adds to Figure 23 the ODU SNCP protection local to ENNI.

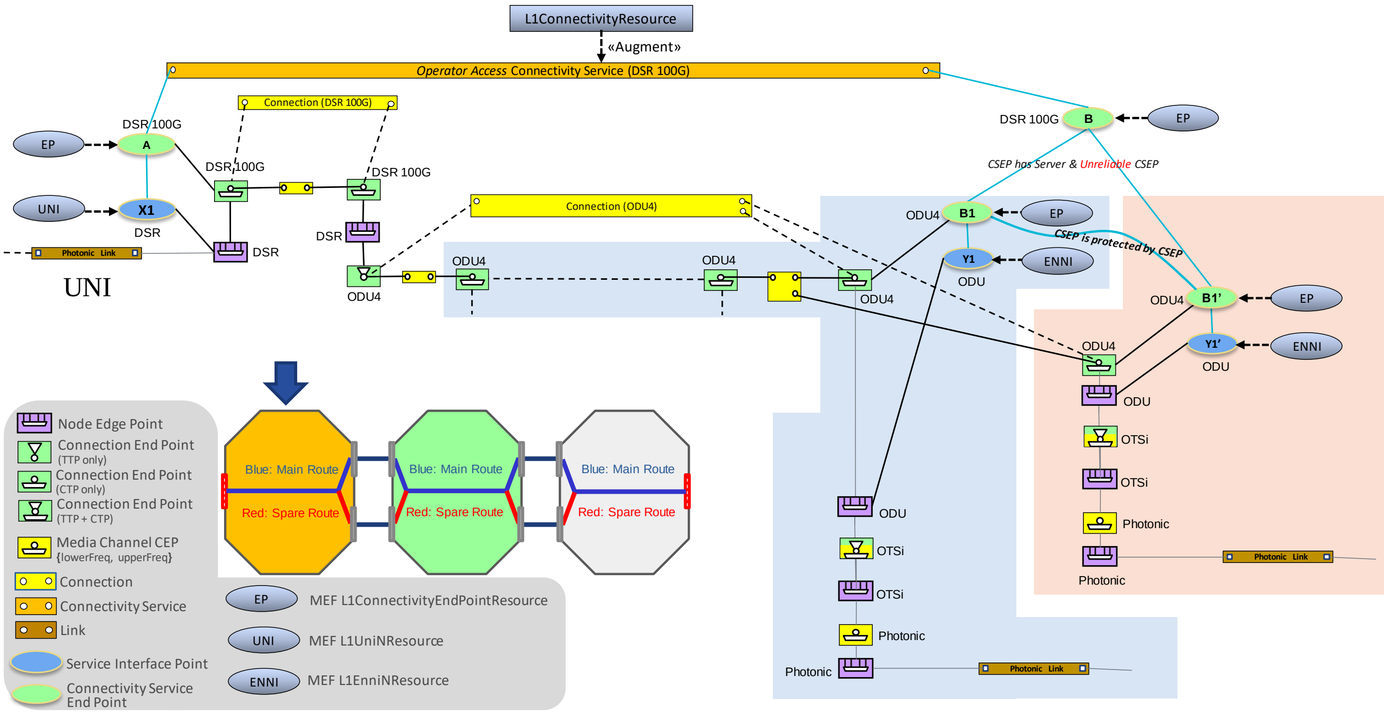

Figure 26 – ENNI Handoff Type 1 – ENNI Protected, Access Unprotected

Figure 27 adds to Figure 23 the ODU SNCP e2e protection for Subscriber L1 Service.

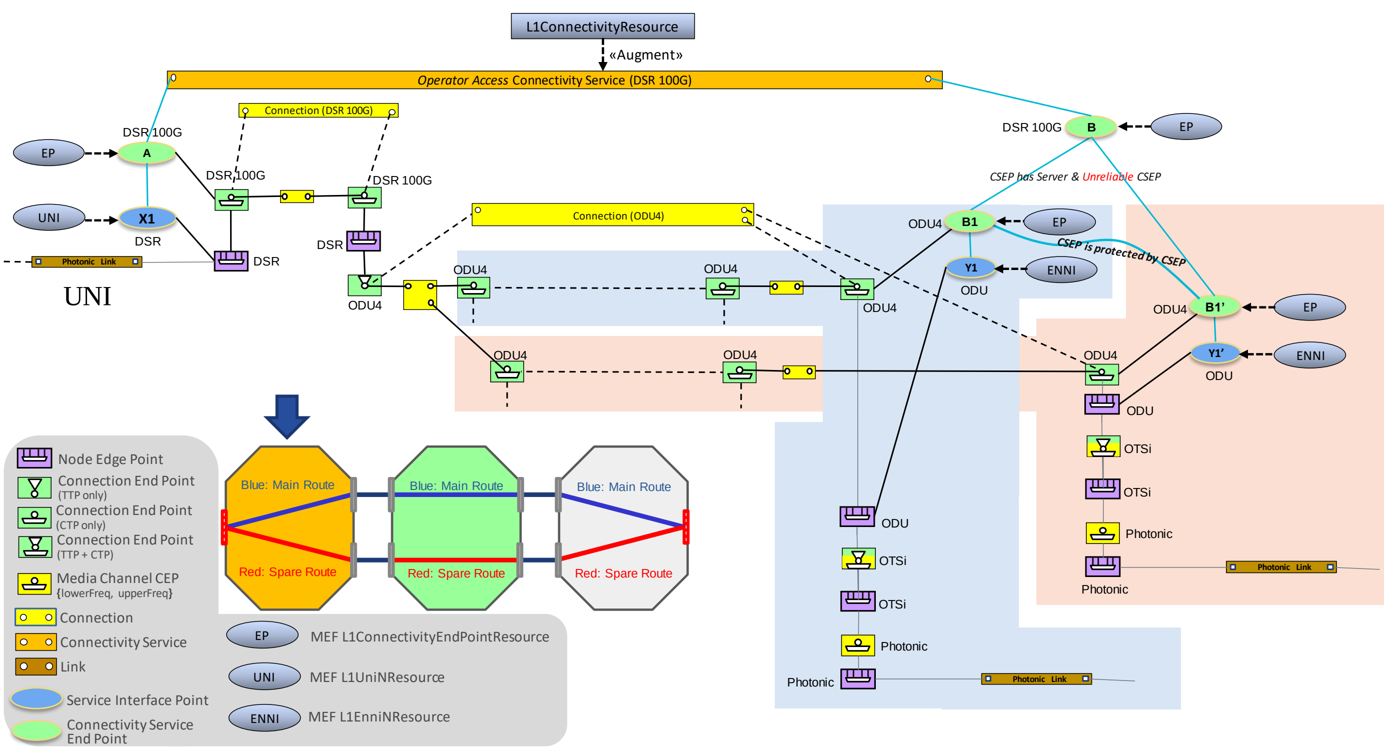

Figure 27 – ENNI Handoff Type 1 – Subscriber L1 Service e2e Protection

Figure 28 adds to Figure 23 the ODU SNCP protection schemes separately protecting the Operator L1 Access Service and the ENNI Link.

