



**Working Draft**  
**MEF W102 v0.2**

**LSO Legato Internet Protocol Service Schemas  
and Developer Guide**

**December 2022**

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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.

*Editor Note 1: This list will be finalized before Letter Ballot. Any member that comments in at least one CfC is eligible to be included by opting in before the Letter Ballot is initiated. Note it is the MEF member that is listed here (typically a company or organization), not their individual representatives.*

*Editor Note 2: AddressFamily updates need to be discussed.*

*Editor Note 3: BGP data type needs to be discussed and reviewed.*



## 2 Abstract

This MEF Standard consisting of this Developer Guide and its associated software artifacts (JSON/YAML Schemas) defines and describes the service-specific payload for the LSO Legato API for a set of Service Functions – specifically, Service Order and Service Inventory, for IP Services. The document starts with an overview of LSO Legato and IP Subscriber and Operator Services. It then provides a basic information model for the MEF IP Service Attributes. The final sections describe the Data Model focused on the JSON/YAML Schemas associated with this specification.

This document can be thought of as a developer's guide for the IP Services Data Model and the schemas provided that embody the Data Model. MEF Services are described by a set of Service Attributes. Each Service Attribute describes an aspect of the service that is agreed between the provider and the user of the service. The document that describes the Service Attributes for Subscriber and Operator IP Services is MEF 61.1 [6] and MEF 61.1.1 [7] . The corresponding Information Model representing these resources and attributes is MEF 112 [10].

This Standard normatively incorporates the following files by reference as if they were part of this document, from GitHub repository [https://github.com/MEF-GIT/MEF-LSO/tree/develop\\_ip/schema/serviceSchema/ip](https://github.com/MEF-GIT/MEF-LSO/tree/develop_ip/schema/serviceSchema/ip).

### 3 Terminology and Abbreviations

This section defines the terms used in this document. In many cases, the normative definitions of 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. If the reference includes an asterisk (\*), the definition has been adapted from the original.

Term	Definition	Reference
Business Applications	The Service Provider functionality supporting Business Management Layer functionality (e.g., product catalog, order management, billing, relationship management, etc.)	MEF 55.1 [9]
BUS	See <i>Business Applications</i>	MEF 55.1 [9]
Information Model	A representation of concepts of interest to an environment in a form that is independent of data repository, data definition language, query language, implementation language, and protocol.	IETF RFC 3444 [3]
Order	One or more Service Order Items formulated into a fulfillment request made by a Client to a Server.	This document (derived from MEF 57.2)
Service Attribute	Specific information that is agreed upon between the provider and the user of the service, that describes some aspect of the service behavior or capability.	MEF 61.1 [6]
Service Provider	In the context of this document, a Service Provider is an Ethernet Service Provider. In this document, we use Service Provider to include Super Operator as specified in MEF 26.2 (also referred to as SP/SO).	This Document

**Table 1-Terminology and Abbreviations**

## 4 Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 (RFC 2119 [2], RFC 8174 [4]) 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 Prefixes

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

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

LSO Legato provides a programmatic interface for establishing an automated exchange of information (i.e., Service Order, Service Inventory) between a Business Application and Service Orchestration Function. These APIs are hierarchically structured. The outer-most structure includes information relating to the access method (e.g., REST), next is information relating to the function being requested (e.g., Service Order or Inventory, etc.) and the inner-most structure contains information relating to the specific service, for example IP Service).

The specific types of IP Services are Subscriber and Operator IP Services. Subscriber IP Services are requested between a Customer and a Service Provider or a Service Provider and a Partner. Operator IP Services are requested between a Service Provider (SP) and a Partner. The Service Attributes for Subscriber and Operator IP Services are defined in MEF 61.1 [6] and MEF 61.1.1 [7]. The corresponding Information Model that is used as a reference for JSON/YAML Subscriber and Operator IP Service schemas is MEF 112 [10].

This specification is accompanied by a Data Model for Subscriber and Operator IP Services instantiated as a set of JSON/YAML schemas that can be used within the Legato API to perform Service Order and Service Inventory requests.

The Data Model for Subscriber IP Services includes resource representations for:

- IPVC: An IP Service is formed of an IP Virtual Connection (IPVC) that links together IPVC End Points at Els.
- IPVC End Point: A logical entity at an External Interface (EI), to which a subset of packets that traverse the EI is mapped.
- IP UNI: A User Network Interface (UNI) is a demarcation point between the responsibility of the SP and the responsibility of the Subscriber. Note that a given UNI always relates to a single SP and a single Subscriber.
- IP UNI Access Link: An individual connection between the Subscriber and the SP that forms part of a UNI.
- IP UNI Access Link Trunk: A UNI Access Link Trunk is a construct that encapsulates the details of Layer 1 and Layer 2 configuration shared by one or more UNI Access Links.

The Data Model for Operator IP Services includes resource representations for:

- IP ENNI: An External Network Network Interface (ENNI) is the demarcation point between the responsibility of one Operator and another - other words, it is the interface where the two Operators interconnect.

- IP ENNI Common: ENNI Common Attributes that apply to each agreed between two LLOs (Lowest Level Operators).
- IP ENNI Link: An ENNI can comprise one more distinct IP Links, each of which is a single IP hop. These links are known as ENNI Links, and typically each corresponds to a distinct IP subnet (which can have both IPv4 and IPv6 addressing). ENNI Links are assumed to be point-to-point.

The document contains the following sections:

An overview of LSO Legato (Section 7)

An overview of IP Services Model (Section 8)

An overview of Subscriber IP Services (Section 9)

An overview of Operator IP Services (Section 10)

Subscriber and Operator Service Superclasses (Section 11)

Data Model Design Principles and Assumptions (Section 12)

Data Models for IP Services (Section 13)

Relationship between the Entities (Section 14)

Subscriber IP Service Data Model (Section 15)

Operator IP Service Data Model (Section 16)

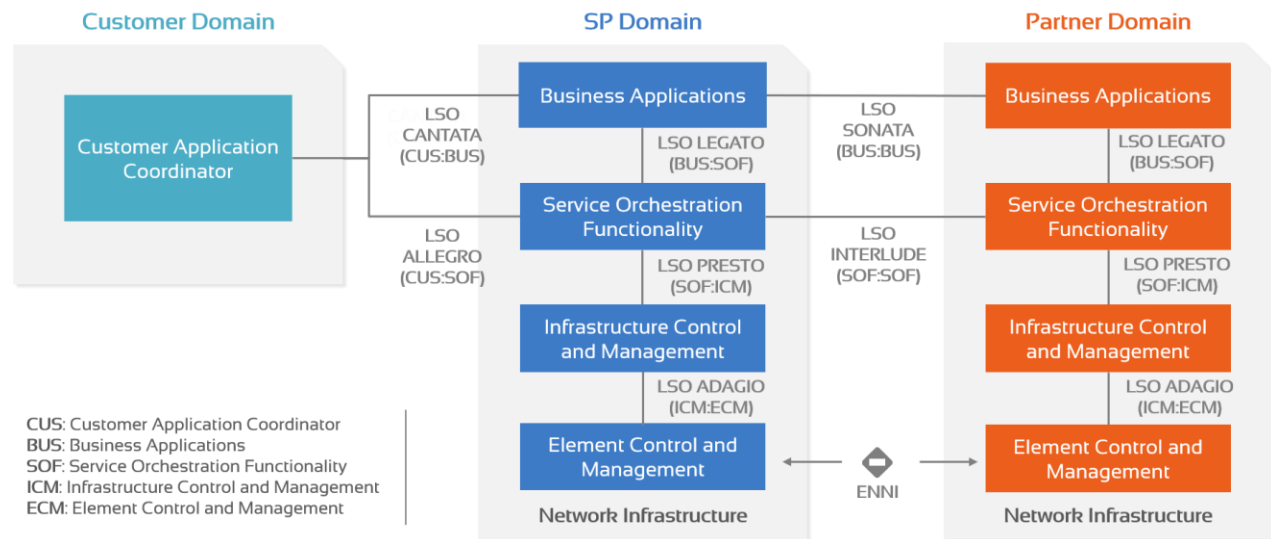
Common Classes and Types (Section 17)

IP Bandwidth Profile and Bandwidth Profile Envelope (Section 18)

IP SLS (Section 19)

## 7 Overview of LSO Legato

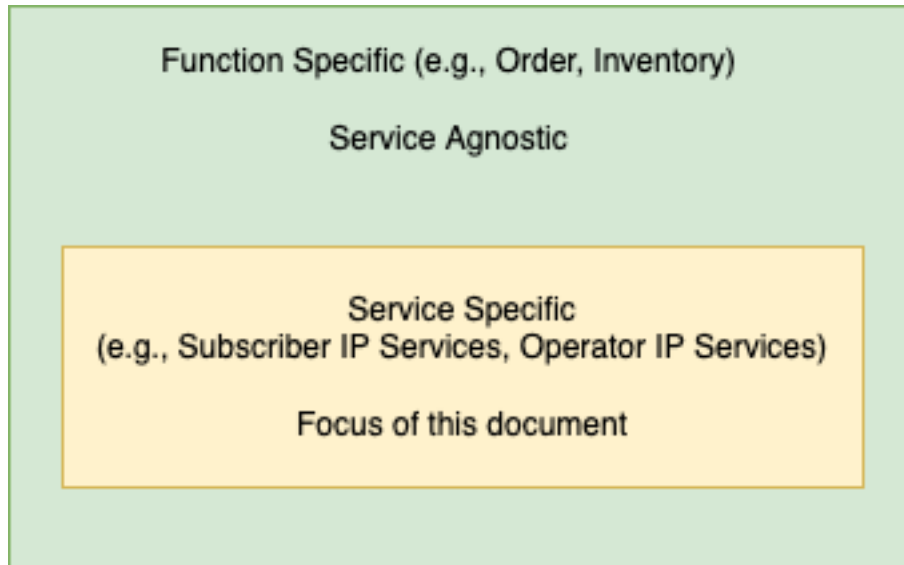
MEF 55.1 [9] describes the Reference Architecture for Lifecycle Service Orchestration (LSO) of MEF-defined connectivity services. MEF 55.1 [9] defines seven LSO Reference Points that are abstract interconnection points between different domains - either within the service provider domain (intra-domain) or between service provider and other business entities (inter-domain). One of these LSO Reference Points is LSO Legato which defines the abstract boundary point between a Service Provider's or Partner's Business Application (BA) and Service Orchestration Functionality (SOF) for providing connectivity services provisioning.



**Figure 1-LSO Reference Diagram**

The access to automated service provisioning functionality is provided using the Service Provisioning API at LSO Legato. LSO Legato provides a suite of APIs for provisioning, inventory, performance management which are standardized by MEF as LSO Legato APIs, and which are made available by MEF in a series of releases of the LSO Legato SDK.

The LSO Legato APIs comprise two parts: one is the service-independent functionality, or Basic API Structure, and the second is the service-specific payload, or Information Payload, as shown in Figure 2.



**Figure 2-LSO Legato API Structure**

This document defines the service-specific payload, shown as JSON Data Model in Figure 2, specifically for a MEF 3.0 Subscriber and Operator services as defined in MEF 61.1 [6], MEF 61.1.1 [7] and MEF 112 [10]. The envelope resources of the API and association to specific payload resources will be discussed in detail later in this document.



## 8 Overview IP Services Model

The IP Services model has eight main classes, Ipvc, IpvcEndPoint, IpUni, IpUniAccessLink, IpUniAccessLinkTrunk, IpEnni, IpEnniCommon and IpEnniLink. An IP Service is defined as having an IPVC and one or more IPVC End Points.

The IP Service Model supports Subscriber and Operator IP Services. Figure 3 shows the entire IP Services Model including classes used for both Subscriber and Operator IP Services. Further details for both Service types will be provided in this document.

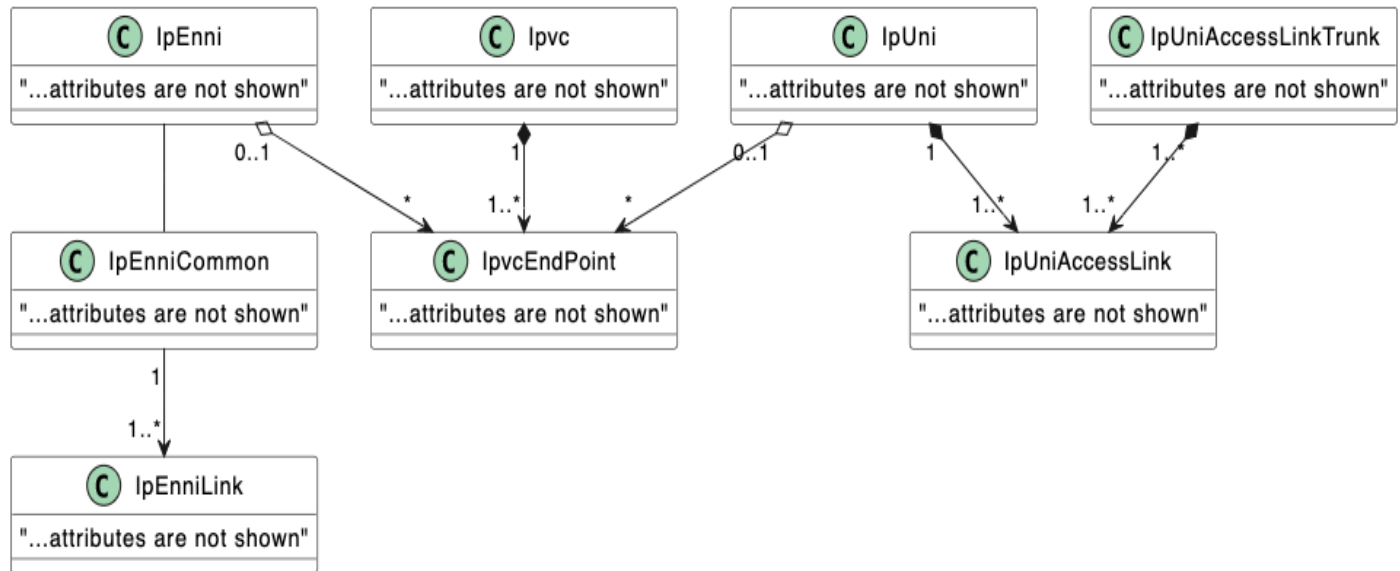


Figure 3-IP Service Model Overview

## 9 Overview of Subscriber IP Services

This specification describes a data model for MEF-defined IP Subscriber Services. A Subscriber IP Service is an IP Service provided to an end user (the Subscriber) by a Service Provider. There is no restriction on the type of organization that can act as a Subscriber; for example, a Subscriber can be an enterprise, a mobile operator, an IT system integrator, a government department, etc. At its most basic, a Subscriber IP Service provides connectivity for IP Packets between different parts of the Subscriber's network (usually at different physical locations) or between the Subscriber's network and an external network, such as the public Internet or a private cloud service.

A User Network Interface (IpUni) is the demarcation point between the responsibility of the SP and the responsibility of the Subscriber. A given IpUni always relates to a single SP and a single Subscriber.

A given IpUni consists of one or more distinct IP links, each of which is a single IP hop from a service perspective (i.e., there is no intermediate router that processes the IP Packets traversing the link). Each such IP link is known as a UNI Access Link (IpUniAccessLink) and is a subnetwork corresponding to a distinct IP subnet (which can have both IPv4 and IPv6 addressing).

An IP Service is formed of an IP Virtual Connection (Ipcv) that links together IPVC End Points (IpcvEndPoints) at External Interfaces (EIs). In the case of a Subscriber IP Service, the IPVC End Points (IpcvEndPoints) are specifically at UNIs (IpUnis).

Each IpUniAccessLink is carried by an underlying construct that encapsulates the Layer 1 and Layer 2 characteristics of the link. This construct is the UNI Access Link Trunk (IpUniAccessLinkTrunk). An IpUniAccessLinkTrunk may carry packets for a single IpUniAccessLink, as is the case where the IpUniAccessLink is a direct physical connection or may carry packets for multiple IpUniAccessLinks.

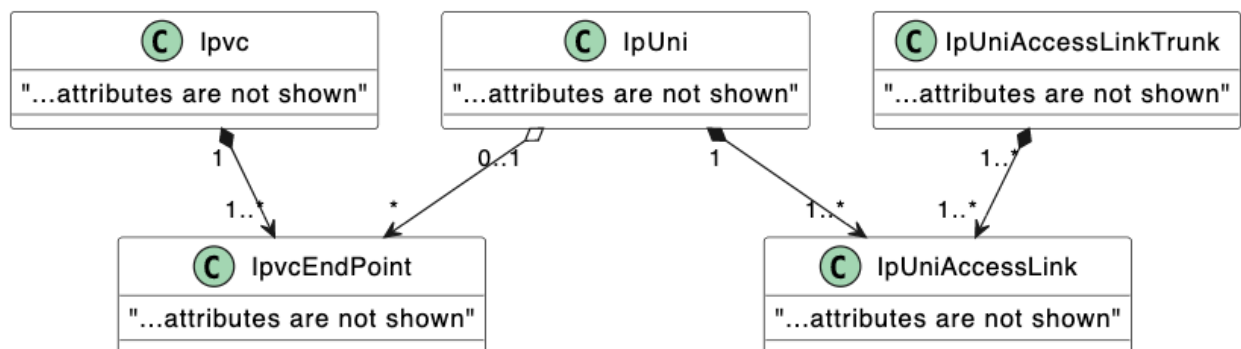


Figure 4-Subscriber IP Service Model

For Subscriber IP Services an IPVC has one or more IPVC End Points. The IPVC End Point points to exactly one IP UNI, and the IP UNI has one or more IP UNI Access Links.

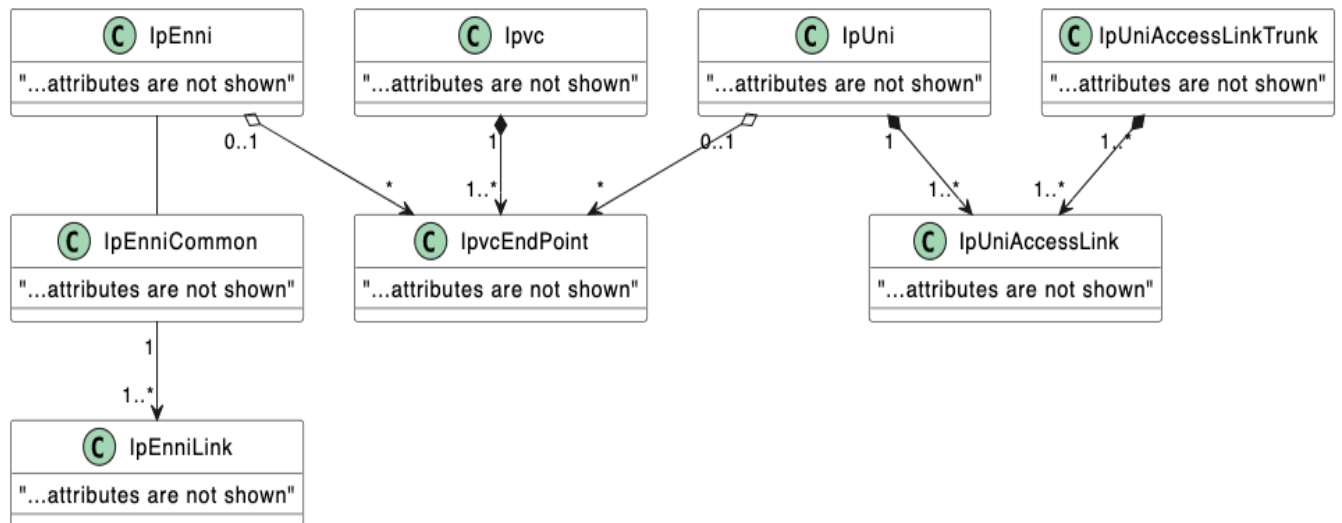
## 10 Overview of Operator IP Services

This specification describes a data model for MEF-defined IP Operator Services. When a Service Provider provides an end-to-end Subscriber IP Service to a Subscriber, they might not be able to implement the entire service using their own network - for instance, one of the Subscriber UNIs might not be in a geographic region where the Service Provider does not operate. In this case, the Service Provider must partner with another Operator who can reach that UNI. The Operator provides an IP connectivity service between the UNI and a point where they can interconnect with the SP's network as described in MEF 61.1 [6], MEF 61.1.1 [7] and MEF 112 [10].

An External Network Network Interface (ENNI) is the demarcation point between the responsibility of one Operator and another - in other words, it is the interface where two Operators interconnect.

Like a UNI, an ENNI can comprise one or more distinct IP Links, each of which is a single IP hop. These links are known as ENNI Links, and typically each corresponds to a distinct IP subnet (which can have both IPv4 and IPv6 addressing). ENNI Links are assumed to be point-to-point.

When two Operators are connected by several ENNI Links, they need to agree how these links are grouped together to form ENNIs (via the ENNI List of ENNI Links Common Attribute). Each ENNI Link belongs to exactly one ENNI.



**Figure 5-Operator IP Service Model**

For Operator IP Services an IPVC has one or more IPVC End Points. The IPVC End Point points to one IP ENNI. The IP ENNI points to an IP ENNI Common and the IP ENNI has one or more IP ENNI Links.

## 11 Subscriber and Operator Service Superclasses

Several of the IP main classes are sub-classed from a parent class that holds common attributes that are used by similar classes in the IP Services model. The superclass objects are IpServicesExternalInterfaceLink and IpServicesExternalInterface.

The IpServicesExternalInterfaceLink represents the Link Interface used for IP services. This is an abstract class and the super class. It contains the common attributes of IpEnniLink and IpUniAccessLink.

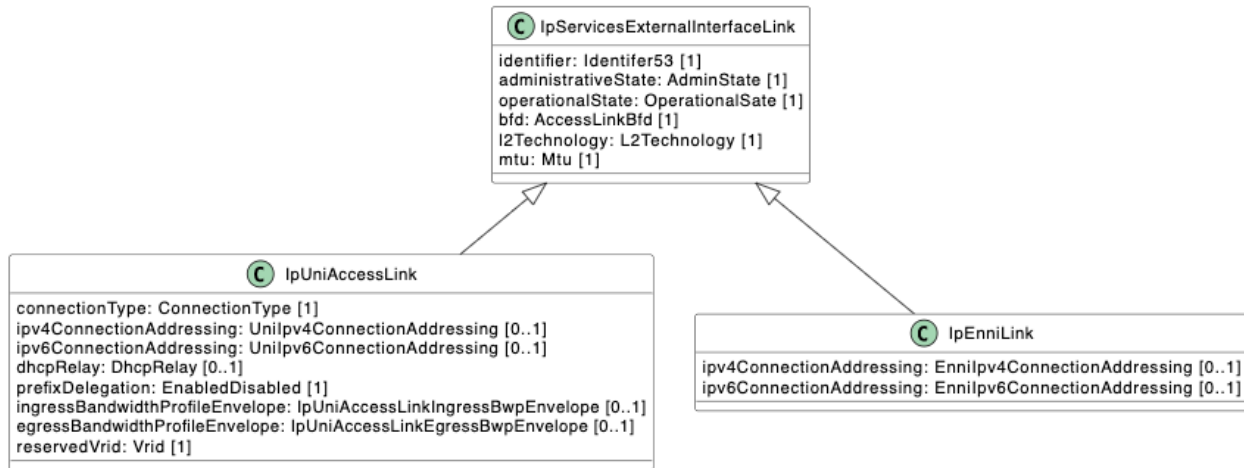


Figure 6-IpServicesExternalInterfaceLink Model

The IpServicesExternalInterface represents the physical interface used for IP services. This is an abstract class and the superclass. It contains the common attributes of IpEnni and IpUni.