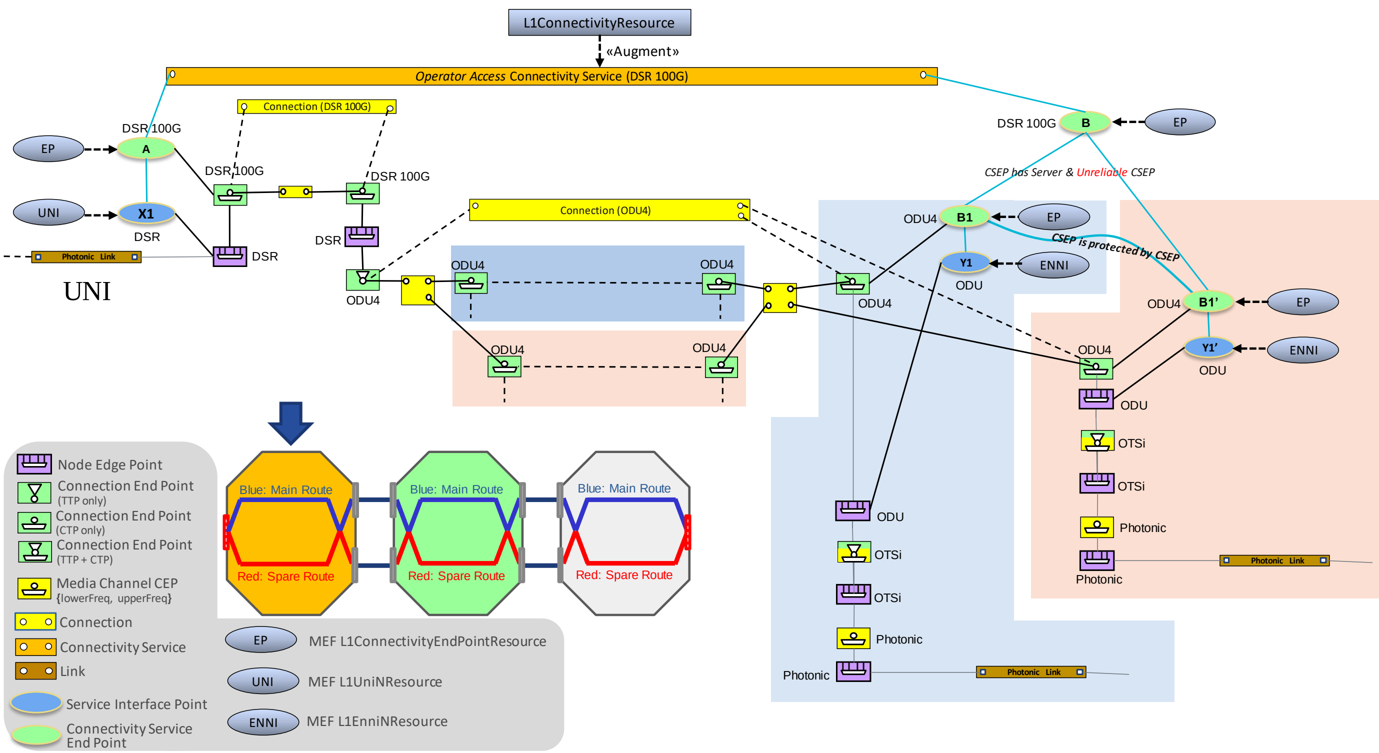

Figure 28 – ENNI Handoff Type 1 – ENNI Protected and Access Protected

B.2 ENNI Handoff Type 1 – Transit

Figure 29 illustrates the case of an ODU4 trunked across a transit Operator network between a pair of ENNIs where there is no multiplexing on either side (ENNI Type 1).

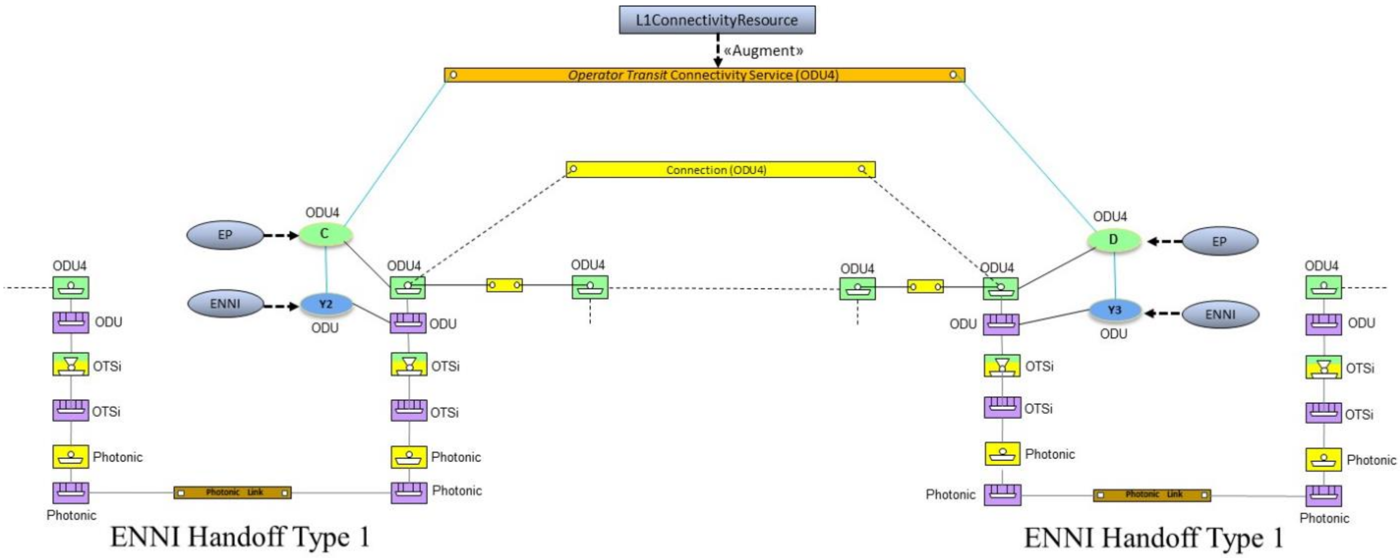

Figure 29 – ENNI Handoff Type 1 – Transit

In case of Subscriber L1 Service e2e Protection (as in Figure 27), then two distinct, independent Transit L1 Connectivity Services are foreseen.