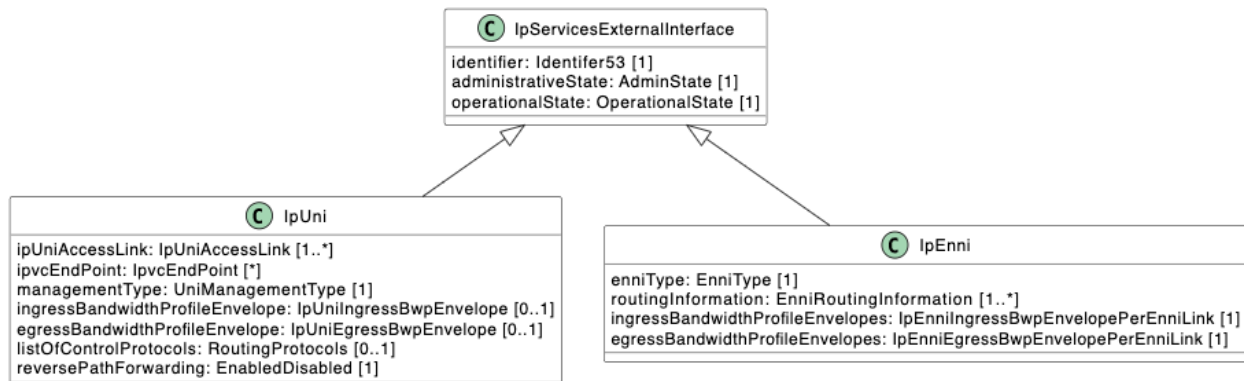


Figure 7-IpServicesExternalInterface Model

## 12 Data Model Design Principles and Assumptions

A Service Attribute for a Service can have a value that is a simple datatype such as an integer or string (or list of simple datatypes) or a value that is an object with multiple properties or a composition of objects. Within this document each simple value (integer, string, Boolean, etc.) is referred to as a Service-Specific Attribute. A Service-Specific Attribute could be a Service Attribute (in the case where the Service Attribute itself has a simple type) or it could be a parameter within a Service Attribute (if the Service Attribute is a structured object or a composition of such objects). The classification for each Service-Specific Attribute may be different across Service Function, Service Action, and Service Offering.

- **Mandatory** – attributes that must be provided by the Client in a Service Order request or must be returned by the SOF for an Inventory request as specified in Section 0.
- **Optional** – attributes that may be provided by the Client in a Service Order request and may be returned by the SOF for an Inventory request as specified in Section 12.2.
- **Fixed** – attributes that are hard coded and may be specified by the Client in a Service Order request and may be returned by the SOF for an Inventory request as specified in Section 12.3.

As noted above, the classification may depend on:

**Service Function** – a given Service-Specific Attribute may, for example, be classified as Fixed for the Create Service Order request; while it may be classified as Mandatory for the Create Service Order request.

**Service Action** – a given Service-Specific Attribute may, for example, be classified as Mandatory for the Create Service Order request for an INSTALL of a new service, while it may be classified as Fixed for the Create Service Order request for a CHANGE of an installed Service.

**Service Offering** – a given Service-Specific Attribute may, for example, be classified as Mandatory for Create Service Order request for Service Order (e.g., Premium Service), while it may be classified as Fixed for the Create Service Order request for a different Service Order (e.g., Basic Service).

The Service-Specific Attribute classification can be defined and negotiated during the onboarding process or defined in a Service Catalog.

**[R1]** The SOF and Client **MUST** agree, for each Service-Specific Attribute, whether the attribute is Mandatory, Optional, or Fixed for each Service Function (Service Order) and Service Action (INSTALL, CHANGE) for a Service Offering.

**[R2]** The SOF and Client **MUST** agree, for each Service-Specific Attribute, whether the attribute is Mandatory, Optional, or Fixed for Inventory for a Service Offering.

**[R3]** If, for a Service Offering, a Service-Specific Attribute is classified as Optional for any Service Function, and if applicable, Service Action, the SOF and the Client **MUST** agree on the default value for the attribute.

- [R4] The SOF **MUST** reject and API request if the value for a Service-Specific Attribute requested by the Client is not a supported value for the applicable Service Offering.

The IP Service data model supports both INSTALL and CHANGE actions for Service Order for IPVC, IP UNI, IP UNI Access Link, IP UNI Access Link Trunk, IPVC End Point, ENNI, and ENNI Link. The IP Service data model supports the RETRIEVE action for Inventory for all Service Order components.

The location and physical layer of a UNI Access Link Trunk or ENNI Link cannot be changed once it is ordered; instead, this is handled as an installation (UNI Access Link Trunk or ENNI Link at new location) and disconnect (UNI Access Link Trunk or ENNI Link at previous location), as there is often a requirement for a smooth transition with minimum downtime.

## 12.1 Mandatory Service-Specific Attributes

- [R5] If a Service-Specific Attribute is agreed to be Mandatory for a Service Function (Service Order) and Service Action (INSTALL, CHANGE), then the Client **MUST** include a value for the Service Attribute in the corresponding API request.

- [R6] If a Service-Specific Attribute is agreed to be Mandatory for Inventory, then the SOF **MUST** include a value for the attribute in the corresponding API response.

- [R7] When the SOF receives a Service Order request in which any of the Mandatory Service-Specific Attributes are not included, the request **MUST** be rejected by the SOF.

## 12.2 Optional Service-Specific Attributes

- [O1] If a Service-Specific Attribute is agreed to be Optional for a Service Function (Service Order) and Service Action (INSTALL, CHANGE), then the Client **MAY** include a value for the attribute in the corresponding API request.

- [R8] The SOF **MUST** apply the agreed default value for an Optional Service-Specific Attribute if a value is not included by the Client in the corresponding API request.

- [R9] If a Service-Specific Attribute is agreed to be Optional for Inventory, then the SOF **MUST** include a value for the attribute in the corresponding API response if the value is not the agreed default value.

- [O2] If a Service-Specific Attribute is agreed to be Optional for Inventory, then the SOF **MAY** include a value for the attribute in the corresponding API response if the value is the agreed default value.

## 12.3 Fixed Service-Specific Attributes

A Service-Specific Attribute may be classified a Fixed for a Service Function and Service Action when only one value is applicable for the SOF. This can be the case for example if:

- the SOF supports only a single value, or
- the value is derived by the SOF from the value of one more other Service-Specific Attributes, or
- the SOF specifies a single value in the Service Catalog for a specific Service Offering, or
- the Client and SOF agree on a single value during onboarding.

Since these a Service-Specific Attributes, each value must still be agreed in some way between the Client and the SOF, which implies that even in the first two cases, the SOF must make the Client aware of what the value is or how it is derived, before the Client places and order. How this is done is outside the scope of this document.

The SOF applies the one applicable value for every request for which the Service-Specific Attribute is classified as Fixed.

**[R10]** The Client and SOF **MUST** agree on whether the Client can include Service-Specific Attributes that have been classified as Fixed in API requests for Service Order.

**[R11]** If the Client and SOF agree that Service-Specific Attributes classified as Fixed cannot be included in API requests (see [R10]), the Client and SOF **MUST** agree on whether the SOF includes Service-Specific Attributes classified as Fixed in the corresponding API responses.

**[R12]** If the Client and SOF agree that Service-Specific Attributes classified as Fixed cannot be included in the API requests (see [R10]), the SOF **MUST** reject an API request from the Client if it includes Service-Specific Attributes that has been classified as Fixed for the Service Function (Service Order), and Service Action (INSTALL, CHANGE).

**[R13]** If the Client and SOF agree that the Service-Specific Attributes classified as Fixed cannot be included in the API requests (see [R10]), and if a Service-Specific Attribute that has been classified as Fixed for Inventory, then the SOF **MUST NOT** include a value for a Service-Specific Attribute in the Inventory API response.

**[R14]** If the Client and SOF agree that Service-Specific Attributes classified as Fixed can be included in API requests (see [R10]), the SOF **MUST** reject an API request from the Client if it includes a Service-Specific Attribute that has been classified as Fixed for the Service Function (Service Order) or Service Action (INSTALL, CHANGE) and includes a value that is different than the agreed-on fixed value.

684                   **[R15]**     If the Client and SOF agree that the Service-Specific Attributes classified as Fixed can  
685                   be included in API requests (see [R10]), and if a Service-Specific Attribute is classified  
686                   to be Fixed for Inventory for a Service Offering, then the SOF **MUST** include a value  
687                   for the Service-Specific Attribute in the Inventory API responses.

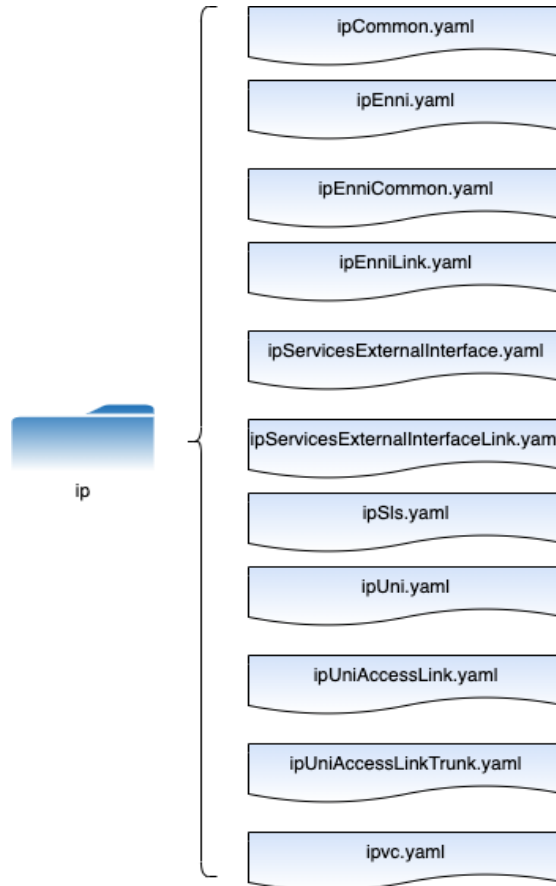


## 13 Data Models for IP Services

The data models for the IP Service configuration are expressed as a set of YAML/JSON schemas based on JSON schema draft 7 and encoded in YAML. These schemas accompany this document. This section explains the organization and structure of these schemas.

### 13.1 Organization and Structure of the Schemas

The schemas are organized into a file structure as shown in Figure 8.



**Figure 8-Schema Files Organization**

Both Subscriber and Operator IP Service schemas are provided in the same directory. There is 1 file that provide common resources that are shared with Subscriber and Operator IP services:

- ip/ipCommon.yaml – provides classes shared among all IP services.

These common classes are referenced in the relevant product component schema files. For example, the **IpUniAccessLink.ipv4ConnectionAddressing** attribute specified in IpUniAccessLink.yaml file refers to common **UniIpv4ConnectionAddressing** definition:

**ipv4ConnectionAddressing:**

**description:** UniIpv4ConnectionAddressing is a data type representing how Ipv4addresses are allocated to the devices on the UNI Access Link. Reference MEF 61.1 Section 13.4 UNI Access Link IPv4 Connection Addressing Service Attribute.

**\$ref:** ["./ipCommon.yaml#/definitions/Ipv4ConnectionAddressing"](#)

The *ipCommon* YAML file contains resources that are common across Subscriber and Operator IP service components as well as a number of utility resources and types.

On a CHANGE request a single Service Attribute cannot be changed. The Client must send a full-service configuration including all Mandatory Service Attributes (Section 12.1) and all Optional Service Attributes (Section 12.2) that were previously specified by the Client (in an INSTALL request or previous CHANGE request). Any Optional Service Attributes that are not specified in a CHANGE request are reset to their default value.

**[R16]** The Service Inventory for a product **MUST** include all Service Attributes that are categorized as Mandatory.

**[R17]** The Service Inventory for a product **MUST** include all Service Attributes that are categorized as Optional.

**[O3]** The Service Inventory for a service **MAY** contain Service Attributes that are categorized as Fixed.

Including Service Attributes in the Inventory as specified in the previous requirements facilitates the CHANGE action. The Buyer can RETRIEVE the current values for the Service Attributes and make the desired changes and submit the CHANGE request.

## 13.2 Additional Details

This section includes an explanation of some additional conventions for the schema structure as well as some additional attributes that have been added to facilitate product specification for some common edge cases.

### 13.2.1 Naming Conventions

In the schemas, resource and type names are UpperCamelCase and Service Attribute property names are lowerCamelCase.

## 14 Relationships Between Entities

This section describes the constraints and relationships between the primary Service Order Items for both Subscriber and Operator IP Services. There are specific Service Order Items for both Subscriber and Operator IP Services that are described in respective sections below.

### 14.1 Subscriber IP Services Relationships Between Entities

This section description the constraints and relationships between the five primary Service Order Items (IPVC, IPVC End Point, IP UNI, IP UNI Access Link, and IP UNI Access Link Trunk) for Subscriber IP Services.

The use case for Subscriber IP Services is based on ordering the IPVC, IPVC End Point, a new or existing IP UNI, a new IP UNI Access Link, and IP UNI Access Link Trunk.

The Subscriber IPVC Service is associated with exactly one IPVC, The IPVC is associated with one or more IPVC End Points, associated IP UNIs with each IPVC End Point, associated IP UNI Access Link with each IP UNI and associated IP UNI Access Link Trunk with each IP UNI Access Link. Figure 9 illustrates the Service-agnostic Service Order with several Service Order Items and their Service-specific relationship to a Subscriber IP Service.

A Service Order is composed of one or more Service Order Items. This is supported in the service-agnostic part of the Service Order API. The service-specific payload (IP Services) is where the main components are supported as part of IP Service Schemas. Each Service Order Item is then associated with a service-specific orderable component (i.e., Ipvpc) which is within the payload. Figure 9-Subscriber IP Service Order

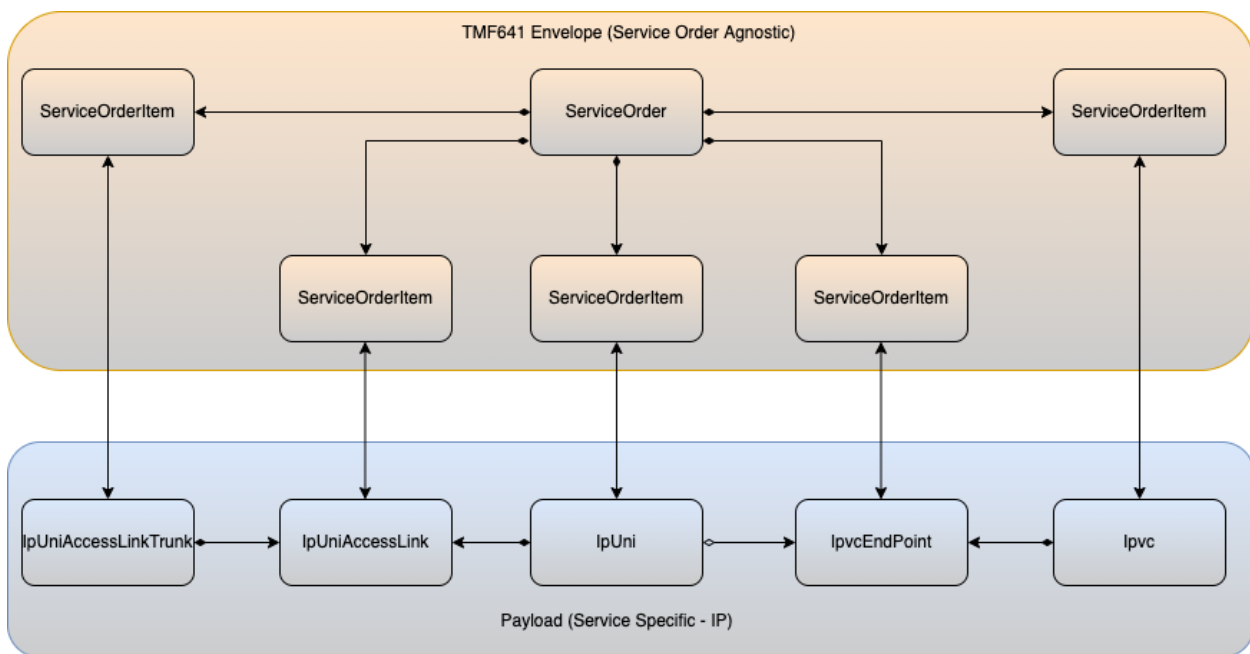


Figure 9-Subscriber IP Service Order API Associations

The relationships between each of the Service Order Items for Subscriber IP Services are shown in Table 3. The values in the Relationship Type column are used in the *relationshipType* field of the *OrderItemRelationship* types. Specification of IP UNI Access Link, IP UNI Access Link Trunk and IPVC are mandatory at INSTALL and CHANGE of the service.

Source Service Resource	Relationship Type	Cardinality	Target Service Resource
IpvcEndPoint	IPUNI_ENDPOINT_OF_IPVC	1	Ipvc
IpvcEndPoint	CONNECTS_TO_IPUNI	1	IpUni
IpUniAccessLink	PART_OF_IPUNI	1	IpUni
IpUniAccessLinkTrunk	PROVIDES_LINK	1	IpUniAccessLink

**Table 3-Subscriber IP Service Relationship Roles**

- [R18]** For a Subscriber IP Service, the Relationship Type field of the Service Relationship Order Item Relationship types **MUST** contain the value shown in the Relationship Type column in Table 3. **Błąd! Nie można odnaleźć źródła odwołania.**
- [R19]** For Service Order, the relationship to an IP UNI Access Link Trunk **MUST** be specified for every INSTALL of, or CHANGE to, a Subscriber IP Service.
- [R20]** For a Subscriber IP Service, the relationship to an IP UNI **MUST** reference an IP UNI Service Order Item.
- [R21]** For a Subscriber IP Service, the relationship to an IP UNI Access Link **MUST** reference an IP UNI Access Link Service Order Item.
- [R22]** For a Subscriber IP Service, the relationship to an IPVC **MUST** reference an IPVC Service Order Item.
- [R23]** For a CHANGE to Subscriber IP Service the relationship to the IP UNI Access Link Trunk **MUST NOT** be changed from the value present in the Service Inventory.

The Subscriber IP UNI, IP UNI Access Link, IP UNI Access Link Trunk and IPVC End Point are included with the IPVC for a Subscriber IP Service Order. The Subscriber IP UNI Access Link Trunk is associated with a specific INSTALL\_LOCATION and is required at INSTALL and CHANGE. Once a Subscriber UNI Access Link Trunk is associated with a specific location, the INSTALL\_LOCATION cannot be changed. The install location is captured in the service-agnostic part of the Service Order API. The value in the Place Relationship Role column in the table below is used in the role field of the *RelatedPlaceRefOrValue* type.

Service Resource	Place Relationship Role	Cardinality	Install	Change
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IpUniAccessLinkTrunk	INSTALL_LOCATION	1	Mandatory	Mandatory
----------------------	------------------	---	-----------	-----------

**Table 4-Subscriber IP Place Relationship Role**

**[R24]** For a Subscriber IP Service, the Role field (role) of the Related Place (*RelatedPlaceRefOrValue*) type **MUST** contain one of the values shown in the Place Relationship Role column in Table 4.

**[R25]** For Service Order, the Related Place (*RelatedPlaceRefOrValue*) **MUST** be specified for every INSTALL of, or CHANGE to an IP UNI Access Link Trunk.

**[R26]** For a CHANGE to an IP UNI Access Link Trunk service, the Related Place **MUST NOT** be changed from the value present in the Service Inventory.

Changing the UNI Access Link Trunk location is not supported for an IP Service. The value included in a CHANGE request must be identical to the value in the Inventory. The relationships applicable to Subscriber IP Services are shown in the following diagram:

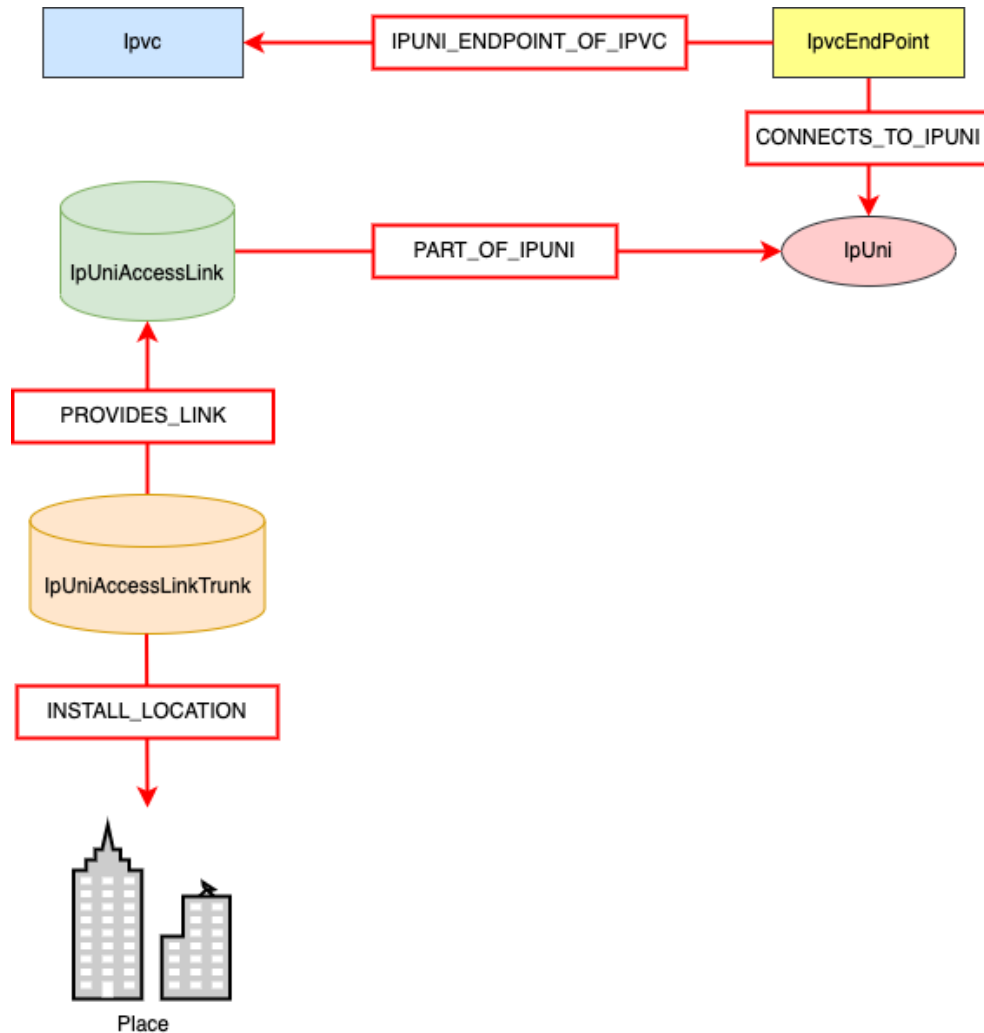


Figure 10-Subscriber IP Services Entities and Relationships

## 14.2 Operator IP Services Relationships Between Entities

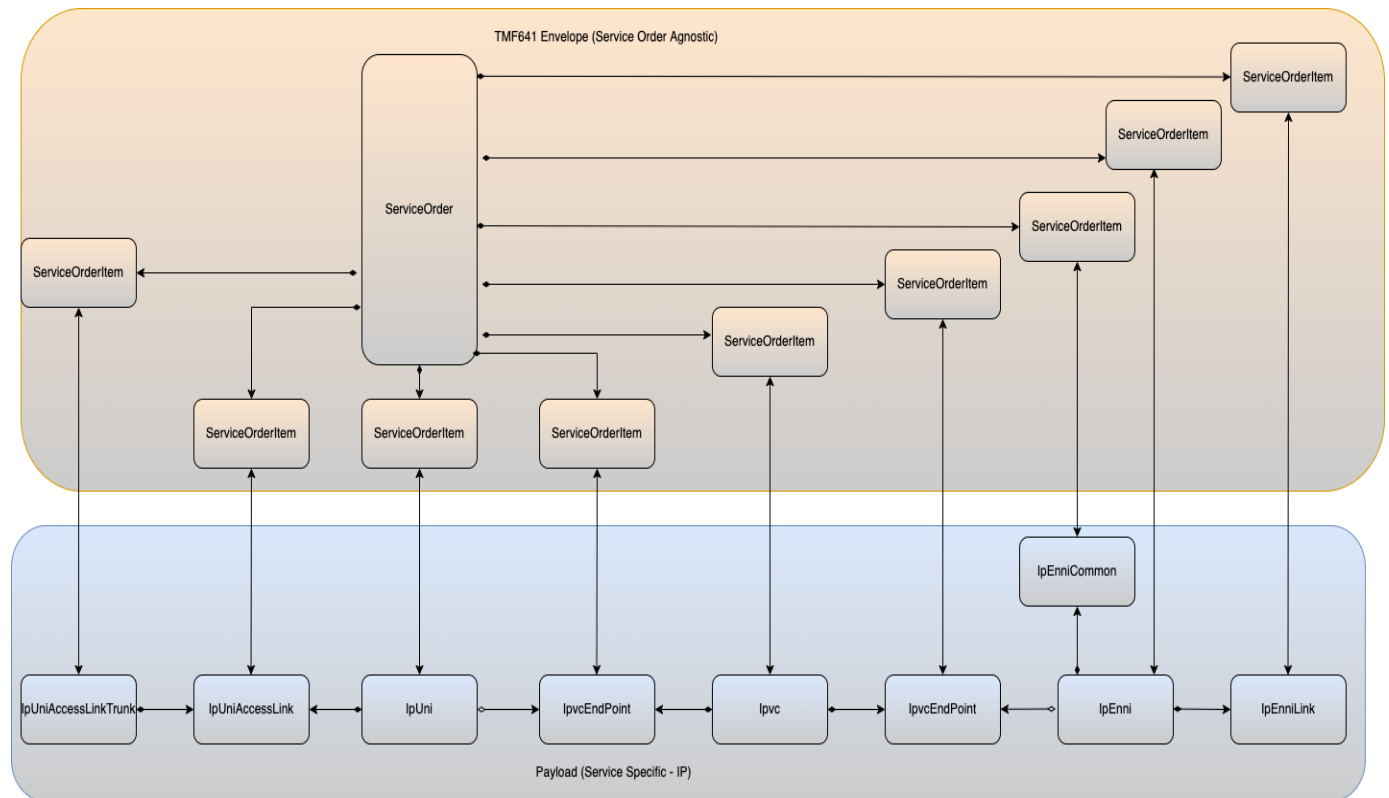
This section description the constraints and relationships between the eight primary Service Order Items (IPVC, IPVC End Point, IP UNI, IP UNI Access Link, IP UNI Access Link Trunk, IP ENNI, IP ENNI Trunk and IP ENNI Common) for Operator IP Services.

The use case for Operator IP Services is based on ordering the IPVC, IPVC End Points with a new or existing IP UNI, a new IP UNI Access Link, and IP UNI Access Link Trunk; a new or existing IP ENNI and associated ENNI resources – IP ENNI Common and IP ENNI Trunk.

The Operator IPVC Service is associated with exactly one IPVC, The IPVC is associated with one or more IPVC End Points, associated IP UNIs with each IPVC End Point, associated IP UNI Access Link with each IP UNI and associated IP UNI Access Link Trunk with each IP UNI Access Link. In addition, the IPVC has an

IPVC End Point associated with an IP ENNI. Figure 11 illustrates the Service-agnostic Service Order with several Service Order Items and their Service-specific relationship to an Operator IP Service.

A Service Order is composed of one or more Service Order Items. This is supported in the service-agnostic part of the Service Order API. The service-specific payload (IP Services) is where the main components are supported as part of IP Service Schemas. Each Service Order Item is then associated with a service-specific orderable component (i.e., Ipvpc) which is within the payload. Figure 9-Subscriber IP Service Order



**Figure 11-Operator IP Service Order API Associations**

The relationships between each of the Service Order Items for Operator IP Services are shown in Table 5. The values in the Relationship Type column are used in the relationshipType field of the OrderItemRelationship types. Specification of IP UNI Access Link, IP UNI Access Link Trunk, IP ENNI, IP ENNI Trunk, IP ENNI Common and IPVC are mandatory at INSTALL and CHANGE of the service.

Source Service Resource	Relationship Type	Cardinality	Target Service Resource
IpvpcEndPoint	IPUNI_ENDPOINT_OF_IPVC	1	Ipvpc
IpvpcEndPoint	IPENNI_ENDPOINT_OF_IPVC	1	Ipvpc
IpvpcEndPoint	CONNECTS_TO_IPUNI	1	IpUni

IpvcEndPoint	CONNECTS_TO_IPENNI	1	IpEnni
IpUniAccessLink	PART_OF_IPUNI	1	IpUni
IpUniAccessLinkTrunk	PROVIDES_LINK	1	IpUniAccessLink
IpEnniLink	PART_OF_IPENNI	1	IpEnni
IpEnni	USES	1	IpEnniCommon

Table 5-Operator IP Service Relationship Roles

- [R27]** For an Operator IP Service, the Relationship Type field of the Service Relationship Order Item Relationship types **MUST** contain the value shown in the Relationship Type column in Table 5. **Błąd! Nie można odnaleźć źródła odwołania.**
- [R28]** For Service Order, the relationship to an IP UNI Access Link Trunk **MUST** be specified for every INSTALL of, or CHANGE to, an Operator IP Service.
- [R29]** For an Operator IP Service, the relationship to an IP UNI **MUST** reference an IP UNI Service Order Item.
- [R30]** For an Operator IP Service, the relationship to an IP UNI Access Link **MUST** reference an IP UNI Access Link Service Order Item.
- [R31]** For an Operator IP Service, the relationship to an IP UNI Access Link Trunk **MUST** reference an IP UNI Access Link Trunk Service Order Item.
- [R32]** For a Subscriber IP Service, the relationship to an IPVC **MUST** reference an IPVC Service Order Item.
- [R33]** For Service Order, the relationship to an IP ENNI Link Trunk **MUST** be specified for every INSTALL of, or CHANGE to, an Operator IP Service.
- [R34]** For an Operator IP Service, the relationship to an IP ENNI **MUST** reference an IP ENNI Service Order Item.
- [R35]** For an Operator IP Service, the relationship to an IP ENNI Link **MUST** reference an IP ENNI Link Service Order Item.
- [R36]** For an Operator IP Service, the relationship to an IP ENNI Common **MUST** reference an IP ENNI Common Service Order Item.
- [R37]** For a CHANGE to Operator IP Service the relationship to the IP UNI Access Link Trunk **MUST NOT** be changed from the value present in the Service Inventory.

The Operator IP UNI, IP UNI Access Link, IP UNI Access Link Trunk, IPVC End Points, IP ENNI Link, IP ENNI and IP ENNI Common are included with the IPVC for an Operator IP Service Order. The Operator IP UNI



Access Link Trunk and IP ENNI Trunk is associated with a specific INSTALL\_LOCATION and is required at INSTALL and CHANGE. Once an Operator UNI Access Link Trunk is associated with a specific location, the INSTALL\_LOCATION cannot be changed. The same is true for an ENNI Link The install location is captured in the service-agnostic part of the Service Order API. The value in the Place Relationship Role column in the table below is used in the role field of the *RelatedPlaceRefOrValue* type.

Service Resource	Place Relationship Role	Cardinality	Install	Change
IpUniAccessLinkTrunk	ACCESS_LINK_INSTALL_LOCATION	1	Mandatory	Mandatory
IpEnniLink	ENNI_LINK_INSTALL_LOCATION	1	Mandatory	Mandatory

**Table 6-Operator IP Place Relationship Roles**

**[R38]** For an Operator IP Service, the Role field (role) of the Related Place (*RelatedPlaceRefOrValue*) type **MUST** contain one of the values shown in the Place Relationship Role column in Table 6.

**[R39]** For Service Order, the Related Place (*RelatedPlaceRefOrValue*) **MUST** be specified for every INSTALL of, or CHANGE to an IP UNI Access Link Trunk.

**[R40]** For Service Order, the Related Place (*RelatedPlaceRefOrValue*) **MUST** be specified for every INSTALL of, or CHANGE to an IP ENNI Link.

**[R41]** For a CHANGE to an IP UNI Access Link Trunk service, the Related Place **MUST NOT** be changed from the value present in the Service Inventory.

**[R42]** For a CHANGE to an IP ENNI Access Link service, the Related Place **MUST NOT** be changed from the value present in the Service Inventory.

Changing the UNI Access Link Trunk location is not supported for an IP Service. The value included in a CHANGE request must be identical to the value in the Inventory. Changing the ENNI Link location is not supported for an IP Service. The value included in a CHANGE request must be identical to the value in the Inventory. The relationships applicable to Operator IP Services are shown in Figure 12.

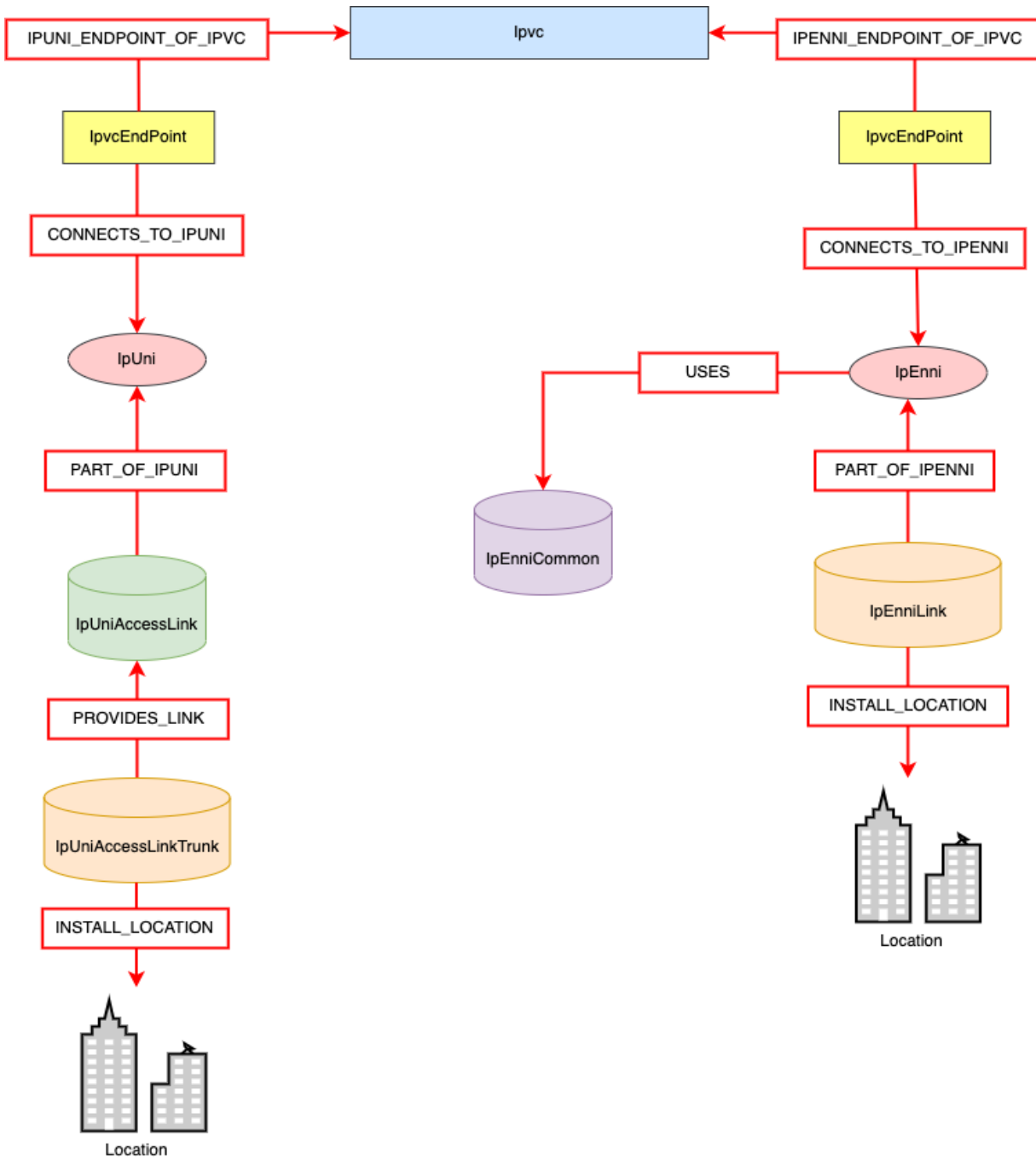


Figure 12-Operator IP Services Entities and Relationships

## 15 Subscriber IP Services Data Model

A Subscriber IP Service is an IP Service provided to an end user (the Subscriber) by a Service Provider. There is no restriction on the type of organization that can act as a Subscriber; for example, a Subscriber can be an enterprise, a mobile operator, an IT system integrator, a government department, etc. At its most basic, a Subscriber IP Service provides connectivity for IP Packets between different parts of the Subscriber's network (usually at different physical locations) or between the Subscriber's network and an external network, such as the public Internet or a private cloud service.

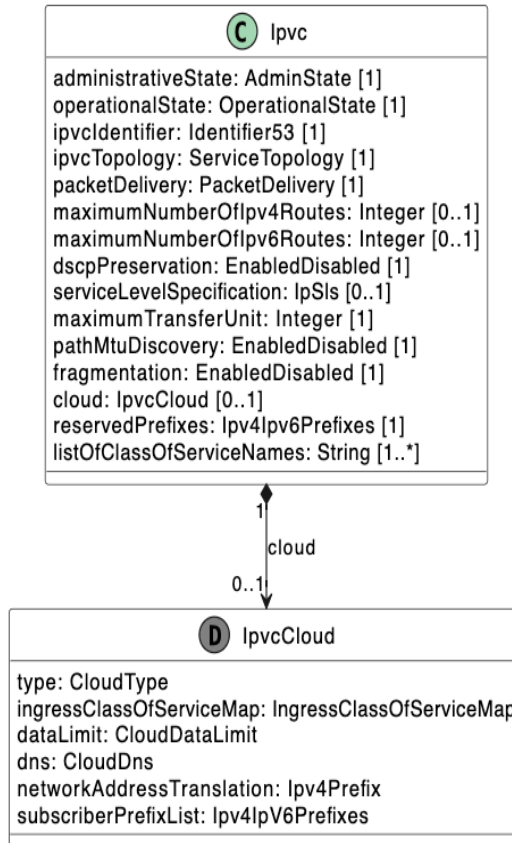
The Resources and corresponding Attributes are listed in groups:

- Subscriber IP Services Resource:

- Ipv4
- Ipv4EndPoint
- IpUni
- IpUniAccessLink
- IpUniAccessLinkTrunk

### 15.1 Ipv4

An IP Service is formed of an IP Virtual Connection (IPVC) that links together IPVC End Points at External Interfaces (EIs). Reference MEF 61.1 Section 7.4 IP Virtual Connections and IPVC End Points. NOTE: The association of IPVC and IPVC End Points is implemented within the envelope part of the API.



**Figure 13- Ipvc Model**

Figure 13 presents the class diagram of classes present in the ipvcl.yaml file. Note that all empty classes on it are only to show the type of the relation attributes while maintaining the readability of the diagram. Their detailed model will be described later.

Schema File Name: ip/ipvcl.yaml			
\$id: urn:mef:iso:spec:legato:ipvcl:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
administrativeState	AdminState	1	This attribute denotes the administrative state of IPVCL. The values supported are LOCKED and UNLOCKED. When set to UNLOCKED, the IPVCL is enabled and ready to forward traffic. When set to LOCKED, the IPVCL is disabled and will block (i.e., not forward) traffic.
operationalState	OperationalState	1	This attribute denotes the operational state of the IPVCL, as

Schema File Name: ip/ipvc.yaml			
\$id: urn:mef:iso:spec:legato:ipvc:v0.0.1:all			
			working ENABLED or not working DISABLED.
ipvcIdentifier	String	1	A unique string identifier for the IPVC. Reference MEF 61.1 Section 10.1 IPVC Identifier Service Attribute.
ipvcTopology	ServiceTopology	1	Attribute denoting the packet flow between any of the IPVC End Points for the IPVC. Reference MEF 61.1 Section 10.2 IPVC Topology Service Attribute.
packetDelivery	PacketDelivery	1	Indicates whether packets are delivered per standard IP routing behavior or by some other means. Reference MEF 61.1 Section 10.4 IPVC Packet Delivery Service Attribute.
maximumNumberOfIpv4Routes	Integer	0..1	Maximum number of IPv4 routes supported by the service as a whole. Reference MEF 61.1 Section 10.5 IPVC Maximum Number of IPv4 Routes Service Attribute. Absence of this attribute corresponds to a value of "Unlimited".
maximumNumberOfIpv6Routes	Integer	0..1	Maximum number of IPv6 routes supported by the service as a whole. Reference MEF 61.1 Section 10.6 IPVC Maximum Number of IPv6 Routes Service Attribute. Absence of this attribute corresponds to a value of "Unlimited".
dscpPreservation	EnabledDisabled	1	Indicates where the SP or Operator is allowed to modify the value of the IP DS field in the IP header of the Subscriber's traffic as it traverses the IPVC. Reference MEF 61.1 Section 10.7 IPVC DSCP Preservation Service Attribute.

Schema File Name: ip/ipvc.yaml			
\$id: urn:mef:iso:spec:legato:ipvc:v0.0.1:all			
serviceLevelSpecification	IpSls	0..1	The set of performance objectives for each CoS Name in the IPVC. The absence of this attribute corresponds to a value of "NONE". Reference MEF 61.1 Section 10.9 IPVC Service Level Specification Service Attribute.
maximumTransferUnit	Integer	1	Indicates the maximum size (in octets) of an IP packet that can traverse the IPVC without fragmentation. Reference MEF 61.1 Section 10.10 IPVC MTU Service Attribute.
pathMtuDiscovery	EnabledDisabled	1	Indicates whether the Path MTU Discovery is supported for the IPVC. Reference MEF 61.1 Section 10.11 IPVC Path MTU Discovery Service Attribute.
fragmentation	EnabledDisabled	1	Indicates whether IPv4 Packets can be fragmented. Reference MEF 61.1 Section 10.12 IPVC Fragmentation Service Attribute.
cloud	IpvcCloud	0..1	Reference MEF 61.1 Section 10.13 IPVC Cloud Service Attribute. The absence of this attribute corresponds to a value of "NONE".
reservedPrefixes	Ipv4Ipv6Prefixes	1	Reference MEF 61.1 Section 10.14 IPVC Reserved Prefixes Service Attribute.
listOfClassOfServiceNames	String	1.. *	The list of CoS Names supported by the IPVC. Reference MEF 61.1 Section 10.8 IPVC List of Class of Service Names Service Attribute.

Table 7-Ipvc Service Attributes

## 15.2 IpvcEndPoint

An IPVC End Point is a logical entity at an EI, to which a subset of packets that traverse the EI is mapped. Reference MEF 61.1 Section 7.4 IP Virtual Connections and IPVC End Points.

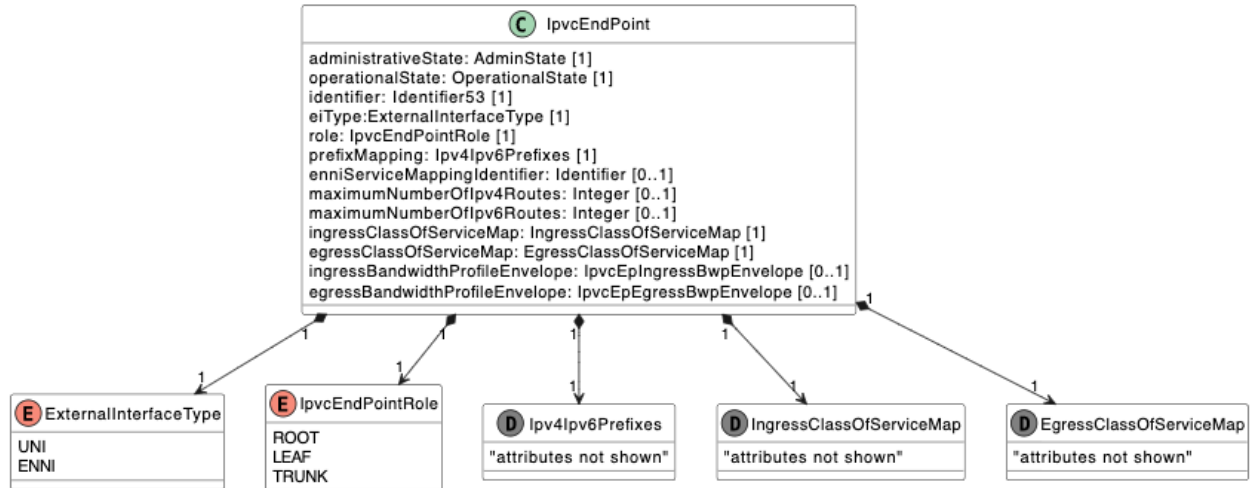


Figure 14-IPvcEndPoint Model

Schema File Name: ip/ipvceEndPoint.yaml			
\$id: urn:mef:iso:spec:legato:ipvceEndPoint:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
administrativeState	AdminState	1	This attribute denotes the administrative state of IPVC End Point. The values supported are LOCKED and UNLOCKED. When set to UNLOCKED, the IPVC End Point is enabled and ready to forward traffic. When set to LOCKED, the IPVC End Point is disabled and will block (i.e., not forward) traffic.
operationalState	OperationalState	1	This attribute denotes the operational state of the IPVC End Point, as working ENABLED or not working DISABLED.
identifier	Identifier53	1	A unique identifier for the IPVC End Point for management purposes. Reference MEF 61.1 Section 11.1 IPVC EP Identifier Service Attribute.
eiType	ExternalInterfaceType	1	Indicates whether the IPVC End Point is at a UNI or an ENNI. (Operator IPVC EPs only). Reference MEF 61.1 Section 11.2 IPVC EP EI Type Service Attribute.