Figure 30 shows the ODU SNCP protection local to ENNIs.

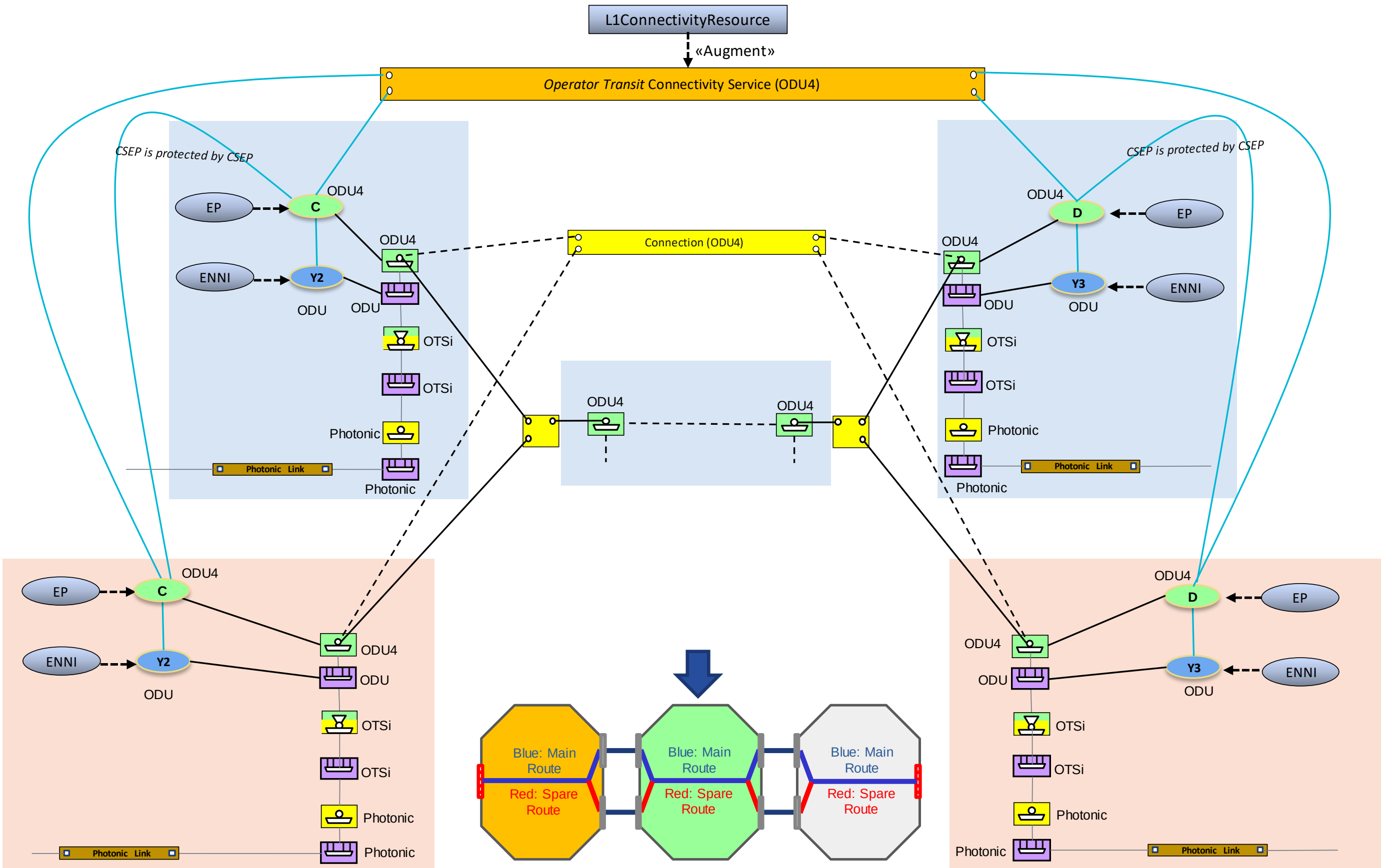

Figure 30 – ENNI Handoff Type 1 – ENNI Protected, Transit Unprotected

Figure 31 shows the ODU SNCP protection schemes separately protecting Transit and ENNI.