<b>Schema File Name: ip/ipvEndPoint.yaml</b> <b>\$id: urn:mef:iso:spec:legato:ipvEndPoint:v0.0.1:all</b>			
role	IpvEndPointRole	1	Role of the IPVC End Point in a a rooted multipoint IPVC. Reference MEF 61.1 Section 11.4 IPVC EP Role Service Attribute.
prefixMapping	Ipv4Ipv6Prefixes	1	Is a list, possibly empty of IP Prefixes. It is used to specify which subnets with the Subscriber Network can access the IPVC via this IPVC EP. Reference MEF 61.1 Section 11.5 IPVC EP Prefix Mapping Service Attribute.
enniServiceMappingIdentifier	Identifier53	0..1	ENNI Service Mapping Identifier assigned by the SP/SO for associating IPVC End Points across and ENNI. (Operator IPVC End Points only). Reference MEF 61.1 Section 11.6 IPVC EP ENNI Service Mapping Identifier Service Attribute.
maximumNumberOfIPv4Routes	Integer	0..1	Maximum number of IPv4 routes supported by this IPVC End Point. Reference MEF 61.1 Section 11.7 IPVC EP Maximum Number of IPv4 Routes Service Attribute. Absence of this attribute corresponds to a value of "Unlimited".
maximumNumberOfIPv6Routes	Integer	0..1	Maximum number of IPv6 routes supported by this IPVC End Point. Reference MEF 61.1 Section 11.8 IPVC EP Maximum Number of IPv6 Routes Service Attribute. Absence of this attribute corresponds to a value of "Unlimited".
ingressClassOfServiceMap	IngressClassOfServiceMap	1	Specification of how ingress packets are mapped to different CoS Names. Reference MEF 61.1 Section 11.9 IPVC EP Ingress Class of Service Map Service Attribute.
egressClassOfServiceMap	EgressClassOfServiceMap	1	Specification of how Class of Service is indicated in egress packets. Reference MEF 61.1

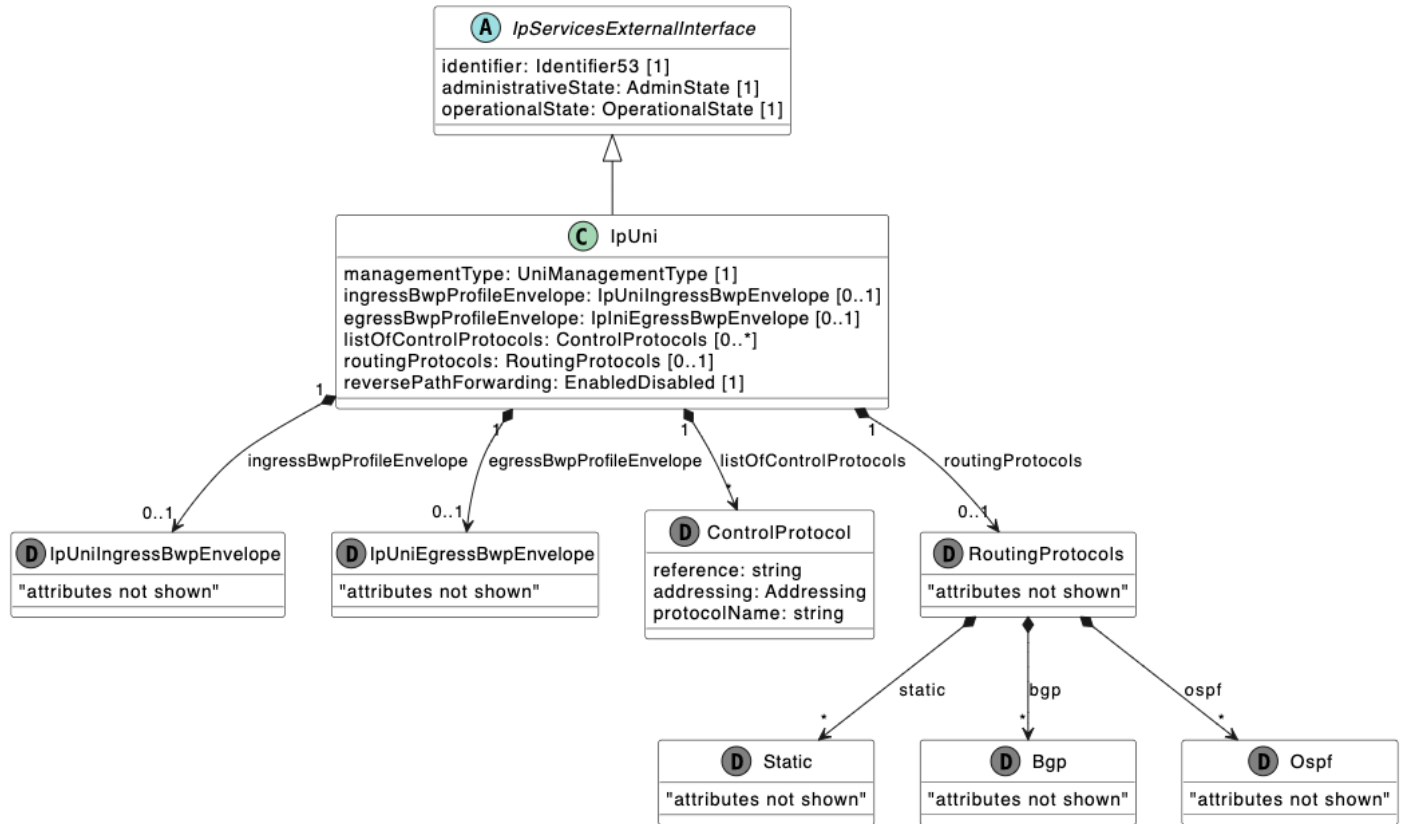


Schema File Name: ip/ipvcEndPoint.yaml			
\$id: urn:mef:iso:spec:legato:ipvcEndPoint:v0.0.1:all			
			Section 11.10 IPVC EP Egress Class of Service Map Service Attribute.
ingressBandwidthProfileEnvelope	IpvcEpIngressBwpEnvelope	0..1	Ingress Bandwidth Profile Envelope for the IPVC End Point. The absence of this attribute corresponds to a value of "None". Reference MEF 61.1 Section 11.11 IPVC EP Ingress Bandwidth Profile Envelope Service Attribute.
egressBandwidthProfileEnvelope	IpvcEpEgressBwpEnvelope	0..1	Egress Bandwidth Profile Envelope for the IPVC End Point. The absence of this attribute corresponds to a value of "None". Reference MEF 61.1 Section 11.12 IPVC EP Egress Bandwidth Profile Envelope Service Attribute.

Table 8-IpvcEndPoint Service Attributes

### 15.3 IpUni

A User Network Interface (UNI) is the demarcation point between the responsibility of the SP and the responsibility of the Subscriber. Note that a given UNI always relates to a single SP and a single Subscriber. Reference MEF 61.1



**Figure 15-IpUni Model**

Figure 15-IpUni presents the class diagram of classes present in the IpUni.yaml file. Note that all empty classes on it are only to show the type of the relation attributes while maintaining the readability of the diagram. Their detailed model will be described later.

Schema File Name: ip/IpUni.yaml			
\$id: urn:mef:iso:spec:legato:IpUni:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
managementType	UniManagementType	1	Attribute indicating whether the CE is the responsibility of the Subscriber or the Service Provider. Reference MEF 61.1 Section 12.2 UNI Management Type Service Attribute.
ingressBwpProfileEnvelope	IpUniIngressBwpEnvelope	0..1	Attribute used for an ingress UNI Bandwidth Profile. Reference MEF 61.1 Section 12.4 UNI Ingress Bandwidth Profile Envelope Service Attribute. Absence of this

Schema File Name: ip/IpUni.yaml			
\$id: urn:mef:iso:spec:legato:IpUni:v0.0.1:all			
			attribute corresponds to a value of "None".
egressBwpProfileEnvelope	IpUniEgressBwpEnvelope	0..1	Attribute used for an egress UNI Bandwidth Profile. Reference MEF 61.1 Section 12.5 UNI Egress Bandwidth Profile Envelope Service Attribute. Absence of this attribute corresponds to a value of "None".
listOfControlProtocols	ControlProtocols	0..*	Indication of IP Control Protocols that are not forwarded transparently by the SP. Reference MEF 61.1 Section 12.6 UNI List of Control Protocols Service Attribute. Absence of this attribute corresponds to a value of "None".
routingProtocols	RoutingProtocols	0..1	List of Routing Protocols used across the UNI. Reference MEF 61.1 Section 12.7 UNI Routing Protocols Service Attribute. Absence of this attribute corresponds to a value of "None".
reversePathForwarding	EnabledDisabled	1	Indicates whether Reverse Path Forwarding checks are used by the SP at the UNI. Reference MEF 61.1 Section 12.8 UNI Reverse Path Forwarding Service Attribute.

Table 9-IpUni Service Attributes

## 15.4 IpUniAccessLink

An individual connection between the Subscriber and the SP that forms part of a UNI. Reference MEF 61.1

**Błąd! Nie można odnaleźć źródła odwołania.** Section 7.3 UNIs and UNI Access Link.

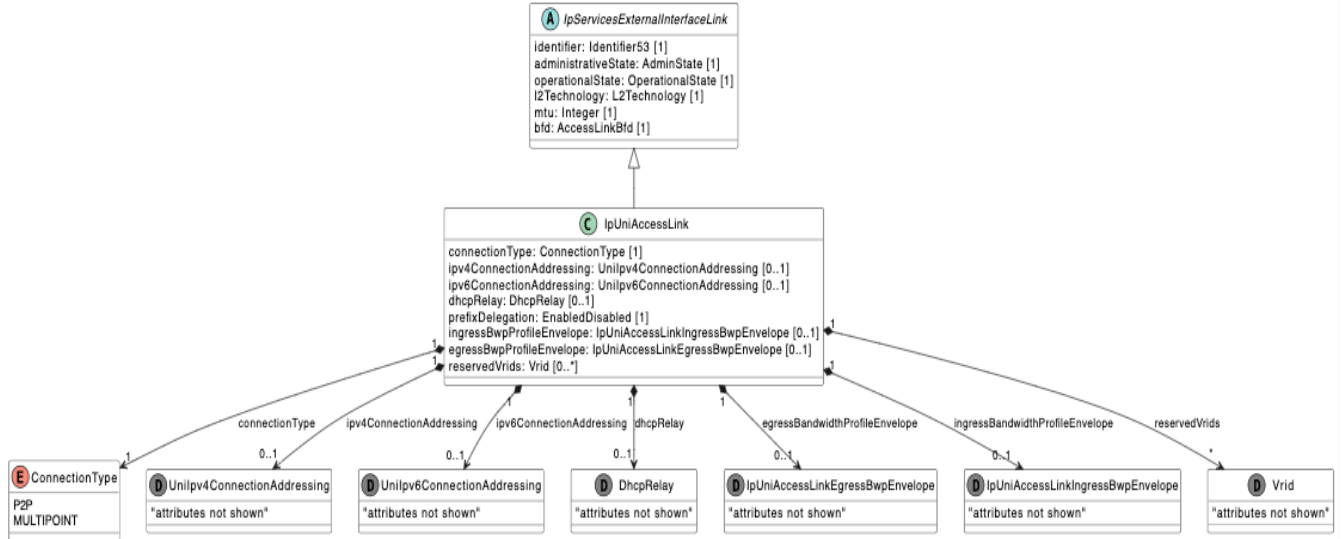


Figure 16-IpUniAccessLink Model

Schema File Name: ip/IpUniAccessLink.yaml

\$id: urn:mef:iso:spec:legato:IpUniAccessLink:v0.0.1:all

Attribute Name	Type	Multiplicity	Description
connectionType	ConnectionType	1	Attribute that indicates the number of interfaces that can be attached to the UNI Access Link. Reference MEF 61.1 Section 13.2 UNI Access Link Connection Type Service Attribute.
ipv4ConnectionAddressing	Unilpv4ConnectionAddressing	0..1	IPv4 Connection Addressing. Reference MEF 61.1 Section 13.4 UNI Access Link IPv4 Connection Addressing Service Attribute. Absence of this attribute corresponds to a value of "None".
ipv6ConnectionAddressing	Unilpv6ConnectionAddressing	0..1	IPv6 Connection Addressing. Reference MEF 61.1 Section 13.5 UNI Access Link IPv6 Connection Addressing Service Attribute. Absence of this attribute corresponds to a value of "None".
dhcpRelay	DhcpRelay	0..1	Indicates whether DHCP Relay functionality is enabled. Reference MEF 61.1 Section 13.6 UNI Access Link DHCP Relay Service Attribute.

Schema File Name: ip/IpUniAccessLink.yaml			
\$id: urn:mef:iso:spec:legato:IpUniAccessLink:v0.0.1:all			
			Absence of this attribute corresponds to a value of "Disabled".
prefixDelegation	EnabledDisabled	1	Indicates whether DHCP Prefix delegation is enabled. Reference MEF 61.1 Section 13.7 UNI Access Link Prefix Delegation Service Attribute.
ingressBwpProfileEnvelope	IpUniAccessLinkIngressBwpEnvelope	0..1	Ingress Bandwidth Profile Envelope for the UNI Access Link. Reference MEF 61.1 Section 13.10 UNI Access Link Ingress Bandwidth Profile Envelope Service Attribute. Absence of this attribute corresponds to a value of "None".
egressBwpProfileEnvelope	IpUniAccessLinkEgressBwpEnvelope	0..1	Egress Bandwidth Profile Envelope for the UNI Access Link. Reference MEF 61.1 Section 13.11 UNI Access Link Egress Bandwidth Profile Envelope Service Attribute. Absence of this attribute corresponds to a value of "None".
reservedVrids	Vrid	0..*	List of VRRP (Virtual Router Redundancy Protocol) VRIDs (Virtual Router Identifier) reserved for use by the SP or Operator. Reference MEF 61.1 Section 13.12 UNI Access Link Reserved VRIDs Service Attribute.

Table 10-IpUniAccessLink Service Attributes

## 15.5 IpUniAccessLinkTrunk

A UNI Access Link Trunk is a construct that encapsulates the details of Layer 1 and Layer 2 configuration shared by one or more UNI Access Links. Reference MEF 61.1.1 Section A1-1 UNI Access Link Trunk Service Attributes.

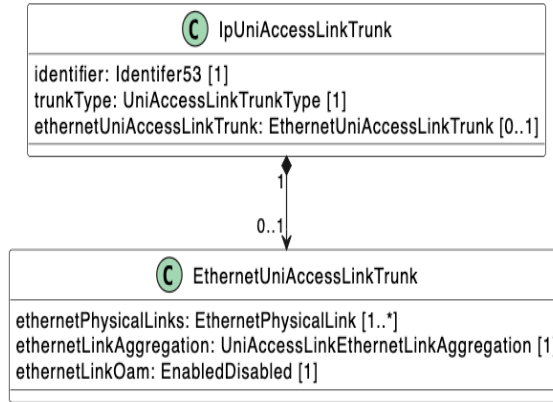


Figure 17-IpUniAccessLinkTrunk Model

Schema File Name: ip/IpUniAccessLinkTrunk.yaml			
\$id: urn:mef:iso:spec:legato:IpUniAccessLinkTrunk:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
identifier	Identifier53	1	Unique identifier for the UNI Access Link Trunk for management purposes. Reference MEF 61.1.1  Section A1-1.1 UNI Access Link Trunk Identifier Service Attribute.
trunkType	UniAccessLinkTrunkType	1	Specifies the Layer 2 technology that is used to implement the UNI Access Link Trunk. Reference  MEF 61.1.1 Section A1-1.2 UNI Access Link Trunk Type Service Attribute.
ethernetUniAccessLinkTrunk	EthernetUniAccessLinkTrunk	0..1	Pointer to EthernetUniAccessLinkTrunk which is one of the possible types.

Table 11-IpUniAccessLinkTrunk Service Attributes

## 15.6 EthernetUniAccessLinkTrunk

A single point-to-point physical Ethernet channel or multiple physical Ethernet links combined into a Link Aggregation Group. The Ethernet frames associated with a given UNI Access Link can be either

untagged/priority tagged or VLAN tagged. Reference MEF 61.1.1 A1-1.3 Ethernet UNI Access Link Trunk Service Attributes.

Schema File Name: ip/ethernetUniAccessLinkTrunk.yaml			
\$id: urn:mef:iso:spec:legato:EthernetUniAccessLinkTrunk:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
ethernetPhysicalLinks	EthernetPhysical Link	1.. *	A list of the physical link types along with some additional capabilities. Reference MEF 61.1.1 Section A1-1.3.1 UNI Access Link Trunk List of Ethernet Physical Links Service Attribute.
ethernetLinkAggregation	UniAccessLinkEthernetLinkAggregation	0.. *	Indicates whether the UNI Access Link Trunk is a Link Aggregation Group, and if so, specifies parameters that control the mapping of Ethernet frames to links in the LAG. Reference MEF 61.1.1 Section A1-1.3.2 UNI Access Link Trunk Ethernet Link Aggregation Service Attribute.
ethernetLinkOam	EnabledDisabled	1	Controls when and how Link OAM per IEEE Std 802.3-2018 is run on the physical links in the UNI Access Link Trunk. The value is either Enabled or Disabled. Reference MEF 61.1.1 Section A1-1.3.3.

**Table 12-EthernetUniAccessLinkTrunk Attributes**

## 16 Operator IP Services Data Model

When a Service Provider provides an end-to-end Subscriber IP Service to a Subscriber, they might not be able to implement the entire service using their own network – for instance, one of the Subscriber's UNIs might be in a geographic region where the Service Provider does not operate. In this case, the Service Provider must partner with another Operator who can reach that UNI. The Operator provides an IP connectivity service between the UNI and a point where they can interconnect with the SP's network. Such IP Services – provided by one Operator to another Operator or a Service Provider, to implement part of an end-to-end Subscriber IP Service – are known as Operator IP Services.

- Operator IP Services:

- IpUni
- IpUniAccessLink
- IpEnni
- IpEnniLink
- IpEnniCommon

### 16.1 IpEnni

An External Network Network Interface (ENNI) is the demarcation point between the responsibility of one Operator and another - other words, it is the interface where the two Operators interconnect. Reference MEF 61.1Błąd! Nie można odnaleźć źródła odwołania. Section 8.2 ENNI and ENNI Links.

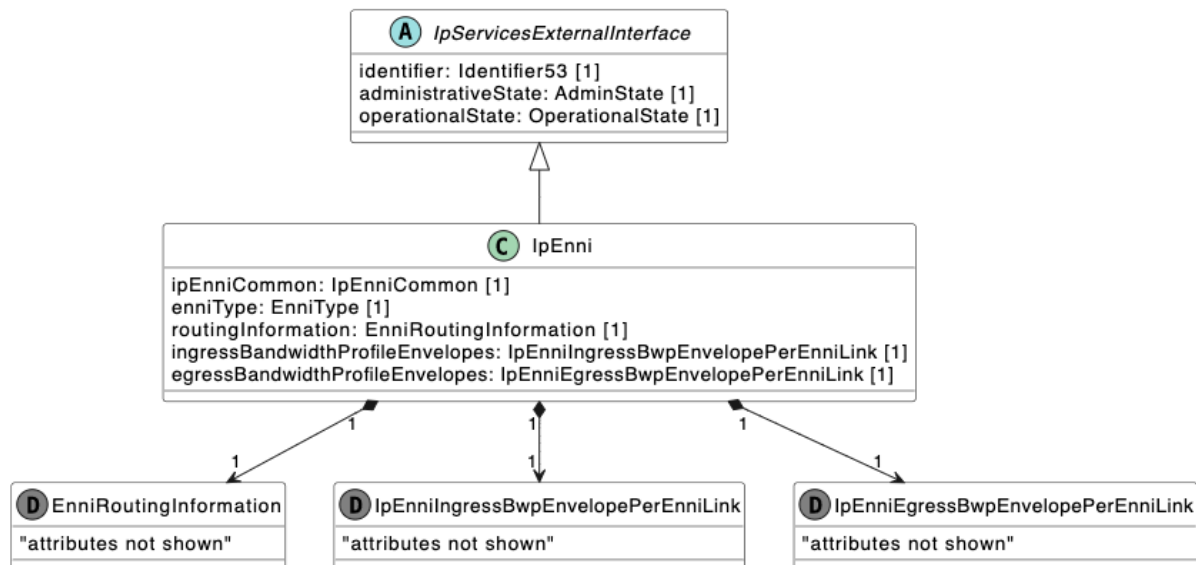


Figure 18-IpEnni Model



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Schema File Name: ip/IpEnni.yaml			
\$id: urn:mef:iso:spec:legato:IpEnni:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
ipEnniCommon	IpEnniCommon	1	Reference to IP ENNI Common.
enniType	EnniType	1	Indication of the type of BGP Peering at the ENNI. Reference MEF 61.1 Section 14.2 ENNI Type Service Attribute.
routingInformation	EnniRoutingInformation	1	Per-service routing information applicable at the ENNI. Reference MEF 61.1 Section 14.3 ENNI Routing Information Service Attribute.
ingressBandwidthProfileEnvelopes	IpEnniIngressBwpEnvelopePerEnniLink	1	Bandwidth Profile Envelope per ENNI Link used for an ingress Bandwidth Profile. Reference MEF 61.1 Section 14.4 ENNI Ingress Bandwidth Profile Envelopes Service Attribute.
egressBandwidthProfileEnvelopes	IpEnniEgressBwpEnvelopePerEnniLink	1	Bandwidth Profile Envelope per ENNI Link used for an egress Bandwidth Profile. Reference MEF 61.1 Section 14.5 ENNI Egress Bandwidth Profile Envelopes Service Attribute.

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**Table 13-IpEnni Service Attributes**

## 16.2 IpEnniLink

An ENNI can comprise one or more distinct IP Links, each of which is a single IP hop. These links are known as ENNI Links, and typically each corresponds to a distinct IP subnet (which can have both IPv4 and IPv6 addressing). ENNI Links are assumed to be point-to-point. Reference MEF 61.1 Section 8.2 ENNIs and ENNI Links.

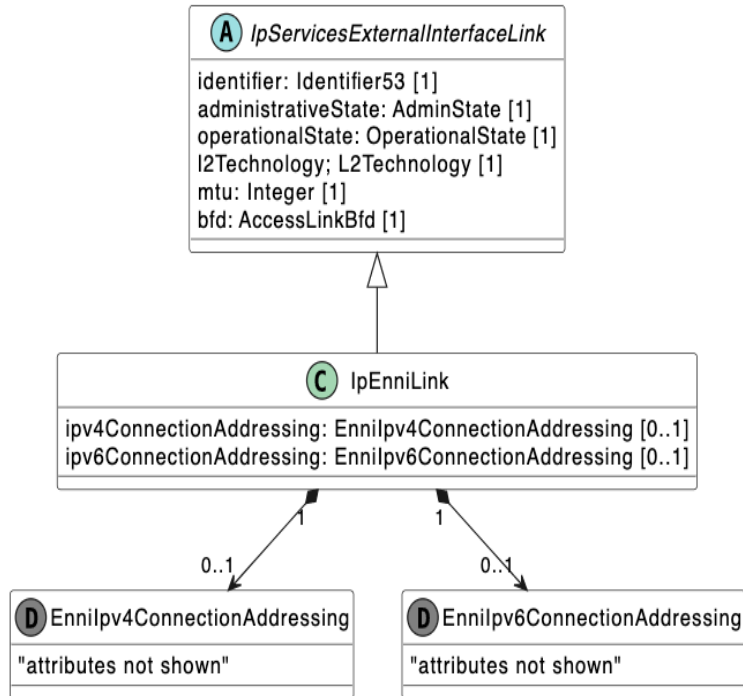


Figure 19-IpEnniLink Model

Schema File Name: ip/IpEnniLink.yaml			
\$id: urn:mef:iso:spec:legato:IpEnniLink:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
ipv4ConnectionAddressing	Ennilpv4Connection Addressing	0..1	IPv4 Connection Addressing. Reference MEF 61.1 Section 16.3 ENNI Link IPv4 Connection Addressing Attribute.
ipv6ConnectionAddressing	Ennilpv6Connection Addressing	0..1	IPv6 Connection Addressing. Reference MEF 61.1 Section 16.4 ENNI Link IPv6 Connection Addressing Attribute.

Table 14-IpEnniLink Service Attributes

### 16.3 IpEnniCommon

ENNI Common Attributes that apply to each ENNI agreed between two LLOs (Lowest Level Operators). Reference MEF 61.1Błąd! Nie można odnaleźć źródła odwołania. Section 15 ENNI Common Attributes.

Schema File Name: ip/lpEnniCommon.yaml			
\$id: urn:mef:iso:spec:legato:lpEnniCommon:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
peeringIdentifier	Identifier53	1	Unique identifier for the ENNI for management purposes. Reference MEF 61.1 Section 15.1 ENNI Peering Common Attribute.
peeringType	EnniPeeringType	1	Indication of the type of BGP Peering at the ENNI. Reference MEF 61.1 Section 15.2 ENNI Peering Type Common Attribute.
controlProtocolsList	ControlProtocols	0..*	Indication of IP Control Protocols that are not forwarded transparently by the LLO. Reference MEF 61.1 Section 15.4 ENNI List of Control Protocols Common Attribute.
routingProtocols	RoutingProtocols	1	List of Routing Protocols used across the ENNI. Reference MEF 61.1 Section 15.5 ENNI Routing Protocols Common Attribute.
serviceMap	EnniServiceMap	1	Mapping of ENNI Service Mapping Contexts across the ENNI. Reference MEF 61.1 Section 15.6 ENNI Service Map Common Attribute.

Table 15-lpEnniCommon Attributes

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## 17 Common Classes and Types

This section is structure like the previous section but focuses on common classes and types used by the Service Attributes. Most of these are structured to support a variety of IP Services. This section details the data types and enumerations that are used by the IP Service model.

### 17.1 AccessLinkBfd

The Access Link BFD Service Attribute indicates whether Bidirectional Forwarding Detection (BFD) is enabled on the UNI Access Link. Reference MEF 61.1 Section 13.8 UNI Access Link BFD Service Attribute and Section 16.5 ENNI Link BFD Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
connectionAddressFamily	ConnectionAddressFamily	1	The Connection Address Family parameter specifies whether the session is established over IPv4 or IPv6 or whether two separate sessions are established using IPv4 and IPv6. Reference MEF 61.1 Section 13.8 UNI Access Link BFD Service Attribute and Section 16.5 ENNI Link BFD Attribute.
transmissionInterval	BfdTransmissionInterval	1	BFD allows for asymmetrical operation, where packets can be sent a different interval in each direction, and a different detect multiplier can be used. For simplicity, this specification mandates symmetrical operation. Units are in milliseconds. Reference MEF 61.1 Section 13.8 UNI Access Link BFD Service Attribute and Section 16.5 ENNI Link BFD Attribute.
detectMultiplier	Integer	1	BFD Detect multiple as an Integer. Reference MEF 61.1 Section 13.8 UNI Access Link BFD Service Attribute and Section 16.5 ENNI Link BFD Attribute.

authenticationType	BfdAuthenticationType	1	BFD Authentication as describer in RFC 5880. Reference MEF 61.1 Section 13.8 UNI Access Link BFD Service Attribute and Section 16.5 ENNI Link BFD Attribute.
activeEnd	BfdActiveEnd	1	BFD Active End. At least one end of BFD session has to have an active role, meaning that it sends out asynchronous control messages regardless of whether it has received any. Reference MEF 61.1 Section 13.8 UNI Access Link BFD Service Attribute.

Table 16-AccessLinkBfd Attributes

## 17.2 Addressing

File: ip/ipCommon.yaml

Enumeration representing the Address type for the Control Protocols data type.

Contains Enumeration Literals:

- SP\_OPERATOR\_ADDRESSES:
  - If the addressing information is SP/Operator Addresses, then Ingress IP Packets for the specified protocol that have a multicast or broadcast destination address, or a unicast destination address that is reachable within the SP's or Operator's network, are considered to be IP Control Protocol Packets, and Egress IP Packets for the specified protocol that have a source address that is reachable within the SP's or Operator's network are considered to be IP Control Protocol Packets.
- ANY:
  - If the addressing information is Any, then all IP Packets for the specified protocol that cross the UNI are considered to be IP Control Protocol Packets.

## 17.3 BfdActiveEnd

File: ip/ipCommon.yaml

At least one end of the BFD session must have an active role, meaning that it sends out asynchronous control messages regardless of whether it has received any. This enumeration represents the values that can be set for the BFD Active End. Reference MEF 61.1 Section 13.8 UNI Access Link BFD Service Attribute [R171] and [R172].

Contains Enumeration Literals:

- SUBSCRIBER:
  - Subscriber takes active BFD role.
- SP:
  - Service Provider takes active BFD role.
- BOTH:
  - Subscriber and Service Provider take active BFD role.

#### **17.4 BfdAuthenticationType**

*File: ip/ipCommon.yaml*

UNI Access Link BFD authentication type. When Authentication is NOT NONE, RFC5880 Section 6.7 Authentication mechanisms are used.

Contains Enumeration Literals:

- NONE:
  - No BFD authentication.
- SIMPLE\_PASSWORD:
  - Simple Password Authentication is the most straightforward (and weakest) form of authentication. In this method of authentication one or more Passwords (with corresponding Key IDs) are configured in each system and one of these Password/ID pairs is carried in each BFD Control packet. The receiving system accepts the packet if the Password and Key ID matches one of the Password/ID pairs configured in that system. Reference IETF RFC5880 Section 6.7.2.
- KEYED\_MD5:
  - The Keyed MD5 and Meticulous Key MD5 Authentication mechanisms are very similar to those used in other protocols. In these methods of authentication, one or more security keys (with corresponding key IDs) are configured in each system. Reference RFC5880 Section 6.7.3 Keyed MD5 and Meticulous Keyed MD5 Authentication.
- METICULOUS\_KEYED\_MD5:

- 1025                   ○ The Keyed MD5 and Meticulous Key MD5 Authentication mechanisms are very similar to  
1026 those used in other protocols. In these methods of authentication, one or more security  
1027 keys (with corresponding key IDs) are configured in each system. Reference RFC5880  
1028 Section 6.7.3 Keyed MD5 and Meticulous Keyed MD5 Authentication.
- 1029           • KEYED\_SHA1:
- 1030                   ○ The Keyed SHA1 and Meticulous Key SHA1 Authentication mechanisms are very similar  
1031 to those used in other protocols. In these methods of authentication, one or more  
1032 secret keys (with corresponding key IDs) are configured in each system. Reference  
1033 RFC5880 Section 6.7.4 Keyed SHA1 and Meticulous Keyed SHA1 Authentication.
- 1034           • METICULOUS\_KEYED\_SHA1:
- 1035                   ○ The Keyed SHA1 and Meticulous Key SHA1 Authentication mechanisms are very similar  
1036 to those used in other protocols. In these methods of authentication, one or more  
1037 secret keys (with corresponding key IDs) are configured in each system. Reference  
1038 RFC5880 Section 6.7.4 Keyed SHA1 and Meticulous Keyed SHA1 Authentication.

## 1039 17.5 BfdTransmissionInterval

1040 *File: ip/ipCommon.yaml*

1041

1042 RFC 7419 **Błąd! Nie można odnaleźć źródła odwołania.** specifies a set of common intervals which are  
1043 used to ensure interoperability.

1044

1045 Contains Enumeration Literals:

- 1046           • 3\_3\_MILLISECONDS:
- 1047                   ○ 3.3 milliseconds
- 1048           • 10\_MILLISECONDS:
- 1049                   ○ 10 milliseconds
- 1050           • 20\_MILLISECONDS:
- 1051                   ○ 20 milliseconds
- 1052           • 50\_MILLISECONDS:
- 1053                   ○ 50 milliseconds
- 1054           • 100\_MILLISECONDS:
- 1055           • 1\_SECOND:

○ 1 second

## 17.6 Bgp

File: *ip/ipCommon.yaml*

When an entry in the UNI Routing Protocol is for BGP, BGP as specified in RFC 4271 is used across the UNI to exchange routing information. Reference MEF 61.1 Section 12.7.3 BGP.

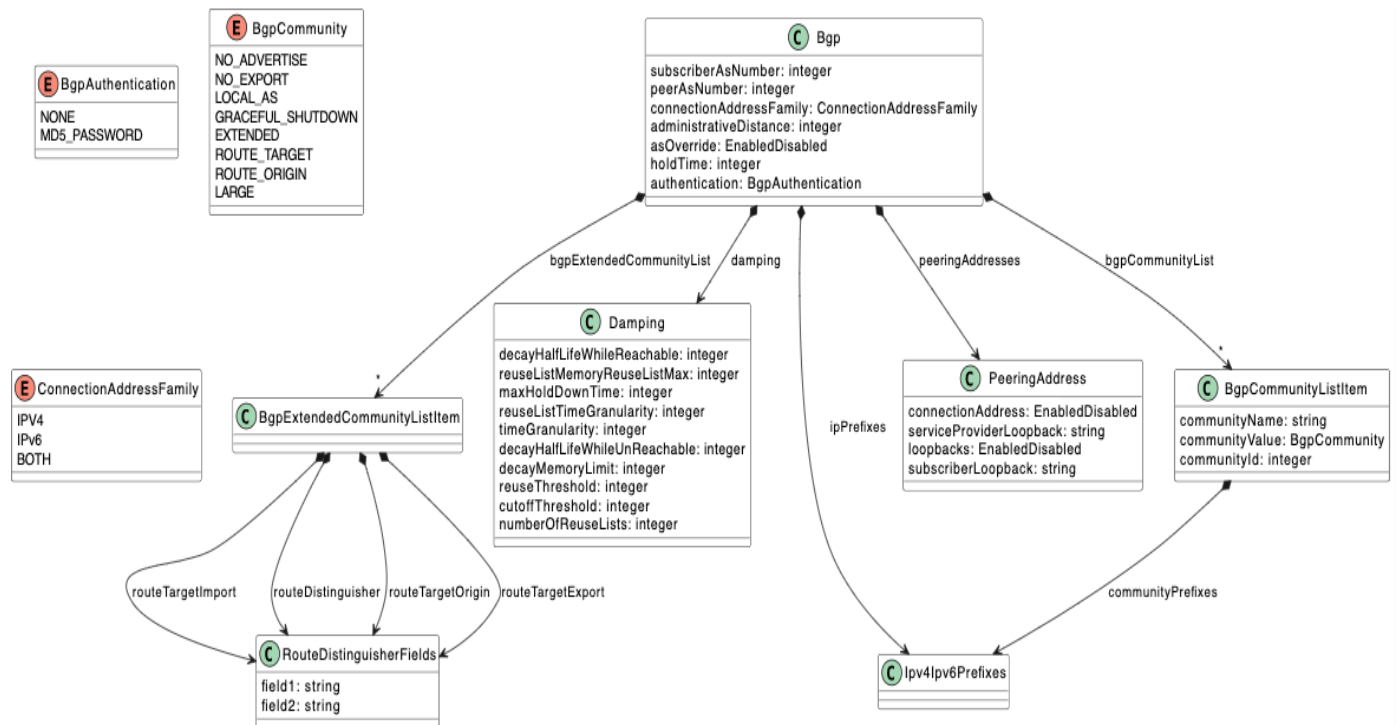


Figure 20-Bgp Model

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipPrefixes	Ipv4Ipv6Prefixes	1	IPv4/IPv6 Prefixes that are advertised using BGP.
subscriberAsNumer	Integer	1	BGP Subscriber Autonomous System number.
peerAsNumber	Integer	1	BGP Peer Autonomous System Number.



connectionAddressFamily	ConnectionAddressFamily	1	Connection Address Family (IPv4 or IPv6).
peeringAddresses	PeeringAddresses	1	Peering Addresses.
authentication	BgpAuthentication	1	BGP Authentication (None or MD5 plus a password).
bgpCommunityList	BgpCommunityListItem	0..*	Used to control which routers are accepted, preferred, distributed, or advertised.
bgpExtendedCommunityList	BgpExtendedCommunityListItem	0..*	Mechanism for labeling information carried in BGP-4. Provide enhancement over existing BGP Community Attribute: An extended range, the addition of type field.
holdTime	Integer	1	Hold time in seconds. Indicates the agreed Hold Time used for BGP sessions. The possible values are 0 or an integer in the range 3 -65535.
damping	Damping	0..1	Route flap damping. When the Damping parameter is NONE, the attribute is NOT set. When not NONE a single set of parameters described in Section 4.3 of RFC 2430 MUST be agreed.
asOverride	EnabledDisabled	1	Autonomous System Override.
administrativeDistance	Integer	1	BGP Administrative Distance.

Table 17-Bgp Attributes

## 17.7 BgpAuthentication

File: ip/ipCommon.yaml

BGP Authentication options as an enumeration.

Contains Enumeration Literals:

- NONE:

1073                   ○ No authentication for BGP.

1074           • MD5\_PASSWORD:

1075                   ○ BGP Authentication is MD5 plus a password.

## 1076   **17.8    BgpCommunity**

1077   *File: ip/ipCommon.yaml*

1078   Set of BGP Community enumerations.

1079   Contains Enumeration Literals:

1080           • NO\_ADVERTISE:

1081                   ○ When a No-Advertise community is attached to a route, the BGP speaker won't  
1082                   advertise the route to any internal or external BGP peers.

1083           • NO\_EXPORT:

1084                   ○ When a No-Export community is attached to a route, the router won't advertise the  
1085                   route to external peers--only to internal peers.

1086           • LOCAL\_AS:

1087                   ○ To avoid any BGP routing loops, there is an important rule regarding the internal BGP  
1088                   neighbors: an IBGP neighbor cannot advertise a route to an IBGP neighbor if it received  
1089                   that route from another IBGP neighbor.

1090           • GRACEFUL\_SHUTDOWN:

1091                   ○ The Graceful SHUTDOWN (65535:0) community is used to smoothly shut down paths a  
1092                   router might use when its peer router is about to be intentionally shut down.

1093           • EXTENDED:

1094                   ○ An Extended community is an 8-byte value that is divided into two main sections:

1095                   An extended community has three fields: type, administrator, assigned number  
1096                   (type:administrator:assigned-number). Based on the value of the high-order byte in the  
1097                   Type field, the administrator field can be an AS or an IP address.

1098           • ROUTE\_TARGET:

1099                   ○ The Route Target community is used in MPLS VPN environments to separate two  
1100                   customers routing tables.

1101           • ROUTE\_ORIGIN:

1102                   ○ In an MPLS VPN environment, the route origin community is used to identify where  
1103                   routes originated from, so that readvertisement back to that site is avoided.

1104           • LARGE:

1105                   ○ A Large community is a 12-byte BGP community that was developed when the 4-byte AS  
1106                   began to be allocated. Since each of the standard or extended communities use 2-byte  
1107                   values for the AS, a 4-byte AS would not fit into the standard 2-byte value.

## 17.9 BgpCommunityListItem

BGP Community List.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
communityId	Integer	1	Unique identifier for BGP Community.
communityName	String	1	The name of BGP Community.
communityPrefixes	Ipv4Ipv4Prefixes	1	The prefixes that the BGP Community contains.
communityValue	BgpCommunity	1	BGP Community value.

Table 18-BgpCommunityListItem Attributes

## 17.10 BgpExtendedCommunityListItem

BGP Extended Community List.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
routeDistinguisher	RouteDistinguisherFields	1	Route Distinguisher.
routeTargetImport	RouteDistinguisherFields	1	Import route target.
routeTargetExport	RouteDistinguisherFields	1	Export route target.
routeTargetOrigin	RouteDistinguisherFields	1	Origin route target.

Table 19-BgpExtendedCommunityListItem Attributes

## 17.11 BwRate

File: ip/ipCommon.yaml

Enumeration representing bandwidth rate units.

Contains Enumeration Literals:

- BPS:
  - Bits per second.
- KBPS:
  - Kilobits per second.
- MBPS:
  - Megabits per second.
- GBPS:
  - Gigabits per second.

## 17.12 BurstBehavior

File: *ip/ipCommon.yaml*

Enumeration used to select the Bandwidth Profile Flow Burst Behavior attribute. Reference MEF 61.1 **Błąd! Nie można odnaleźć źródła odwołania.** Section 17.3 Table 29 Bandwidth Profile Parameters for a Bandwidth Profile Flow.

Contains Enumeration Literals:

- OPTIMIZE\_DELAY:
  - Enumeration representing the Burst Behavior of optimization of delay.
- OPTIMIZE\_THROUGHPUT:
  - Enumeration representing the Burst Behavior of optimization of throughput.

## 17.13 CloudDataLimit

Specifies an absolute limit on the amount of data the Subscriber can transmit to, or receive from, the cloud service in a given time period. It is either Unlimited or a 4-tuple (scdl, tcsl, ucdl, dcdl). Reference MEF 61.1 Section 10.13.3 Cloud Data Limit.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
startTime	DateTime	1	Specifies a start time.

duration	Duration	1	Specifies a duration. Together with the start time, it describes a service of contiguous time intervals, starting at the specified start time and each lasting for the specified duration.
upload	Integer	1	An integer indicating a limit, in octets, on the amount of IP traffic that can be transmitted towards the cloud service during each time interval described by startTime and duration.
download	Integer	1	An integer indicating a limit, in octets, on the amount of IP traffic received from the cloud service that can be delivered to the Subscriber during each time interval described by startTime and duration.

Table 20-CloudDataLimit Attributes

## 17.14 CloudDns

Data type representing a Domain Name System.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
dnsType	DnsType	1	Domain Name System type.
dnsServerIpv4List	String	0.. *	DNS server list an IPv4 addresses.
dnsServerIpv6List	String	0.. *	DNS server list an IPv6 addresses.

Table 21-CloudDns Attributes

## 17.15 CloudType

File: ip/ipCommon.yaml

Indicates the type of cloud service being accessed. Reference MEF 61.1 Table 10-Subscriber IPVC Cloud Service Attribute parameters.

1157

1158 Contains Enumeration Literals:

1159     • INTERNET\_ACCESS:

1160         ○ Indicates the cloud access IPVC is used to access the public Internet.

1161     • PRIVATE:

1162         ○ Indicates the cloud access IPVC provides a direct connection over the Service Provider's  
1163         network to a cloud service.1164 **17.16 ConnectionAddressFamily**1165 *File: ip/ipCommon.yaml*

1166

1167 Specifies whether the session is established over IPv4 or IPv6 or whether two separate session are  
1168 established using IPv4 and IPv6.

1169

1170 Contains Enumeration Literals:

1171     • IPV4:

1172         ○ IPv4 is used for establishing the BFD session.

1173     • IPV6:

1174         ○ IPv6 is used for establishing the BFD session.

1175     • BOTH:

1176         ○ IPv4 and IPv6 are used for establishing the BFD session.

1177 **17.17 ConnectionType**1178 *File: ip/ipCommon.yaml*

1179

1180 An enumeration representing the connection type.

1181

1182 Contains Enumeration Literals:

1183     • P2P:

1184         ○ Point-to-Point. Indicates that the link is logically point to point.

- MULTIPOINT:
  - Multipoint. Indicating that the link is logically multipoint.

## 17.18 ConnectorType

Enumeration representing type of connector presented to Subscriber.

Contains Enumeration Literals:

- RJ45:
  - Enumeration representing connector type for Copper based on IEC 60603-7, TIA568.
- SC:
  - Enumeration representing connector type for Fiber based on IEC 61754-4.
- LC:
  - Enumeration representing connector type for Fiber based on IEC 61754-20.

## 17.19 ControlProtocols

Data type representing Control Protocols. Each entry consists of a 3-tuple containing the protocol name, addressing information (either SP/Operator Addresses or Any) and one or more references. Reference MEF 61.1 Section 12.6 UNI List of Control Protocols Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
protocolName	String	1	Protocol name.
reference	String	1..*	Protocol reference.
addressing	Addressing	0..1	Enumeration representing the addressing.

**Table 22-ControlProtocols Attributes**

## 17.20 Damping

BGP Damping parameters as defined in RFC 2439Błąd! Nie można odnaleźć źródła odwołania. BGP Route Flap Damping, Section 4.2.

Schema File Name: ip/ipCommon.yaml
------------------------------------

Attribute Name	Type	Multiplicity	Description
cutoffThreshold	Integer	1	This value is expressed as a number of route withdrawals. It is the value above which a route advertisement will be suppressed.
reuseThreshold	Integer	1	This value is expressed as a number of route withdrawals. It is the value below which a suppressed route will now be used again.
decayHalfLifeWhileReachable	Integer	1	This value is the time duration in seconds during which the accumulated stability figure of merit will be reduced by half if the route is considered reachable (whether suppressed or not).
decayHalfLifeWhileUnreachable	Integer	1	This value is the time duration in seconds during which the accumulated stability figure of merit will be reduced by half if the route is considered unreachable. If not specified or set to zero, no decay will occur while a route remains unreachable.
decayMemoryLimit	Integer	1	This is the maximum time (in seconds) that any memory of previous instability will be retained given that the route's state remains unchanged, whether reachable or unreachable. This parameter is generally used to determine array sizes.
timeGranularity	Integer	1	This is the time granularity in seconds used to perform all decay computations.
reuseListTimeGranularity	Integer	1	This is the time (in seconds) interval between evaluations of the reuse lists. Each reuse list corresponds to an additional time increments.
reuseListMemoryReuseListMax	Integer	1	This is the time (in seconds) value corresponding to the last reuse



			list. This may be the maximum value of  T-hold for all parameter sets of may be configured.
numberOfReuseLists	Integer	1	This is the number of reuse lists. It may be determined from reuse-list-max or set explicitly.
maxHoldDownTime	Integer	1	This value is the maximum time a route can be suppressed no matter how unstable it has been prior to this period of stability. In seconds.

Table 23-Damping Attributes

## 17.21 DateTime

Data type representing time and date.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
time	String	1	Time of day as a String
date	String	1	Date as a String.