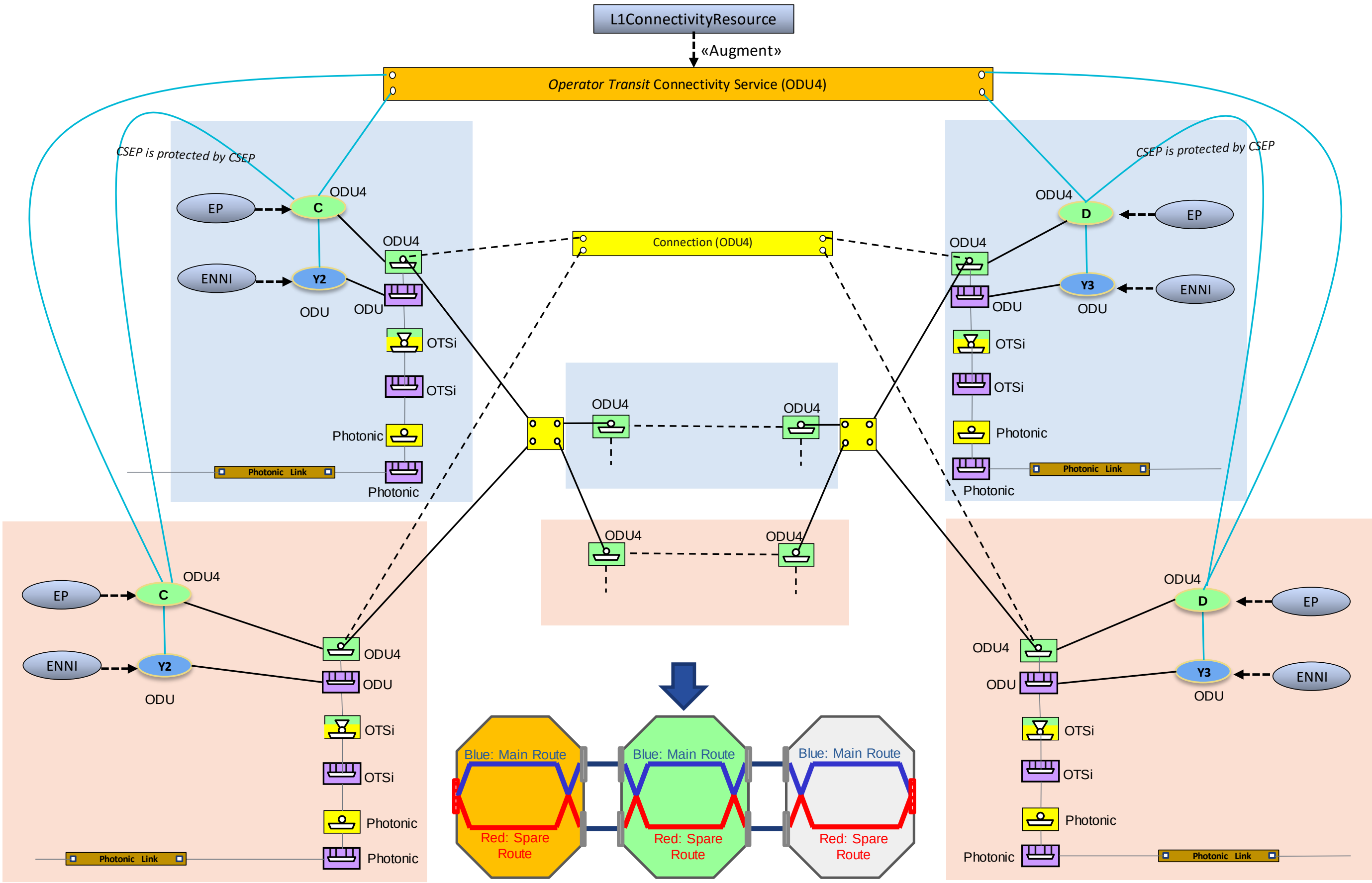

Figure 31 – ENNI Handoff Type 1 – ENNI Protected, Transit Protected

B.3 ENNI Handoff Type 2

Figure 32 illustrates the case of a 10GigE client mapped into a LO ODU2 which is multiplexed into a HO ODU4 which is handed off at an ENNI where there is no multiplexing on the other side (ENNI Type 2).

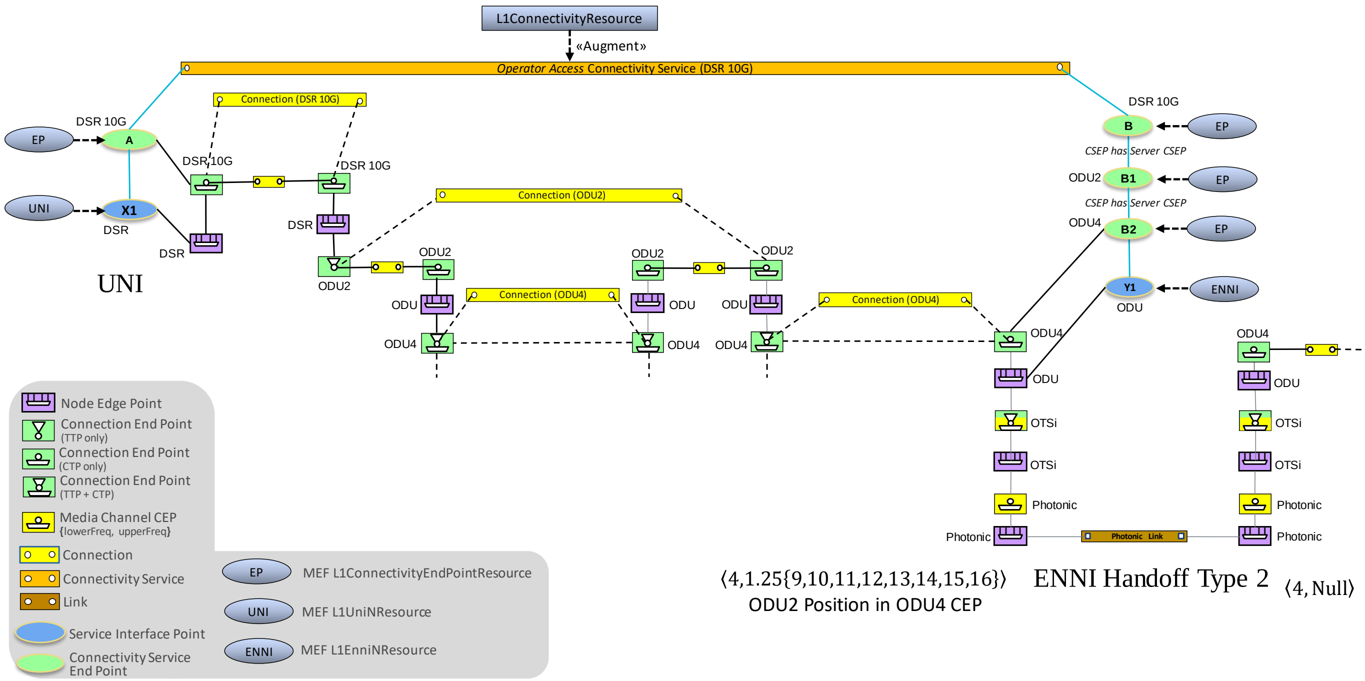

Figure 32 – ENNI Handoff Type 2 – Access Aggregation

Figure 33 shows the *OtukOverHead* and *PathOverhead* attributes.