Table 24-DateTime Attributes

## 17.22 DhcpRelay

Dynamic Host Configuration Protocol (DHCP) Relay functionality is useful when the Subscriber uses DHCP (per RFC 2131**Błąd! Nie można odnaleźć źródła odwołania.** and RFC 8415**Błąd! Nie można odnaleźć źródła odwołania.**) in the Subscriber Network but does not want to place a DHCP server (or possibly a pair of redundant DHCP servers) in each part of the network.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
dhcpServerList	DhcpServer	1..*	Non-empty list of IP addresses for DHCP Servers belonging to the Subscriber. Reference MEF 61.1  Section 13.6 UNI Access Link DHCP Relay Server Attribute.

ipvcEndPointIdentifier	ipvcEndPoint	1	IPVC identifier as described in MEF 61.1 Section 11.1.
------------------------	--------------	---	--

Table 25-DhcpRelay Attributes

## 17.23 DhcpServer

Data type representing a DHCP Server.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4Address	String	0.. *	List of DHCP Server(s) IPv4 addresses.
ipv6Address	String	0.. *	List of DHCP Server(s) IPv6 addresses.

Table 26-DhcpServer Attributes

## 17.24 DnsType

File: ip/ipCommon.yaml

Enumeration representing the different types of DNS.

Contains Enumeration Literals:

- DHCP:
  - If DNS type is Dynamic Host Configuration Protocol, the SP provides DNS server addresses via DHCP at each UNI.
- PPP:
  - If DNS type is Point to Point Protocol, the SP provides DNS service addresses via PPP at each UNI.
- STATIC:
  - If DNS type is Static, the DNS server addresses are listed explicitly.
- SLAAC:
  - If DNS type is Stateless Address Auto Configuration, the SP provides DNS server addresses via SLAAC Router Advertisement options (per RFC 8106).

## 17.25 Dscp

Differentiated Service Code Point is a 6-bit value that can be used to classify traffic for the purpose of associating specific forwarding behavior. Reference RFC 2474.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
value	Integer	1	0 <= value <= 63.

**Table 27-Dscp Attributes**

## 17.26 DscpMapping

Ethernet PCP mapping for CoS name to PCP value.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
cosName	String	1	Class of Service name.
ipds	Dscp	1	DSCP value (Integer 0 to 63).

**Table 28-DscpMapping Attributes**

## 17.27 Duration

Data type representing time duration.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
value	Integer	1	Time value.
durationUnits	DurationUnits	1	Time duration units.

**Table 29-Duration Attributes**

## 17.28 DurationUnits

*File: ip/ipCommon.yaml*

Enumeration represents time duration.

Contains Enumeration Literals:

- NS:
  - Nanoseconds
- US:
  - Microseconds
- MS
  - Milliseconds
- SEC
  - Seconds
- MIN
  - Minutes
- HOUR
  - Hour
- DAY
- WEEK
- MONTH
- YEAR

## 17.29 EgressClassOfServiceMap

Pair of values (D, P). D specifies how to set the DS field in Egress IP Data Packets based on CoS Name. It is either None, or a mapping from CoS Names to DSCP values. P specifies how to set the PCP field in VLAN Tagged Ethernet Frames containing Egress IP Data Packets based on CoS Name. It is either None, or a mapping from CoS Names to PCP values. Reference MEF 61.1 Section 11.10 IPVC EP Egress Class of Service Map Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
pcpMapping	PcpMapping	0..*	Reference to CoS to Ethernet PCP mapping.

dscpMapping	DscpMapping	0..*	Reference to CoS to IP DSCP mapping.
-------------	-------------	------	--------------------------------------

Table 30-EgressClassOfServiceMap Attributes

### 17.30 EndPointIdentifierAndCosName

Data type representing IPVC End Point Identifier and CoS name used for Bandwidth Profiles.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipvcEndPointIdentifier	String	1	IPVC End Point Identifier for an IPVC End Point located at the UNI.
cosName	String	1	Class of Service Name.

Table 31-EndPointIdentifierAndCosName Attributes

### 17.31 EnniIpv4ConnectionAddressing

The ENNI Link IPv4 Connection Addressing specifies how IPv4 addresses are allocated to the devices connected to the ENNI Link. It is either NONE or STATIC, plus in the case of STATIC, some additional parameters. Reference MEF 61.1 Section 16.3 ENNI Link IPv4 Connection Addressing Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
enniLinkIpv4AddressType	EnniLinkIpv4AddressType	0..1	IPv4 address type for ENNI Link. Values are None or STATIC. If the attribute is not assigned that is equivalent of NONE.
ipv4PrimarySubnet	EnniIpv4Subnet	1	IPv4 Primary Subnet for ENNI Link.
ipv4SecondarySubnet	EnniIpv4Subnet	0..*	IPv4 Secondary Subnet for ENNI Link.

Table 32-EnniIpv4ConnectionAddressing Attributes

### 17.32 EnniIpv4Subnet

Data type representing IPv4 Subnet for ENNI Links. Reference MEF 61.1 16.3 ENNI Link IPv4 Connection Addressing Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4Prefix	Ipv4Prefix	1	IPv4 Prefix (IPv4 address prefix and mask length between 0 and 31, in bits).
firstLlIpv4Address	String	1	First LLO (Lowest Level Operator) IPv4 Address.
secondLlIpv4Address	String	1	Second LLO (Lowest Level Operator) IPv4 Address.

Table 33-EnnIIPv4Subnet Attributes

### 17.33 EnnIIPv6ConnectionAddressing

The ENNI Link IPv6 Connection Addressing specifies how IPv6 addresses are allocated to the devices connected to the ENNI Link. It is one of the three values None, Static or LL-only, plus in the case of Static, some additional properties. Reference MEF 61.1 Section 16.4 ENNI Link IPv6 Connection Addressing Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
enniLinkIpv6AddressType	EnniLinkIpv6AddressType	0..1	IPv6 address type for ENNI Link. Values are NONE, STATIC and LL-only. If the attribute is not assigned that is equivalent of NONE.
enniIPv6Subnet	EnnIIPv6Subnet	0..1	IPv6 Subnet for ENNI Link.

Table 34-EnnIIPv6ConnectionAddressing Attributes

### 17.34 EnnIIPv6Subnet

Data type representing IPv6 Subnet for ENNI Links. Reference MEF 61.1 Section 16.4 ENNI Link IPv6 Connection Addressing Attribute.

Attribute Name	Type	Multiplicity	Description
ipv6Prefix	Ipv6Prefix	1	IPv6 Prefix (IPv6 address prefix and mask length between 0 and 127 in bits).

firstLloIPv6Address	String	1	First LLO (Lowest Level Operator) IPv6 Address.
secondLloIPv6Address	String	1	Second LLO (Lowest Level Operator) IPv6 Address.

Table 35-EnniIPv6Subnet Attributes

### 17.35 EnniList

The ENNI List of ENNI Links Common Attribute is a list of 3-tuples of the form (*ID*, *L1*, *Links*). Each entry in the list corresponds to a distinct L1 link across the ENNI – in most cases, this means a separate physical link (although virtual or logical links are not precluded). The first element in the 3-tuple, *ID*, is the identifier of the L1 link. The second element, *L1*, contains the details of the L1 technology used for the link. The third element, *Links*, is a list (possibly empty) of ENNI Link Identifiers (see section 16.1) for the ENNI Links in this ENNI that traverse the L1 link. Reference MEF 61.1 Section 15.3 ENNI List of ENNI Links Common Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
identifier	Identifier53	1	L1 Link Identifier. Reference MEF 61.1 Section 15.3.1 L1 Link Identifier.
enniIdentifier	Identifier53	1..*	ENNI Identifiers.
l1Technology	L1Technology	0..1	Layer 1 technology.

Table 36-EnniList Attributes

### 17.36 EnniPeeringType

File: ip/ipCommon.yaml

Attribute indicates the type of BGP Peering used across the ENNI. The possible values are Option A, Option B, Option C or Option B and C. They refer to the options described in RFC 4364. Reference MEF 61.1 Section 15.2 ENNI Peering Type Common Attribute. For Options reference MEF 61.1 Section 8.6 Connecting Services across an ENNI.

Contains Enumeration Literals:

- OPTION\_A:

- 1330 ○ A separate eBGP session is used across each ENNI Link and each session carries routes  
1331 for one service. This results in packets for different services being sent over different  
1332 ENNI Links. The packets can be plain IP Packets since it is the different links that  
1333 distinguish them.
- 1334 • **OPTION\_B:**
- 1335 ○ One or more eBGP sessions are used across the ENNI, each exchanging labelled VPN  
1336 routes for multiple services. The routes for different services are distinguished by  
1337 attributes such a Route Distinguishers and Route Targets. This results in IP Packets  
1338 across the ENNI being encapsulated in MPLS where IP Packets for different services have  
1339 different MPLS labels. Typically, each packet has a single MPLS label, that identifies both  
1340 the egress PE and the service.
- 1341 • **OPTION\_C:**
- 1342 ○ One or more eBGP sessions are used across the ENNI only to distribute labeled unicast  
1343 routes (and labels) towards each Operator's own routers; furthermore, multi-hop eBGP  
1344 sessions are used between the ingress PE and the egress PE (or equivalent route  
1345 reflectors) to exchange labelled VPN routes for each service. This results in IP Packets  
1346 across the ENNI being encapsulated in MPLS, typically with two MPLS labels, one  
1347 representing the egress PE, and the second that (roughly speaking) identifies the  
1348 service.
- 1349 • **OPTIONS\_B\_AND\_C:**
- 1350 ○ Combination of Options B and C.

### 1351 17.37 EnniRoutingInformation

1352 For an ENNI Option A, the ENNI Routing Information Service Attribute is a mapping of ENNI Service  
1353 Mapping Identifiers to four-tuples of the form (Administrative Distance, Route Flap Damping, AS  
1354 Override, Static Routes). Each four-tuple applies to the corresponding ENNI Service Mapping Identifier.  
1355 Reference MEF 61.1 Section 14.3.1 ENNI Routing Protocols for Option A.

1356

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
enniServiceMappingIdentifier	Identifier53	1	A string identifier that is used at the ENNI to match the IPVC EP on one side of the ENNI with IPVC EPs on the other side. Reference MEF 61.1 Section 11.6 IPVC EP ENNI Service Mapping Identifier Service Attribute.



administrativeDistance	Integer	1	<p>The Administrative Distance for a given ENNI Service Mapping Identifier is an integer greater than 0 that indicates the value of the administrative distance assigned by the Operator to eBGP routes received from another Operator over the ENNI Links that are assigned to that ENNI Service Mapping Identifier at an ENNI using Option A. Reference MEF 61.1 Section 14.3.1.1 Administrative Distance.</p>
routeFlapDamping	EnabledDisabled	1	<p>The Route Flap Damping parameter for a given ENNI Service Mapping Identifier indicates whether the Operator applies route flap damping to routes received from another Operator over the ENNI Links assigned to that ENNI Service Mapping Identifier. Reference MEF 61.1 Section 14.3.1.2 Route Flap Damping.</p>
asOverride	EnabledDisabled	1	<p>The AS Override parameter for a given ENNI Service Mapping Identifier indicates whether AS Override behavior is enabled at the ENNI, for routes advertised towards another Operator over the ENNI Links assigned to that ENNI Service Mapping Identifier. Reference MEF 61.1 Section 14.3.1.3 AS Override.</p>
staticRoute	StaticRoute	0..*	<p>The Static Routes parameter for a given ENNI Service Mapping Identifier is a list of static routes over the ENNI for the service identified by that ENNI Service Mapping Identifier. The list can be empty.</p>

			Reference MEF 61.1 Section 14.3.1.4 Static Routes.
--	--	--	--

Table 37-EnniRoutingInformation Attributes

## 17.38 EnniServiceMap

For an ENNI using Option A, the ENNI Service Map Common Attribute is a mapping from ENNI Service Mapping Contexts a set of ENNI Link Identifiers for ENNI Links in the ENNI. Reference MEF 61.1 Section 15.6.1 ENNI Service Map for Option A.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
enniServiceMappingContext	EnniServiceMappingContext	1	Pointer to ENNI Service Mapping Context.
enniLinks	EnniList	1	Pointer to ENNI Link list.

Table 38-EnniServiceMap Attributes

## 17.39 EnniServiceMappingContext

A pair of SP/SO, ENNI Service Mapping Identifier. It uniquely identifies services for a given SP/SO on either side of the ENNI that have been assigned the same ENNI Service Mapping Identifier. Reference MEF 61.1 Section 15.6.1 ENNI Service Map for Option A.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
serviceProvider	String	1	Service Provider identifier.
serviceOperator	String	1	Service Operator identifier.
enniServiceMappingIdentifier	String	1	ENNI Service Mapping identifier.

Table 39-EnniServiceMappingContext Attributes

## 17.40 EnniType

File: ip/ipCommon.yaml

1373 Indication of the type of BGP Peering at the ENNI. Reference MEF 61.1 Section 14 ENNI Service  
1374 Attributes.

1375

1376 Contains Enumeration Literals:

- 1377     • OPTION\_A:
- 1378     • OPTION\_B:
- 1379     • OPTION\_C:

#### 1380 **17.41 EthernetPhysicalLayer**

1381 *File: ip/ipCommon.yaml*

1382

1383 Enumeration representing the different Ethernet physical layers. Reference MEF 61.1.1 Table A1-4  
1384 Ethernet PHYs for UNI Access Link Trunks.

1385

1386 Contains Enumeration Literals:

- 1387     • 10BASE\_FB
- 1388     • 10BASE\_FL
- 1389     • 10BASE\_FP
- 1390     • 10BASE\_T
- 1391     • 10BASE\_T1L
- 1392     • 10BASE\_T1S
- 1393     • 10BASE\_TE
- 1394     • 10BROAD36
- 1395     • 10PASS\_TS
- 1396     • 100BASE\_BX10
- 1397     • 100BASE\_FX
- 1398     • 100BASE\_LX10
- 1399     • 100BASE\_T
- 1400     • 100BASE\_T1
- 1401     • 100BASE\_T2
- 1402     • 100BASE\_T4
- 1403     • 100BASE\_TX
- 1404     • 100BASE\_X
- 1405     • 1000BASE\_BX10
- 1406     • 1000BASE\_CX
- 1407     • 1000BASE\_LX

1408	• 1000BASE_LX10
1409	• 1000BASE_PX10
1410	• 1000BASE_PX20
1411	• 1000BASE_RHA
1412	• 1000BASE_RHB
1413	• 1000BASE_RHC
1414	• 1000BASE_SX
1415	• 1000BASE_T
1416	• 1000BASE_T1
1417	• 1000BASE_X
1418	• 2_5GBASE_T
1419	• 2_5GBASE_T1
1420	• 5GBASE_T
1421	• 5GBASE_T1
1422	• 10GBASE_E
1423	• 10GBASE_EW
1424	• 10GBASE_L
1425	• 10GBASE_LR
1426	• 10GBASE_LRM
1427	• 10GBASE_LW
1428	• 10GBASE_LX4
1429	• 10GBASE_R
1430	• 10GBASE_S
1431	• 10GBASE_SR
1432	• 10GBASE_SW
1433	• 10GBASE_T
1434	• 10GBASE_T1
1435	• 10GBASE_X
1436	• 25GBASE_CR
1437	• 25GBASE_CR_S
1438	• 25GBASE_ER
1439	• 25GBASE_SR
1440	• 25GBASE_T
1441	• 40GBASE_CR4
1442	• 40GBASE_ER4
1443	• 40GBASE_FR
1444	• 40GBASE_LR4
1445	• 40GBASE_R
1446	• 40GBASE_SR4
1447	• 40GBASE_T
1448	• 50GBASE_CR

- 1449       • 50GBASE\_ER
- 1450       • 50GBASE\_FR
- 1451       • 50GBASE\_LR
- 1452       • 50GBASE\_SR
- 1453       • 100GBASE\_CR10
- 1454       • 100GBASE\_CR2
- 1455       • 100GBASE\_CR4
- 1456       • 100GBASE\_DR
- 1457       • 100GBASE\_ER4
- 1458       • 100GBASE\_LR4
- 1459       • 100GBASE\_R
- 1460       • 100GBASE\_SR10
- 1461       • 100GBASE\_SR2
- 1462       • 100GBASE\_SR4
- 1463       • 200GBASE\_CR4
- 1464       • 200GBASE\_DR4
- 1465       • 200GBASE\_ER4
- 1466       • 200GBASE\_FR4
- 1467       • 200GBASE\_LR4
- 1468       • 200GBASE\_SR4
- 1469       • 400GBASE\_DR4
- 1470       • 400GBASE\_ER8
- 1471       • 400GBASE\_FR8
- 1472       • 400GBASE\_LR8
- 1473       • 400GBASE\_SR16
- 1474       • 400GBASE\_SR4\_2
- 1475       • 400GBASE\_SR8

## 1476   **17.42   EthernetPhysicalLink**

1477   *File: ip/ipCommon.yaml*

1478

1479   Data type representing UNI Access Link Trunk List of Ethernet Physical Links of form <id,pl,fs,ct,gn> as  
1480   defined in MEF 61.1.1 Section A1-1.3.1.

1481

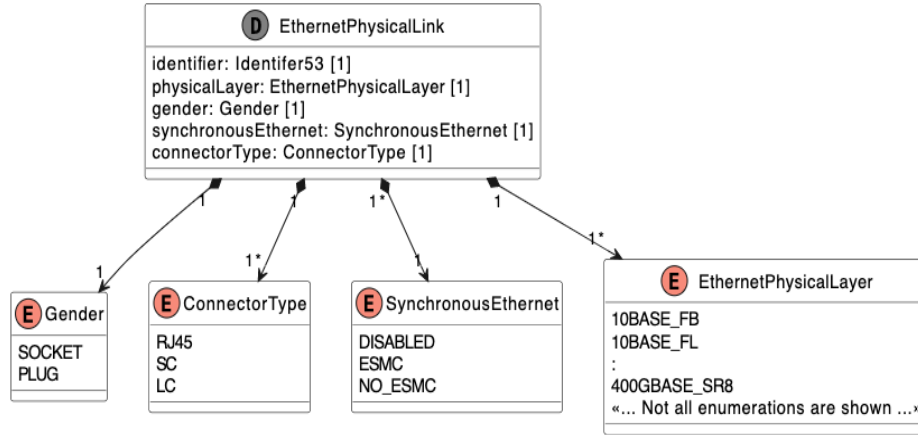


Figure 21-EthernetPhysicalLink Model

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
identifier	EthernetPhysical Link	1	The value of id is an identifier for the physical link.
physicalLayer	EthernetPhysical Layer	1	The value of pl specifies a physical layer.
gender	Gender	1	The value of gn indicates the gender of the connector presented to the Subscriber.
synchronousEthernet	SynchronousEthernet	1	Enumeration representing value of fs synchronous ethernet.
connectorType	ConnectorType	1	Enumeration representing ct Connector Type.

Table 40-EthernetPhysicalLink Attributes

### 17.43 ExternalInterfaceType

File: ip/ipCommon.yaml

Enumeration representing the different External Interface types.

Contains Enumeration Literals:

- UNI:
  - External interface type is UNI (User Network Interface).

- ENNI:

- External interface type is ENNI (External Network Network Interface).

#### 17.44 ForwardingInformation

Forwarding information, consisting of either a nexthop IP address in the Subscriber Network (if the access medium is multipoint capable, e.g., Ethernet), or a specific UNI Access Link (if the access medium is strictly point-to-point, e.g., HDLC, PPP over DSL).

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
nextHopIpAddress	String	0..1	Next Hop IP Address.
uniAccessLink	Identifier53	0..1	UNI Access Link unique identifier.

**Table 41-ForwardingInformation Attributes**

#### 17.45 Gender

Enumeration representing the gender of the connector presented to the Subscriber.

Contains Enumeration Literals:

- SOCKET:

- Subscriber is expected to provide a cable (copper or fiber) with a plug (with a connector type specified in *ct*).

- PLUG:

- The SP provides the cable, then it is presenting a plug to the Subscriber (*gn* is *plug*), and the Subscriber is expected to provide equipment that can connect to a plug of type *ct*.

#### 17.46 HeaderFieldTypes

HeaderFieldTypes is an enumeration for fields defined in MEF 61.1 Section 10.13.2 Cloud Ingress Class of Service Map.

Contains Enumeration Literals:

- SOURCE\_IP\_ADDRESS:

- Field type Source IP Address.

- DESTINATION\_IP\_ADDRESS:
  - Field type Destination IP Address.
- L4\_PROTOCOL:
  - Field type Layer 4 Protocol.
- SOURCE\_L4\_PORT:
  - Field type Source Layer 4 Port.
- DESTINATION\_L4\_PORT:
  - Field type Destination Layer 4 Port.
- ETHERNET\_PCP:
  - Field type Ethernet PCP.
- IP\_DS:
  - Field type IP Differentiated Service.

#### 17.47 Identifier53

A data type used for a unique identifier consists of ASCII characters in the range 32-126 inclusive. The length of must be less than or equal to 53 characters.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
identifier	String	1	Unique identifier as a String with length restrictions.

**Table 42-Identifier53 Attributes**

#### 17.48 InformationRate

Data type representing bandwidth in unit of bits per second.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
irValue	Integer	1	The value of the information rate. For example if the rate is 70 kbps, 70 is the value.



irUnits	IrUnits	1	Bandwidth rate units.
---------	---------	---	-----------------------

Table 43-InformationRate Attributes

## 17.49 IrUnits

File: *ip/ipCommon.yaml*

Enumeration representing information rate units.

Contains Enumeration Literals:

- BPS:
  - Bits per second.
- KBPS:
  - Kilobits per second.
- MBPS:
  - Megabits per second.
- GBPS:
  - Gigabits per second.
- TBPS:
  - Terabits per second.
- PBPS:
  - Petabits per second.
- EBPS:
  - Exabits per second.
- ZBPS:
  - Zettabits per second.
- YBPS:
  - Yottabits per second.

## 17.50 IngressClassOfServiceMap

Is a triple (F,M,D) where F is a list of one or more fields in the packet header that are used to determine the CoS Name, M is a mapping from combinations of values of those fields to CoS Names, and D is a default CoS Name used when the map cannot be applied. Reference MEF 61.1 Section 10.13.2 Cloud Ingress Class of Service Map and Section 11.10 IPVC EP Egress Class of Service Map Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
defaultCosName	String	1	Default Class of Service Name. Reference MEF 61.1 Section 10.13.2 Cloud Ingress Class of Service Map and Section 11.9 IPVC EP Ingress Class of Service Map Service Attribute.
headerFieldTypes	HeaderFieldType s	1.. *	Is a list of one or more fields in the packet header that are used to determine the CoS Name. Reference MEF 61.1 Section 10.13.2 Cloud Ingress Class of Service Map.
ingressClassOfServiceMapping	ClassOfServiceMapEntry	0.. *	Pointer to Class of Service Map Entry.

**Table 44-IngressClassOfServiceMap Attributes**

## 17.51 IngressClassOfServiceMapEntry

Values for the Cloud Ingress Class of Service Map. Reference MEF 61.1 Table 11 - Values for the Cloud Ingress Class of Service Map, 11.0 IPVC EP Ingress Class of Service Map Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
cosName	String	1	Class of Service Name.
sourceIpAddress	Ipv4Prefix	0..1	Source IP address.
destinationIpAddress	Ipv4Prefix	0..1	Destination IP address.
l4Protocol	Integer	0..1	Layer 4 protocol number. Integer from 0 to 255.

sourceL4Port	Integer	0..1	Source Layer 4 port number. Integer from 0 to 65535.
destinationL4Port	Integer	0..1	Destination Layer 4 port number. Integer from 0 to 65535.
ipds	DSCP	0..1	DSCP values (Integer 0 to 63).
ethernetPcp	PCP	0..1	PCP values (Integer 0 to 7).

Table 45-IngressClassOfServiceMapEntry Attributes

## 17.52 IpvCloud

The IPV Cloud Service Attribute is a set of parameters describing the access connectivity to the cloud service. Reference MEF 61.1 Section 10.13 IPV Cloud Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
type	CloudType	1	Cloud Type indicates the type of cloud service being accessed. Reference MEF 61.1 Section 10.13.1  Cloud Type.
ingressClassOfServiceMap	IngressClassOfServiceMap	1	Specification of how ingress packets are mapped to different CoS Names. Reference MEF 61.1 Section 10.13.2 Cloud Ingress Class of Service Map.
dataLimit	CloudDataLimit	0..1	Limit on the amount of Data traffic sent to/received from the cloud service. Unlimited or a 4-tuple (scdl, Tcdl, ucdl, dcdl). If not provided, then Unlimited. Reference MEF 61.1 Section 10.13.3  Cloud Data Limit.
dns	CloudDns	0..1	Whether and how DNS is provided for the service. Reference MEF 61.1 Section 10.13.5 Cloud DNS Service.
networkAddressTranslation	Ipv4Prefix	0..1	Whether Network Address Translation is used, and if so the

			IPv4 Prefix. If not selected, then Disabled.  Reference MEF 61.1 Section 10.13.4 Cloud Network Address Translation.
subscriberPrefixList	Ipv4Ipv6Prefixes	0..1	List of Public IP Prefixes used in the Subscriber Network. Reference MEF 61.1 Section 10.13.6 Cloud Subscriber Prefix List.

Table 46-IpvcCloud Attributes

### 17.53 Ipv4EndPointRole

File: ip/ipCommon.yaml

The IPVC End Point Role is one of Root, Leaf, or Trunk and specifies the role the IPVC EP plays in the IPVC Topology. Reference MEF 61.1 Section 11.4 IPVC EP Role Service Attribute.

Contains Enumeration Literals:

- ROOT:
  - The IPVC connects multiple UNIs with restricted connectivity. Reference MEF 61.1 Section 7.10 IPVC Topology.
- LEAF:
  - An IPVC End Point with role of Leaf can only send and receive traffic from IPVC End Points with a role of Root. Reference MEF 61.1 Section 7.10 IPVC Topology.
- TRUNK:
  - Indicates that the IPVC End Points carry traffic from both roots and leaves. Reference MEF 61.1 Section 8.7 Rooted Multipoint Services across an ENNI.

### 17.54 Ipv4Prefix

Data type representing IPv4 address prefix and mask length between 0 and 31 bits.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description

ipv4Address	String	1	IPv4 address.
prefixLength	Integer	1	IPv4 address prefix. Length 0-31.

Table 47-Ipv4Prefix Attributes

## 17.55 Ipv4Subnet

Data type representing IPv4 Subnet. Reference MEF 61.1 Section 13.4 UNI Access Link IPv4 Connection Addressing Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
serviceProviderIpv4Addresses	String	1.. *	Service Provider (for Subscriber IP Services) or Operator (for Operation IP Services) IPv4 Addresses (Non-empty list of IPv4 addresses).
ipv4Prefix	Ipv4Prefix	1	IPv4 address prefix (IPv4 address prefix and mask length between 0 and 31 in bits).
subscriberIpv4Address	String	0..1	Subscriber IPv4 Address (IPv4 address or Not Specified).
ipv4ReservedPrefixList	Ipv4Prefix	0.. *	Reserved Prefixes List (List of IPv4 Prefixes, possibly empty).

Table 48-Ipv4Subnet Attributes

## 17.56 Ipv4Ipv6Prefixes

IPv4 and IPv6 prefix lists. Includes subnet addresses and prefix length.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
listOfIpv4ReservedPrefixes	Ipv4Prefix	0.. *	List of IPv4 address prefixes.
listOfIpv6ReservedPrefixes	Ipv6Prefix	0.. *	List of IPv6 address prefixes.

Table 49-Ipv4Ipv6Prefixes Attributes

## 17.57 Ipv6Prefix

Data type representing IPv6 address prefix and mask length between 0 and 127 in bits.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv6Address	String	1	IPv6 address.
prefixLength	Integer	1	IPv6 address prefix. Length 0-127.

**Table 50-Ipv6Prefix Attributes**

## 17.58 Ipv6Subnet

Data type representing IPv6 Subnet. Reference MEF 61.1 Section 13.5 UNI Access Link IPv6 Connection Addressing Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv6prefix	Ipv6Prefix	1	IPv6 Prefix (IPv6 address prefix and mask length between 0 and 127 in bits).
serviceProviderIpv6Address	String	1..*	Service Provider (for Subscriber IP Services) or Operator (for Operator IP Services) IPv6 Addresses (Non-empty list of IPv6 addresses).
ipv6ReservedPrefixList	Ipv6Prefix	0..*	Reserved Prefixes List (List of IPv6 Prefixes, possibly empty).

**Table 51-Ipv6Subnet Attributes**

## 17.59 LacpVersion

File: ip/ipCommon.yaml

Enumeration representing the LACP version. Reference MEF 61.1.1 Section A1-1.3.2 UNI Access Link Trunk Ethernet Link Aggregation Service Attribute.

Contains Enumeration Literals:

- LACPV1:
- LACPV2:
- STATIC:
- LACP is not used.

## 17.60 L2Technology

Specifies the UNI Access Link Trunk used to carry IP Packets across the UNI along with information needed to identify IP Packets for this UNI Access Link. Reference MEF 61.1.1 Section 13.3 UNI Access Link L2 Technology Service Attribute.

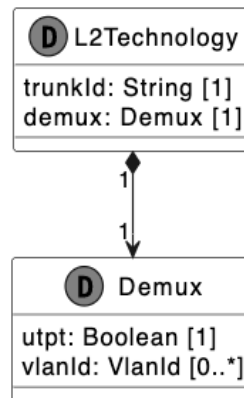


Figure 22-L2Technology Model

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
trunkId	String	1	UNI Access Link Trunk Identifier.
demux	Demux	1	Value that is specific to each type of UNI Access Link Trunk and indicates which Layer 2 sub-channel should be selected for this UNI Access Link.

Table 52-L2Technology Attributes

## 17.61 Ospf

When an entry in the UNI Routing Protocols is for OSPF, OSPF as specified in RFC 2328 for IPv4) and/or RFC 5340 (for IPv6) is used across each UNI Access Link to exchange routing information. Reference MEF 61.1 Section 12.7.2 OSPF.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipPrefixes	Ipv4Ipv6Prefixes	1	IPv4/IPv6 Prefixes that are advertised using OSPF.
areald	Integer	1	Area ID (0-429967295), normally expressed as an IPv4 address.
areaType	OspfAreaType	1	OSPF Area Type enumeration.
authenticationType	OspfAuthenticationType	1	OSPF Authentication Type.
helloInterval	Integer	1	Hello Interval (0-65535, in seconds).
deadInterval	Integer	1	Dead interval (0-4294967295, in seconds).
retransmissionInterval	Integer	1	Retransmit Interval (Integer greater than 0, in seconds).
administrativeDistance	Integer	1	Administrative Distance (Integer greater than 0).

Table 53-OSpf Attributes

## 17.62 OspfAuthenticationType

File: ip/ipCommon.yaml

OSPF Authentication Type enumeration.

Contains Enumeration Literals:

- NONE:
  - This is the default method and means that no authentication is used for OSPF.
- PASSWORD:
  - It is also known as "authentication with unencrypted text", because the password in the update is sent as unencrypted text over the network.
- MESSAGE\_DIGEST:



- The password is never exchanged between peers. Instead, it is calculated using the MD5 algorithm.

### 17.63 OspfAreaType

*File: ip/ipCommon.yaml*

OSPF Area Type enumeration as defined in RFC-3101.

Contains Enumeration Literals:

- NORMAL:
  - The area is not a STUB or NSSA.
- STUB: Stub Area.
- NSSA: Not-so-Stubby Area.

### 17.64 PacketDelivery

*File: ip/ipCommon.yaml*

For each Ingress IP Data Packet that is mapped to one of the IPVC EPs for the IPVC it takes one of two values. STANDARD\_ROUTING or POLICY-BASED\_ROUTING.

Contains Enumeration Literals:

- STANDARD\_ROUTING:
  - If the IPVC Packet Delivery is Standard Routing, the egress UNI and UNI Access Link or egress ENNI and ENNI Link are generally selected by examining the destination IP address in the packet and matching it to an IP Prefix reachable via the IPVC EP at the egress EI – in other words, by normal IP routing.
- POLICY\_BASED\_ROUTING:
  - The behavior and requirements when the IPVC Packet Delivery Service Attribute is set to Policy-Based Routing are deferred to a future revision of this specification (MEF 61.1)

### 17.65 Pcp

A 3-bit field which refers to the IEEE 802.1p class of service and maps to the frame priority level. Different PCP values can be used to prioritize different classes of traffic.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
value	Integer	1	0 <= value <=7.

Table 54-Pcp Attributes

## 17.66 PcpMapping

Ethernet PCP mapping for CoS name to PCP value.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
cosName	String	1	Class of Service name.
ethernetPcp	Pcp	1	PCP value (Integer 0 to 7).

Table 55-PcpMapping Attributes

## 17.67 PeeringAddress

Peering Addresses. Connection Addresses, or Loopbacks plus a list of pairs of IP addresses.

Reference MEF 61.1 Section 12.7.3 BGP.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
connectionAddress	EnabledDisabled	1	If the Peering Addresses parameter is Connection Addresses, a separate BGP peering session is established over each UNI Access Link, using the primary IPv4 addresses in the UNI Access Link IPv4 Connection Addressing Service Attribute (section 13.4) or the first IPv6 addresses in the UNI Access Link IPv6 Connection Addressing Service Attribute (section 13.5), as indicated by the Connection Address Family parameter.
loopbacks	EnabledDisabled	1	If the Peering Addresses parameter is Loopbacks, a list of

			pairs of IP addresses is additionally specified,  each pair containing the Subscriber's loopback address and the SP's or Operator's loopback address. A single BGP peering session is established for each pair of addresses.
serviceProviderLoopback	String	1	Service Provider Loopback IP address.
subscriberLoopback	String	1	Subscriber Loopback IP address.

Table 56-PeeringAddress Attributes

## 17.68 PortMap

LACP Portmap as a 2-tuple <vid,lspl> where vid is VLAN ID and lspl is Link Selection Priority List. Reference MEF 61.1.1 Section A1-1.3.2 UNI Access Link Ethernet Link Aggregation Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
vlanId	String	1	VLAN ID.
linkSelection	Pcp	1	Link Selection Priority List.

Table 57-PortMap Attributes

## 17.69 RouteDistinguisherFields

BGP Route Distinguisher with two fields.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
field_1	String	1	Route Distinguisher field 1.
field_2	String	1	Route Distinguisher field 2.

Table 58-RouteDistinguisherFields Attributes

## 17.70 RoutingProtocols

Data type to support routing protocols and associated parameters that are used to exchange IP

routes across the UNI. The value is a list of protocols (possibly empty), where each entry consists of the protocol name (one of Static, OSPF or BGP) the type of routes that will be exchanged (one of IPv4 or IPv6 or Both) and set of additional parameters as specified. Reference MEF 61.1 Section 12.7 UNI Routing Protocols Service Attributes.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
static	Static	0..1	Reference to Static routing.
ospf	Ospf	0..1	Reference to OSPF routing.
bgp	Bgp	0..1	Reference to BGP routing.

**Table 59-RoutingProtocols Attributes**

## 17.71 ServiceTopology

File: ip/ipCommon.yaml

Enumeration used to represent the different Service Topologies.

Contains Enumeration Literals:

- **MULTIPOINT:**
  - A multipoint IPVC allows packets to flow between any of the IPVC End Points for the IPVC. In this case, every IPVC End Point has a root role. Reference MEF 61.1 Section 10.2 IPVC Topology Service Attribute.
- **ROOTED\_MULTIPPOINT:**
  - A rooted multipoint service is used to implement a hub-and-spoke topology. In a rooted multipoint service, each IPVC End Point is assigned either root or leaf role. Reference MEF 61.1 Section 10.2 IPVC Topology Service Attribute.
- **CLOUD\_ACCESS:**
  - A cloud access IPVC allows traffic to flow between one or more IPVC End Points and the public Internet or private cloud service. Reference MEF 61.1 Section 10.2 IPVC Topology Service Attribute.

## 17.72 Static

When an entry in the UNI Routing Protocols list is Static, the IP Prefixes used in the Subscriber Network that are reachable via this UNI are specified as additional parameters in the entry. These are known as Static IP Prefixes. Reference MEF 61.1 Section 12.7.1 Static.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
staticIpEntry	StaticIpEntry	1..*	Pointer to StaticIpEntry

Table 60-Static Attributes

## 17.73 StaticIpEntry

StaticIpEntry data type including IPv4/IPv6 prefixes, forwarding information and administrative distance.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
staticIpPrefix	Ipv4Ipv6Prefixes	1	Static IP prefix either IPv4 or IPv6.
forwardingInformation	ForwardingInformation	1	Forwarding information with either Next Hop IP address or UNI Access Link identifier.
administrativeDistance	Integer	1	Administrative Distance, an integer > 0.

Table 61-StaticIpEntry Attributes

## 17.74 StaticRoute

Data type representing IP static routes.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4Prefix	Ipv4Prefix	0..1	IPv4 address prefix.
ipv6Prefix	Ipv6Prefix	0..1	IPv4 address prefix.
administrativeDistance	Integer	1	The administrative distance is a numeric metric used to control which routes are selected, when

			there are multiple routes for the same IP Prefix. A lower number indicates a more preferable route.
targetRole	TargetRole	1	The target role indicates whether the route is towards an IPVC EP in the SP/SO's or a higher IPVC with Roole role or Leaf role.

Table 62-StaticRoute Attributes

## 17.75 SynchronousEthernet

Enumeration representing the value of fs which indicates if the physical link supports Synchronous Ethernet.

Contains Enumeration Literals:

- DISABLED:
  - Enumeration representing fs and Synchronous Ethernet MUST NOT be used on corresponding physical link. ESMC - Ethernet Synchronous Messaging Channel.
- ESMC:
  - Enumeration representing fs and Synchronous Ethernet MUST be used on corresponding physical link. ESMC - Ethernet Synchronous Messaging Channel.
- NO\_ESMC:
  - Enumeration representing fs and Synchronous Ethernet MUST NOT be used on corresponding physical link. ESMC - Ethernet Synchronous Messaging Channel.

## 17.76 TargetRole

File: ip/ipCommon.yaml

Enumeration representing the Static Route Target Role. Reference MEF 61.1 Section 14.3.1.4 Static Routes.

Contains Enumeration Literals:

- ROOT:
  - Root role.
- LEAF:

- Leaf role.

## 17.77 TimeDuration

File: ip/ipCommon.yaml

This class is used to describe durations expressed as a 2-tuple, (value,units). The units from nanoseconds to years.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
timeDurationValue	Integer	1	The value of the duration. For example, if duration is 20 ms, this element is 20.
timeDurationUnits	TimeDurationUnits	1	The unit of measure in the duration. For example, if an interval is 2ms, this element is MS.

Table 63-TimeDuration Attributes

## 17.78 TimeDurationUnits

File: ip/ipCommon.yaml

The unit of measure in the duration.

Contains Enumeration Literals:

- NS
- US
- MS
- SEC
- MIN
- HOUR
- DAY
- WEEK

- MONTH

- YEAR

## 17.79 UniAccessLinkEthernetLinkAggregation

Link Aggregation, as described in IEEE Std. 802.1AX-2020 allows one or more parallel instances of full-duplex point-to-point Ethernet links to be aggregated to form a Link Aggregation Group (LAG) such that the MAC Client (the UNI Access Link) can treat the LAG as if it were a single link. Reference MEF 61.1.1 Section A1-1.3.2 UNI Access Link Trunk Ethernet Link Aggregation Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
lacpVersion	LacpVersion	1	Link Aggregation Control Protocol version.
portMap	PortMap	0..*	LAG port map representing VLAN ID to Aggregation Link Map.

Table 64-Ipv6ConnectionAddressing Attributes

## 17.80 UniAccessManagementTrunkType

File: ip/ipUniAccessLinkTrunk.yaml

Enumeration representing the UNI Access Link Trunk Type Service Attribute.

Contains Enumeration Literals:

- ETHERNET:
  - Enumeration value of Ethernet. The data transferred across the UNI Access Link Trunk MUST be formatted as Ethernet MAC frames as specified in clause 3 of IEEE Std. 802.3. Reference MEF 61.1.1 Section A1-1.2 UNI Access Link Trunk Type Service Attribute.
- OTHER:
  - Enumeration value of Other. The Subscriber and Service Provider of SP/SO and Operator MUST agree on the format of the data transferred across the UNI Access Link Trunk. Reference MEF 61.1 Section A1-1.2 UNI Access Link Trunk Type Service Attribute [A1-R18].



## 17.81 UniAccessLinkIpv4AddressType

*File: ip/ipCommon.yaml*

Enumeration representing IPv4 Address Types specific for UNI Access Links.

Contains Enumeration Literals:

- DHCP:
  - Dynamic Host Configuration Protocol (DHCP) is used by the Subscriber devices to request IPv4 addresses in each subnet from the SP or Operator.
- STATIC:
  - IPv4 addresses in each IPv4 subnet are statically assigned to the SP or Operator and to the Subscriber.
- UNNUMBERED:
  - The SP or Operator and the Subscriber each assign an IPv4 address (from their own address pools) independently. These addresses can be on different subnets, and so an interface-based routing protocol is needed to ensure reachability.

## 17.82 UniAccessLinkIpv6AddressType

*File: ip/ipCommon.yaml*

Enumeration representing IPv6 Address Types specific for UNI Access Links.

Contains Enumeration Literals:

- DHCP:
  - Dynamic Host Configuration Protocol (DHCP) is used by the Subscriber devices to request IPv6 addresses in each subnet from the SP or Operator.
- SLAAC:
  - Stateless Address Autoconfiguration (SLAAC) is used by the Subscriber devices to create unique IPv6 global addresses within an IP Prefix advertised by the SP or Operator as describer in RFC 4862.
- STATIC:

- IPv6 addresses in a given IPv6 subnet are statically assigned to the SP or Operator and to the Subscriber.

- LL\_ONLY:

- If the value is LL-only, these are only IPv6 addresses used on the UNI Access Link.

### 17.83 Unilpv4ConnectionAddressing

Unilpv4ConnectionAddressing is a data type representing how IPv4 addresses are allocated to the devices on the UNI Access Link. Reference MEF 61.1 Section 13.4 UNI Access Link IPv4 Connection Addressing Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
uniAccessLinkIpv4AddressType	UniAccessLinkIpv4AddressType	0..1	IPv4 address type for UNI Access Link. Values are DHCP, STATIC and UNNUMBERED.
ipv4PrimarySubnet	Ipv4Subnet	1	IPv4 Primary Subnet.
ipv4SecondarySubnet	Ipv4Subnet	0..*	IPv4 Secondary Subnet List.

**Table 65-Unilpv4ConnectionAddressing Attributes**

### 17.84 Unilpv6ConnectionAddressing

Unilpv6ConnectionAddressing is a data type representing how IPv6 addresses are allocated to the devices on the UNI Access Link. Reference MEF 61.1 Section 13.5 UNI Access Link IPv6 Connection Addressing Service Attribute.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
uniAccessLinkIpv6AddressType	UniAccessLinkIpv6AddressType	0..1	IPv6 address type for UNI Access Link. Values are DHCP, SLAAC, STATIC and LL_ONLY.
subscriberIpv6Address	String	0..1	Subscriber IPv6 address.
ipv6Subnet	Ipv6Subnet	0..*	IPv6 Subnet.

**Table 66-Ipv6ConnectionAddressing Attributes**

## 17.85 UniManagementType

File: *ip/ipCommon.yaml*

Enumeration representing the UNI Management Type options. Reference MEF 61.1 Section 12.2 UNI Management Type Service Attribute.

Contains Enumeration Literals:

- SUBSCRIBER\_MANAGED:
  - Enumeration indicating the CE is the responsibility of the Subscriber.
- PROVIDER\_MANAGED:
  - Enumeration indicating the CE is the responsibility of the Service Provider.

## 17.86 VlanId

File: *ip/ipCommon.yaml*

Data type with single attribute, vlanId which is defined as a PositiveInteger. Value 1 to 4094.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
vlanId	Integer	1	Data type with single attribute, vlanId which is a positive integer. Value 1 to 4094.

Table 67-VlanId Attributes

## 17.87 Vrid

File: *ip/ipCommon.yaml*

Data type representing VRID (Virtual Router ID) as defined in RFC 5798. is a number between 1 and 255.

Schema File Name: ip/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description

value	Integer	1	VRID value as an Integer.
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**Table 68-Vrid Attributes**

## 18 IP Bandwidth Profile and Bandwidth Profile Envelope

The following section provides a detailed information model for the IP Bandwidth Profile and IP Bandwidth Profile Envelope as specified in MEF 61.1 Section 17.1 Structure of Bandwidth Profiles. The following section will provide the complete set of IP Bandwidth Profile/Bandwidth Profile Envelope models.

### 18.1 IP Bandwidth Profile and Envelope

The two data types that each specific model inherits are IpBwpEnvelope and IpBwpFlow.

#### 18.1.1 IpBwpFlow

A Bandwidth Profile Flow is a stream of IP Packets meeting certain criteria. The criteria than can be used depends on which BWP Envelope the BWP Flow is a part of. Reference MEF 61.1 Section 17.2 Bandwidth Profile Flows.