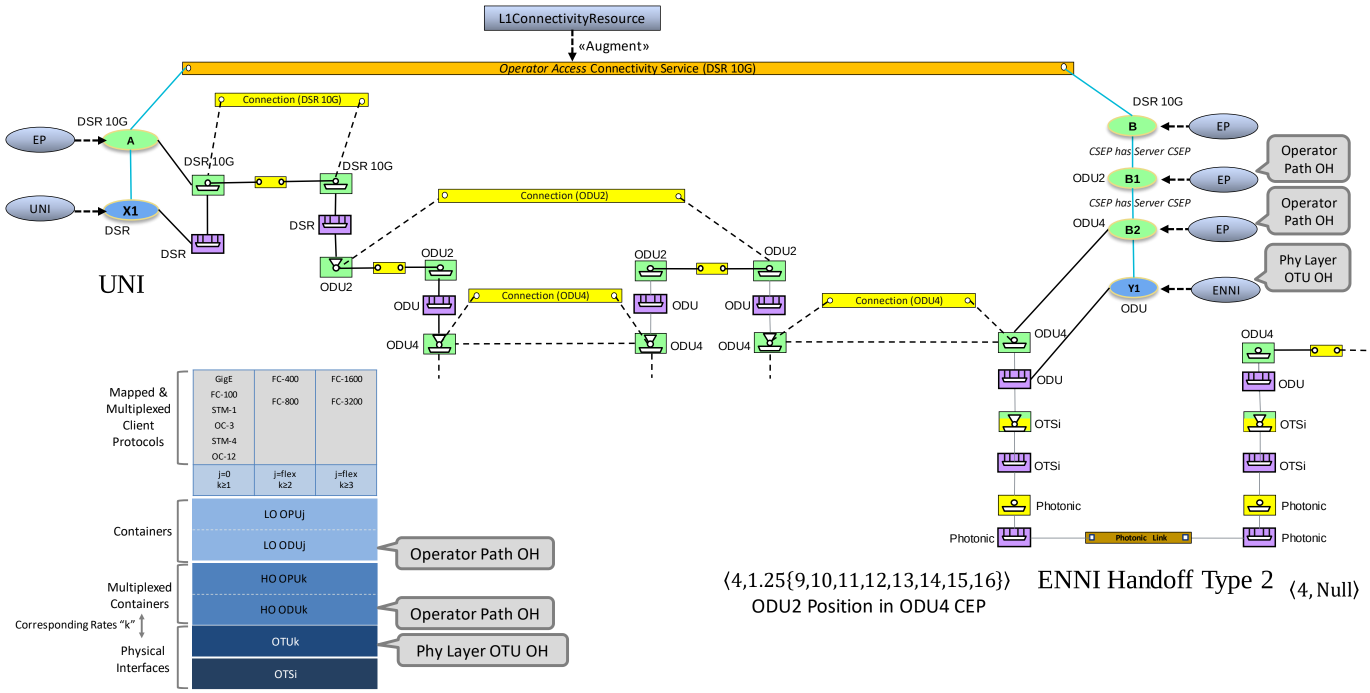

Figure 33 – ENNI Handoff Type 2 – Access, with OTU/ODU parameters

Figure 34 shows the *OtukOverHead* and *PathOverhead* attributes in case of two multiplexing stages.

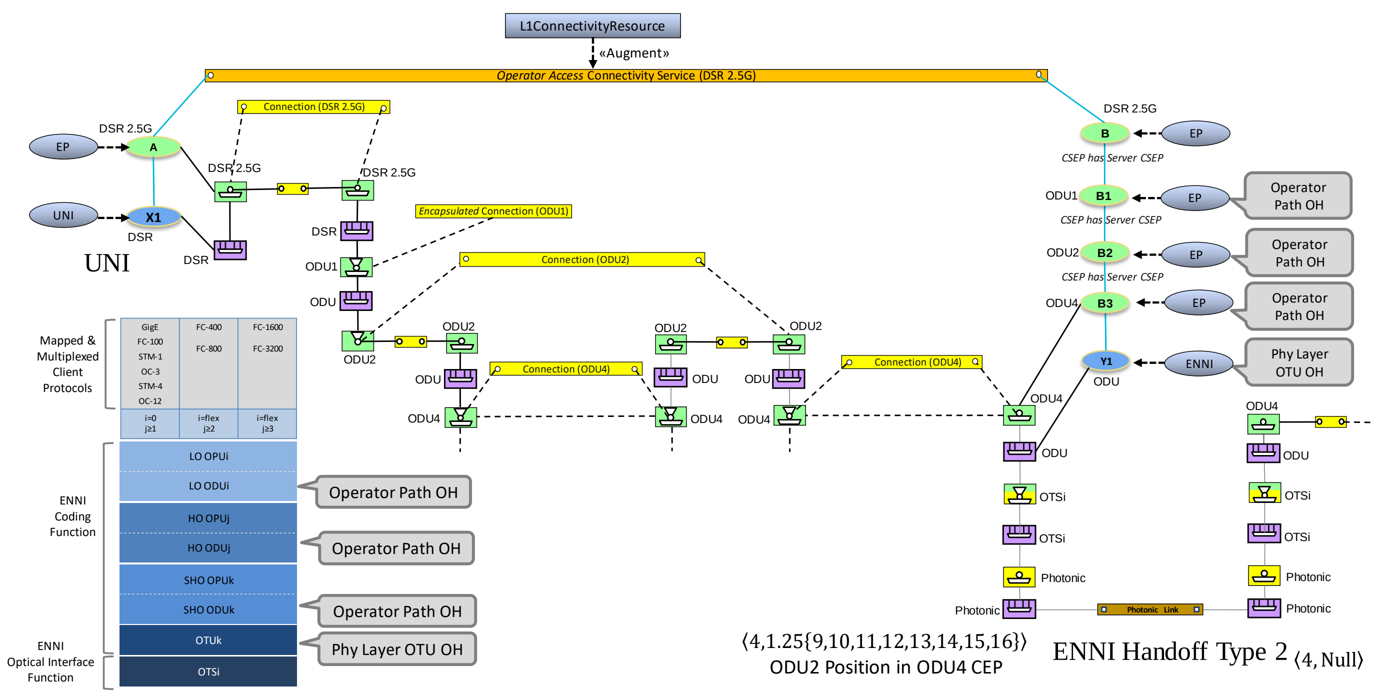

Figure 34 – ENNI Handoff Type 2 – Access, with OTU/ODU parameters – 2 stages mux

Figure 35 illustrates the case of an ODU4 trunked across a transit Operator network between a pair of ENNIs where there is multiplexing on the other sides (ENNI Type 2).

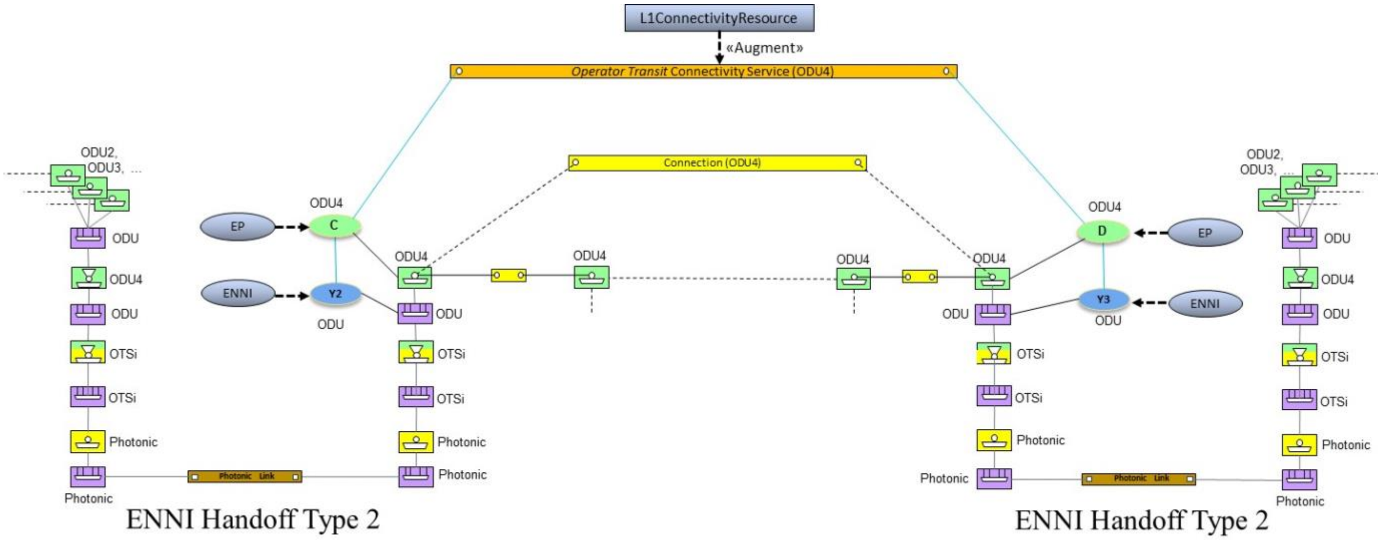

Figure 35 – ENNI Handoff Type 2 – Transit

B.4 ENNI Handoff Type 3

Figure 36 illustrates the case of a 10GigE client mapped into a LO ODU2 which is multiplexed into a HO ODU4 which is handed off at an ENNI where there is also multiplexing on the other side (ENNI Type 3).

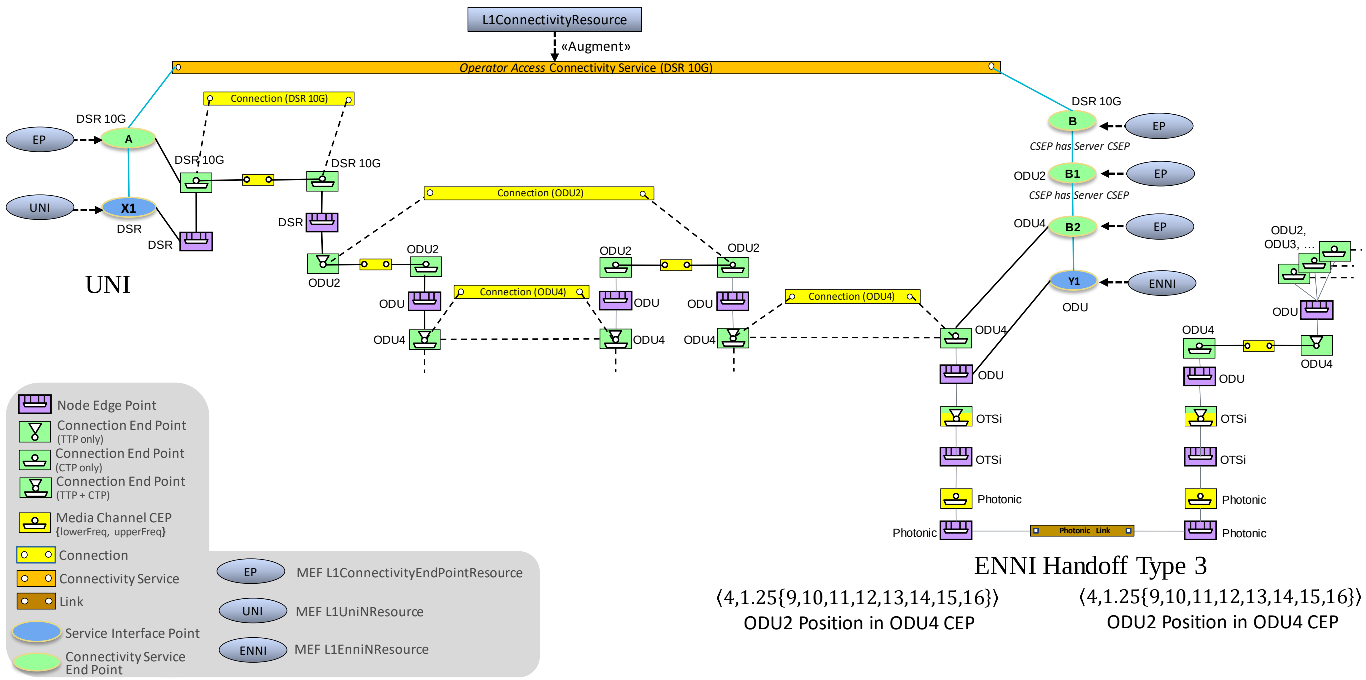

Figure 36 – ENNI Handoff Type 3 – Access Aggregation

Figure 37 shows the *OtukOverHead*, *HighOrderOdukOverHead* and *PathOverhead* attributes.

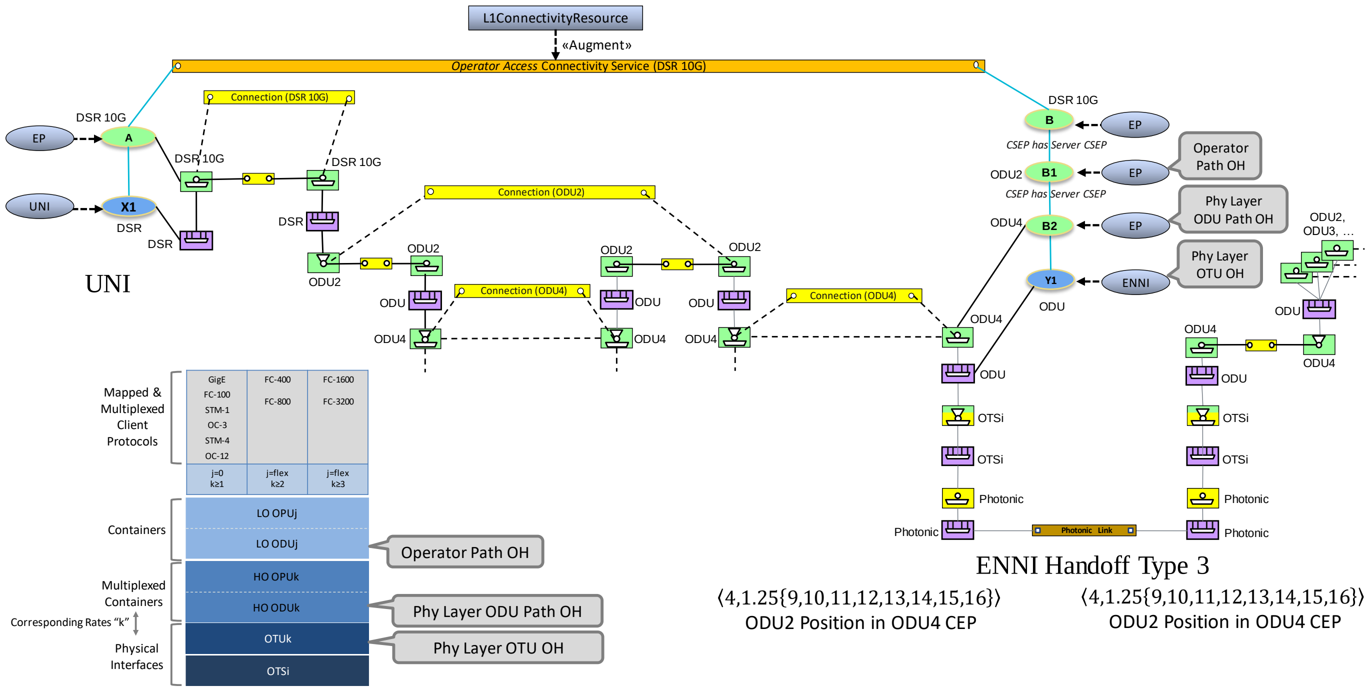

Figure 37 – ENNI Handoff Type 3 – Access, with OTU/ODU parameters

Figure 38 shows the *OtukOverHead*, *HighOrderOdukOverHead* and *PathOverhead* attributes in case of two multiplexing stages.

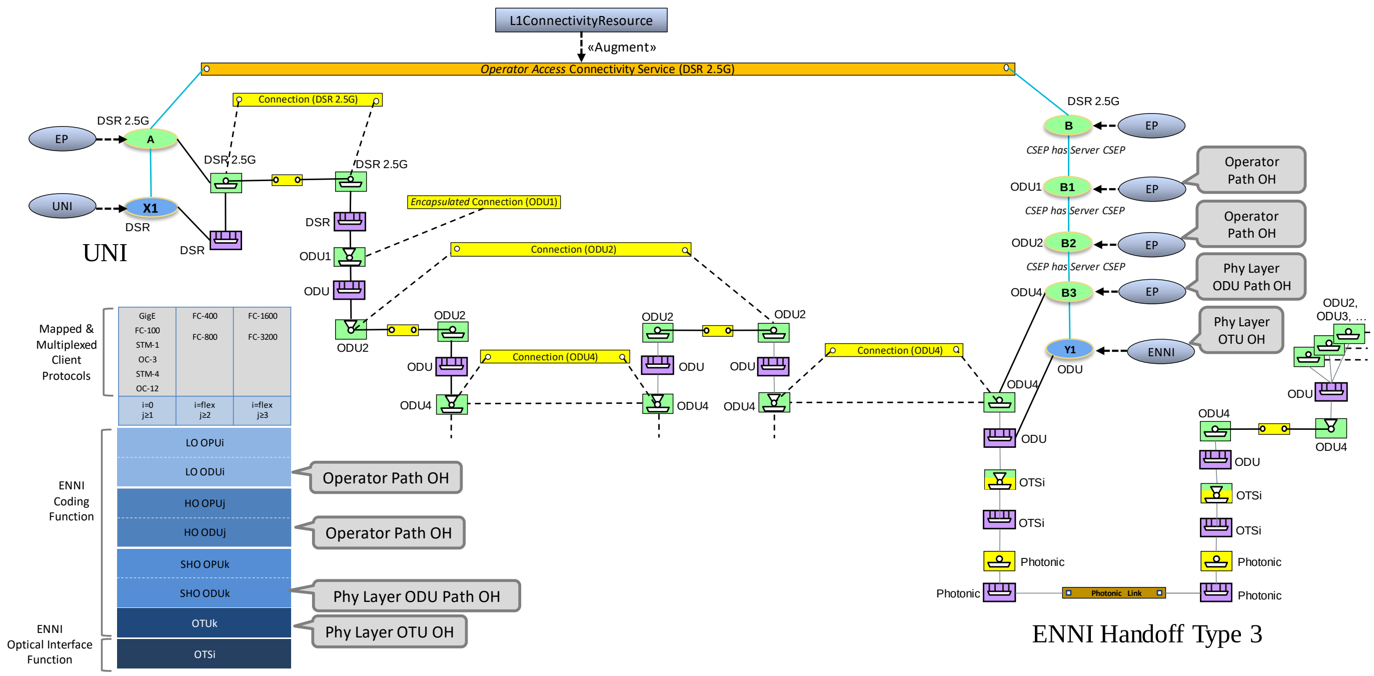

Figure 38 – ENNI Handoff Type 3 – Access, with OTU/ODU parameters – 2 stages mux

Figure 39 adds to Figure 32 and Figure 36 the ODU SNCP protection local to ENNI.

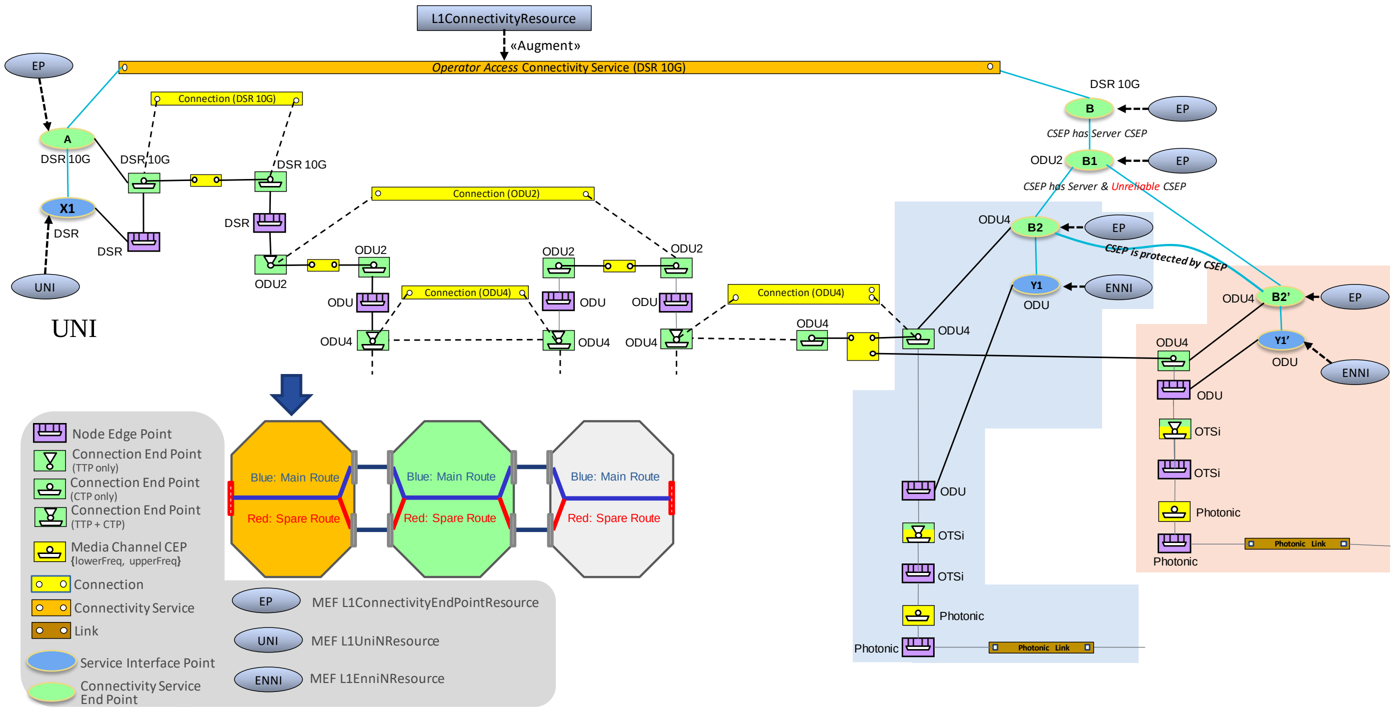

Figure 39 – ENNI Handoff Type 2 or 3 – ENNI Protected, Access Aggregation Unprotected

Figure 40 illustrates the case of a LO ODU2 trunked across a transit Operator network between a pair of ENNIs where it is multiplexed into a HO ODU4 at the left ENNI and multiplexed into a HO ODU3 at the right ENNI. There is also multiplexing on the other side of each ENNI (ENNI Type 3).

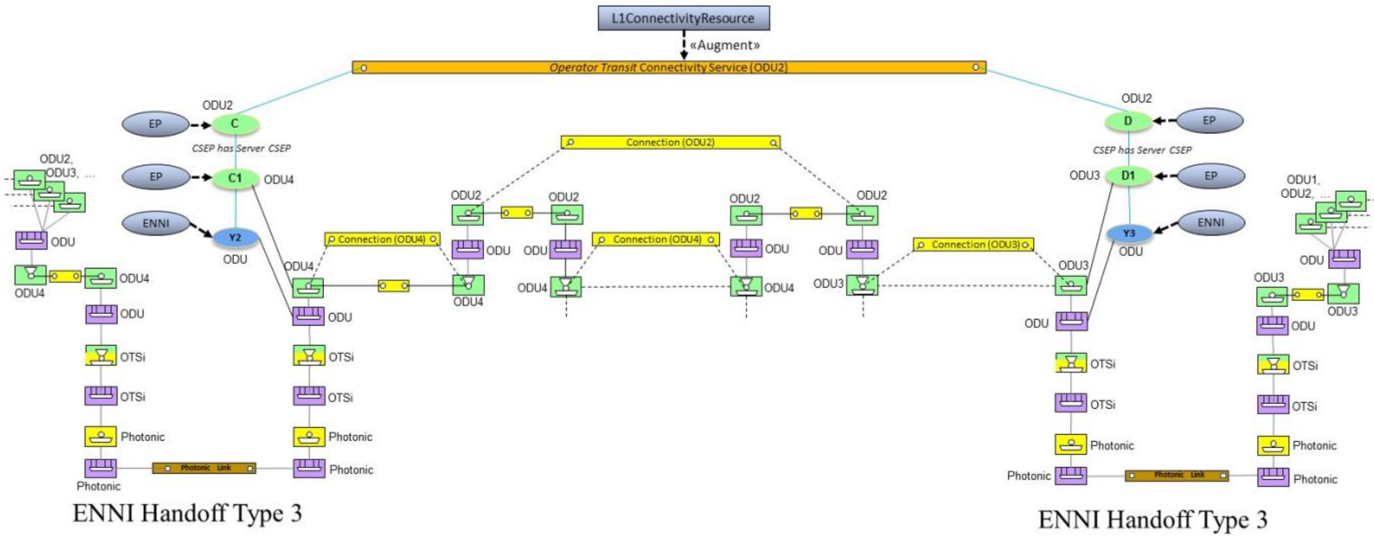

Figure 40 – ENNI Handoff Type 3 – Transit Aggregation