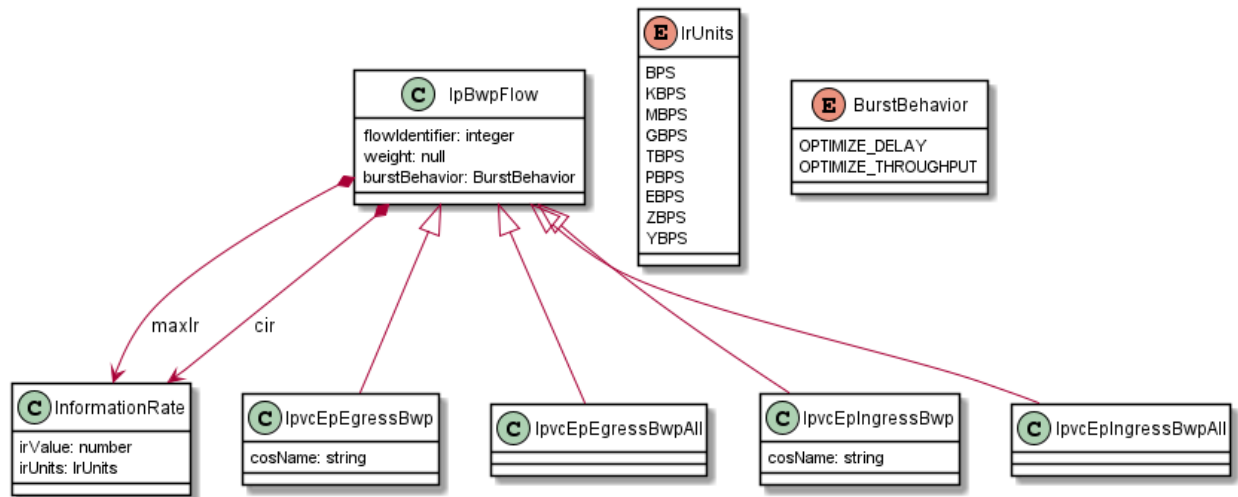


Figure 23-IpBwpFlow Model

#### 18.1.2 BurstBehavior

Enumeration used to select the Bandwidth Profile Flow Burst Behavior attribute. Reference MEF 61.1 Section 17.3 Table 29 Bandwidth Profile Parameters for a Bandwidth Profile Flow.

Contains Enumeration Literals:

- OPTIMIZE\_DELAY:
  - Enumeration representing the Burst Behavior of optimization of delay.
- OPTIMIZE\_THROUGHPUT:
  - Enumeration representing the Burst Behavior of optimization of throughput.

### 18.1.3 IpBwpEnvelope

A BWP Envelope is a list of Bandwidth Profile Flows, plus additional parameters for the BWP as a whole. A BWP Envelope is a set of one or more BWP Flows that are associated such that the amount of traffic for one flow can affect the amount that is permitted for another flow. Reference MEF 61.1 Section 17.3 Bandwidth Profile Envelopes.

Attribute Name	Type	Multiplicity	Description
maxIrE	InformationRate	1	The Envelope Maximum Information Rate in bits per second. This is the limit on the total aggregate information rate of traffic across all BWP Flows in the Envelope. Reference MEF 61.1 Section 17.3 Bandwidth Profile Envelopes.
tE	Float	1	The Envelope IR Time in milliseconds. This is the time period over which average Information Rates are calculated and thus it limits the size of a burst. Reference MEF 61.1 Section 17.3 Bandwidth Profile Envelopes.

Table 69-IpBwpEnvelope

### 18.1.4 IpBwpFlow

A Bandwidth Profile Flow is a stream of IP Packets meeting certain criteria. The criteria than can be used depends on which BWP Envelope the BWP Flow is a part of. Reference MEF 61.1 Section 17.2 Bandwidth Profile Flows.

Attribute Name	Type	Multiplicity	Description
flowIdentifier	Integer	1	Identifier for the BWP Flow within the BWP Envelope. Unique integer between 1 and n where n is the number of BWP Flows in the BWP Envelope. Reference MEF 61.1 Table 29 - Bandwidth Profile Parameters for a Bandwidth Profile Flow.
cir	InformationRate	1	Identifier for Committed Information Rate in bits per second. Average information rate of IP Packets that is committed to

			this BWP Flow. Reference MEF 61.1 Table 29 - Bandwidth Profile Parameters for a Bandwidth Profile Flow.
maxlr	InformationRate	1	Identifier for Maximum Information Rate in bits per second. Limit on the average information rate of IP Packets for this BWP Flow. Reference MEF 61.1 Table 29 - Bandwidth Profile Parameters for a Bandwidth Profile Flow.
weight	Integer	1	Identifier for Weight as an integer greater than or equal to 0. Relative weight for this BWP Flow compared to other BWP Flows in the BWP Envelope. Reference MEF 61.1 Table 29 - Bandwidth Profile Parameters for a Bandwidth Profile Flow.
burstBehavior	BurstBehavior	1	Identifier for Burst Behavior either Optimize-Delay or Optimize-Throughput. Whether the SP is requested to optimize the delay characteristic of this flow, or the throughput. Reference MEF 61.1 Table 29 - Bandwidth Profile Parameters for a Bandwidth Profile Flow.

Table 70-IpBwpFlow

## 18.2 UNI Ingress Bandwidth Profile Envelope

The following section details the UNI Ingress Bandwidth Profile Envelope model as defined in MEF 61.1 Section 12.4. Note that the tables below do not repeat inherited attributes from superclasses.

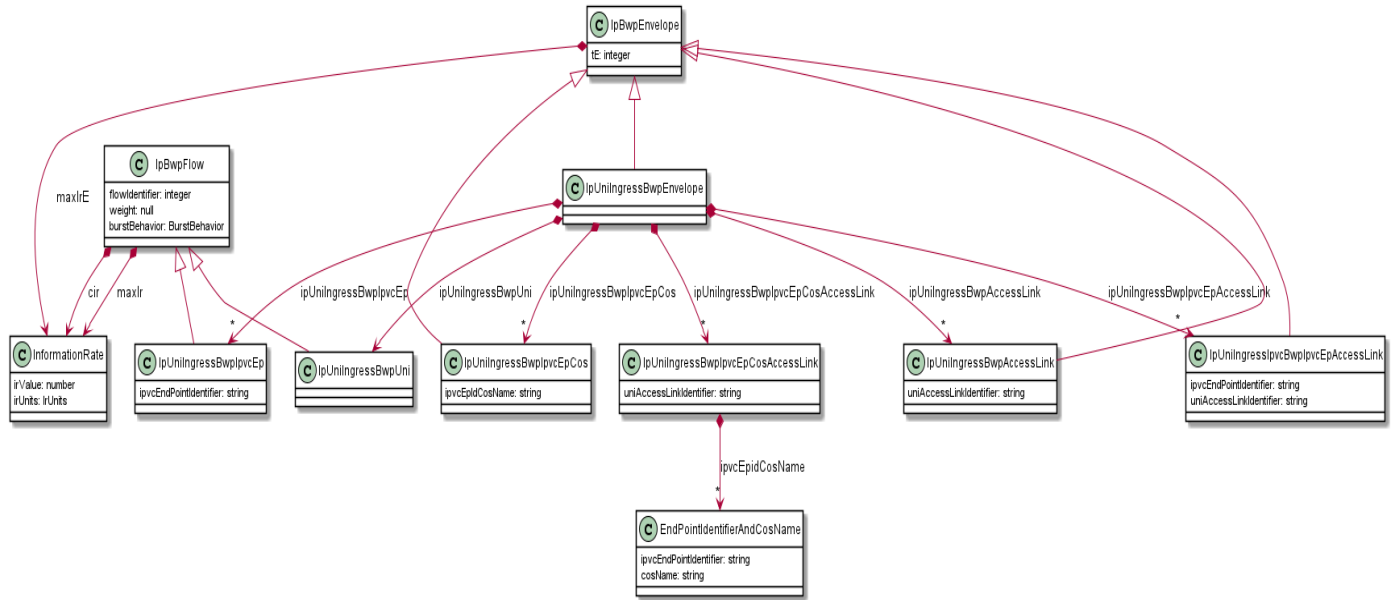


Figure 24-IpUnlIngressBwpEnvelope Model

### 18.2.1 IpUnlIngressBwpEnvelope

A single Bandwidth Profile Envelope consisting of parameters and Bandwidth Profile Flow specifications. If specified, the BWP Envelope is used for an ingress Bandwidth Profile. The BWP Flows can be defined per UNI, per IPVC EP, per UNI Access Link, per CoS Name, etc. Reference MEF 61.1 Section 12.4 UNI Ingress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipUnlIngressBwpIpvcEpCos	IpUnlIngressBwpIpvcEpCos	0.. *	Pointer to IpUnlIngressBwpIpvcEpCos.
ipUnlIngressBwpAccessLink	IpUnlIngressBwpAccessLink	0.. *	Pointer to IpUnlIngressBwpAccessLink.
ipUnlIngressBwpIpvcEpBwpAccessLink	IpUnlIngressIpvcEpBwpAccessLink	0.. *	Pointer to IpUnlIngressIpvcEpBwpAccessLink.
ipUnlIngressBwpIpvcEpCosAccessLink	IpUnlIngressBwpIpvcEpCosAccessLink	0.. *	Pointer to IpUnlIngressBwpIpvcEpCosAccessLink
ipUnlIngressBwpIpvcEp	IpUnlIngressBwpIpvcEp	0.. *	Pointer to IpUnlIngressBwpIpvcEp.
ipUnlIngressBwpUni	IpUnlIngressBwp	0..1	Pointer to IpUnlIngressBwpUni



**Table 71-IpUnIngressBwpEnvelope Attributes**
**18.2.2 IpUnIngressBwp**

All Ingress IP Data Packets at the UNI. Reference MEF 61.1 Section 12.4 UNI Ingress BWP Envelope.

NOTE: No attributes are needed.

**18.2.3 IpUnIngressBwplpvcEp**

All Ingress IP Data Packets at the UNI that are mapped to any of a given set of IPVC EPs. Reference MEF 61.1 Section 12.4 UNI Ingress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
ipvcEndPointIdentifier	String	1..*	IPVC End Point Identifier for an IPVC End Point located at the UNI. Reference MEF 61.1 Table 28.

**Table 72-IpUnIngressBwplpvcEp Attributes**
**18.2.4 IpUnIngressBwplpvcEpCos**

All Ingress IP Data Packets at the UNI that are mapped to any of a given set of (IPVC, EP, CoS Name) pairs. Reference MEF 61.1 Section 12.4 UNI Ingress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
ipvcEpIdCosName	EndPointIdentifier AndCosName	1..*	IPVC End Point and CoS Identifier. Reference MEF 61.1 Table 28.

**Table 73-IpUnIngressBwplpvcEpCos Attributes**
**18.2.5 IpUnIngressBwpAccessLink**

All Ingress IP Data Packets at the UNI that are received over one of a give set of UNI Access Links. Reference MEF 61.1 Section 12.4 UNI Ingress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
uniAccessLinkIdentifier	String	1..*	UNI Access Link Identifier. Reference MEF 61.1 Table 28.

**Table 74-IpUnIngressBwpAccessLink Attributes**

## 18.2.6 IpUnilngressBwplpvcEpAccessLink

All Ingress IP Data Packets at the UNI that are received over one of a given set of UNI Access Links, and are mapped to any of a given set of IPVC End Points. BWP Flow Parameters are a set each entry comprising of a UNI Access Link Identifier for a UNI Access Link in the UNI, a set, each entry comprising IPVC End Point Identifier for an IPVC End Point located at the UNI. Reference MEF 61.1 Section 12.4 UNI Ingress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
uniAccessLinkIdentifier	String	1..*	UNI Access Link Identifier. Reference MEF 61.1 Table 28.
ipvcEndPointIdentifier	String	1..*	IPVC End Point Identifier. Reference MEF 61.1 Table 28.

**Table 75-IpUnilngressIpvcEpBwpAccessLink Attributes**

## 18.2.7 IpUnilngressBwplpvcEpCosAccessLink

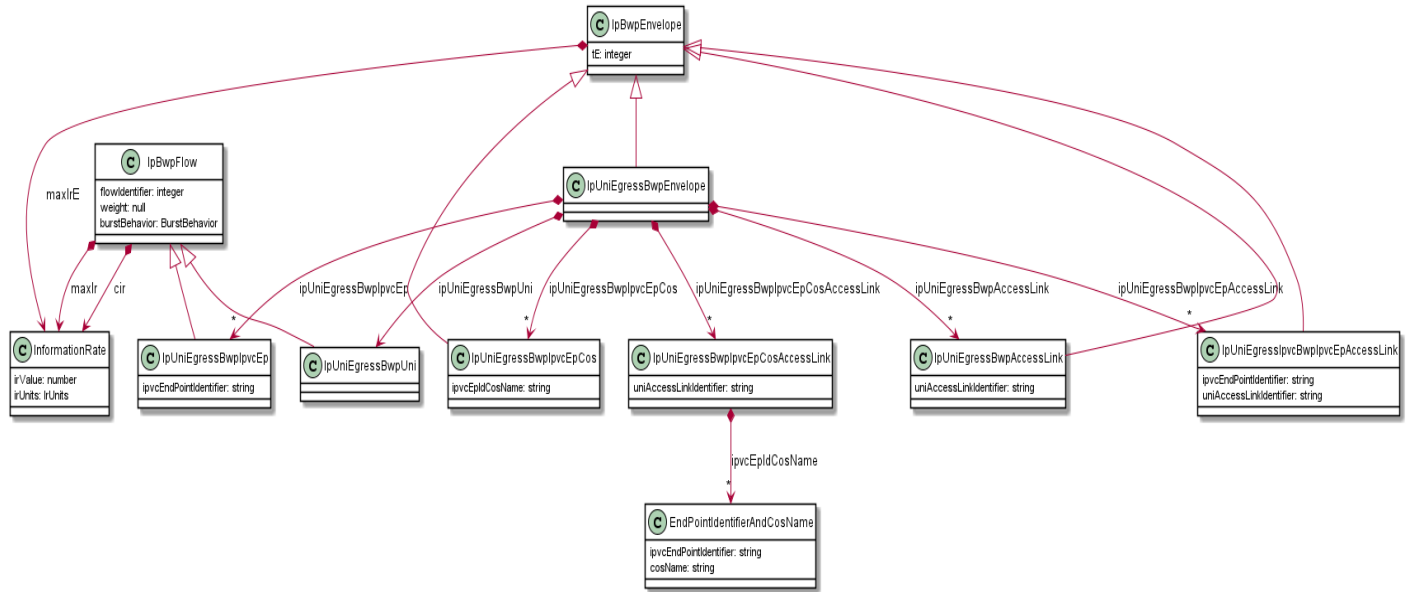
All Ingress IP Data Packets at the UNI that are received over one of a given set of UNI Access Links, and that are mapped to the any of a given set of (IPVC EP, CoS Name) pairs. Reference MEF 61.1 Section 12.4 UNI Ingress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
uniAccessLinkIdentifier	String	1..*	UNI Access Link Identifier. Reference MEF 61.1 Table 28.
ipvcEpIdCosName	EndPointIdentifierAndCosName	1..*	IPVC End Point and CoS Identifier. Reference MEF 61.1 Table 28.

**Table 76-IpUnilngressBwplpvcEpCosAccessLink Attributes**

## 18.3 UNI Egress Bandwidth Profile Envelope

The following section details the UNI Egress Bandwidth Profile Envelope model as defined in MEF 61.1 Section 12.5. Note that the tables below do not repeat inherited attributes from superclasses.



**Figure 25-IpUniEgressBwpEnvelope Model**

A single Bandwidth Profile Envelope consisting of parameters and Bandwidth Profile Flow specifications. If specified, the BWP Envelope is used for an egress Bandwidth Profile. The BWP Flows can be defined per UNI, per IPVC EP, per UNI Access Link, per CosName, etc. Reference MEF 61.1 Section 12.5 UNI Egress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipUniEgressBwpUni	IpUniEgressBwpUni	0..1	Pointer to IpUniEgressBwpUni
ipUniEgressBwplpvcEp	IpUniEgressBwplpvcEp	0.. *	Pointer to IpUniEgressBwplpvcEp
ipUniEgressBwplpvcEpCos	IpUniEgressBwplpvcEpCos	0.. *	Pointer to IpUniEgressBwplpvcEpCos
ipUniEgressBwpAccessLink	IpUniEgressBwpAccessLink	0.. *	Pointer to IpUniEgressBwpAccessLink
ipUniEgressIpvcBwpEpAccessLink	IpUniEgressIpvcEpBwpAccessLink	0.. *	Pointer to IpUniEgressIpvcEpBwpAccessLink
ipUniEgressBwplpvcEpCosAccessLink	IpUniEgressBwplpvcEpCosAccessLink	0.. *	Pointer to IpUniEgressBwplpvcEpCosAccessLink

**Table 77-IpUniEgressBwpEnvelope Attributes**

### 18.3.1 IpUniEgressBwp

All Egress IP Data Packets at the UNI. Reference MEF 61.1 Section 12.4 UNI Egress BWP Envelope. NOTE: No attributes are needed.

### 18.3.2 IpUniEgressBwpIpvcEp

All Egress IP Data Packets at the UNI that are mapped to any of a given set of IPVC EPs. Reference MEF 61.1 Section 12.5 UNI Egress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
ipvcEndPointIdentifier	String	1..*	IPVC End Point Identifier for an IPVC End Point located at the UNI. Reference MEF 61.1 Table 28.

**Table 78-IpUniEgressBwpIpvcEp Attributes**

### 18.3.3 IpUniEgressBwpIpvcEpCos

All Egress IP Data Packets at the UNI that are mapped to any of a given set of (IPVC, EP, CoS Name) pairs. Reference MEF 61.1 Section 12.5 UNI Egress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
ipvcEpIdCosName	EndPointIdentifierAndCosName	1..*	IPVC End Point and CoS Identifier. Reference MEF 61.1 Table 28.

**Table 79-IpUniEgressBwpIpvcEpCos Attributes**

### 18.3.4 IpUniEgressBwpAccessLink

All Egress IP Data Packets at the UNI that are received over one of a give set of UNI Access Links. Reference MEF 61.1 Section 12.5 UNI Egress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
uniAccessLinkIdentifier	String	1..*	UNI Access Link Identifier. Reference MEF 61.1 Table 28.

**Table 80-IpUniEgressAccessLink Attributes**

### 18.3.5 IpUniEgressIpvcEpBwpAccessLink

All Egress IP Data Packets at the UNI that are received over one of a given set of UNI Access Links, and are mapped to any of a given set of IPVC End Points. BWP Flow Parameters are a set each entry comprising UNI Access Link Identifier for a UNI Access Link in the UNI, a set, each entry comprising IPVC End Point Identifier for an IPVC End Point located at the UNI. Reference MEF 61.1 Section 12.5 UNI Egress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
uniAccessLinkIdentifier	String	1..*	UNI Access Link Identifier. Reference MEF 61.1 Table 28.
ipvcEndPointIdentifier	String	1..*	IPVC End Point Identifier for an IPVC End Point located at the UNI. Reference MEF 61.1 Table 28.

**Table 81-IpUniEgressIpvcEpBwpAccessLink Attributes**

### 18.3.6 IpUniEgressBwplpvcEpCosAccessLink

All Egress IP Data Packets at the UNI that are received over one of a given set of UNI Access Links, and that are mapped to the any of a given set of (IPVC EP, Cos Name) pairs. Reference MEF 61.1 Section 12.5 UNI Egress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
uniAccessLinkIdentifier	String	1..*	UNI Access Link Identifier. Reference MEF 61.1 Table 28.
ipvcEpIdCosName	EndPointIdentifierAndCosName	1..*	IPVC End Point Identifier for an IPVC End Point located at the UNI. Reference MEF 61.1 Table 28.

**Table 82-IpUniEgressBwplpvcEpCosAccessLink Attributes**

## 18.4 UNI Access Link Ingress Bandwidth Profile Envelope Model

The following section details the UNI Access Link Ingress Bandwidth Profile Envelope model as defined in MEF 61.1 Section 13.10. Note that the tables below do not repeat inherited attributes from superclasses.

### 18.4.1 IpUniAccessLinkIngressBwpEnvelope

A single Bandwidth Profile Envelope consisting of parameters and Bandwidth Profile Flow specifications. An Ingress Bandwidth Profile Envelope can be specified for one of a UNI, a UNI Access, or an IPVC EP. Reference MEF 61.1 Section 13.10 UNI Access Link Ingress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipUniAccessLinkIngressBwp	IpUniAccessLinkIngressBwp	0..1	Pointer to IpUniAccessLinkIngressBwp.
ipUniAccessLinkBwplpvcEp	IpUniAccessLinkIngressBwplpvcEp	0.. *	Pointer to IpUniAccessLinkBwplpvcEp
ipUniAccessLinkBwplpvcEpCos	IpUniAccessLinkIngressBwplpvcEpCos	0.. *	Pointer to IpUniAccessLinkBwplpvcEpCos

Table 83-IpUniAccessLinkIngressBwpEnvelope Attributes

#### 18.4.2 IpUniAccessLinkIngressBwp

All Ingress IP Data Packets at the UNI Access Link. Reference MEF 61.1 Section 13.10 UNI Access Link Ingress BWP Envelope. NOTE: No attributes are needed.

#### 18.4.3 IpUniAccessLinkIngressBwplpvcEp

All Ingress IP Data Packets at the UNI that are received over the UNI Access Link and are mapped to any of a given set of IPVC End Points. Reference MEF 61.1 Section 13.10 UNI Access Link Ingress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
ipvcEpIdentifier	String	1..*	IPVC End Point Identifier for an IPVC End Point located at the UNI Access Link. Reference MEF 61.1 Table 28.

Table 84-IpUniAccessLinkIngressBwplpvcEp Attributes

#### 18.4.4 IpUniAccessLinkIngressBwplpvcEpCos

All Ingress IP Data Packets at the UNI that are received over the UNI Access Link and are mapped to any of a given of IPVC End Point that has a CoS Name. Reference MEF 61.1 Section 13.10 UNI Access Link Ingress BWP Envelope.

Attribute Name	Type	Multiplicity	Description
ipvcEpIdentifier	String	1	IPVC End Point Identifier for an IPVC End Point located at the UNI Access Link. Reference MEF 61.1 Table 28.

ipvcEpIdCosName	EndPointIdentifierAndCosName	1..*	IPVC End Point Identifier for an IPVC End Point located at the UNI. Reference MEF 61.1 Table 28.
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Table 85-IpUniAccessLinkIngressBwpIpvcEpCos Attributes

## 18.5 UNI Access Link Egress Bandwidth Profile Envelope Model

The following section details the UNI Access Link Egress Bandwidth Profile Envelope model as defined in MEF 61.1 Section 13.11. Note that the tables below do not repeat inherited attributes from superclasses.

### 18.5.1 IpUniAccessLinkEgressBwpEnvelope

A single Bandwidth Profile Envelope consisting of parameters and Bandwidth Profile Flow specifications. An Egress Bandwidth Profile Envelope can be specified for one of a UNI, a UNI Access, or an IPVC EP. Reference MEF 61.1 Section 13.11 UNI Access Link Egress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipUniAccessLinkEgressBwp	IpUniAccessLinkEgressBwp	0..1	Pointer to IpUniAccessLinkEgressBwp.
ipUniAccessLinkEgressBwplpvcEp	IpUniAccessLinkEgressBwplpvcEp	0..*	Pointer to IpUniAccessLinkEgressBwplpvcEp.
ipUniAccessLinkEgressBwplpvcEpCos	IpUniAccessLinkEgressBwplpvcEpCos	0..*	Pointer to IpUniAccessLinkEgressBwplpvcEpCos

Table 86-IpUniAccessLinkEgressBwpEnvelope Attributes

### 18.5.2 IpUniAccessLinkEgressBwp

All Egress IP Data Packets at the UNI Access Link. Reference MEF 61.1 Reference MEF 61.11 Section 13.11 UNI Access Link Egress BWP Envelope. NOTE: No attributes are needed.

### 18.5.3 IpUniAccessLinkEgressBwplpvcEp

Attribute Name	Type	Multiplicity	Description
ipvcEpIdentifier	String	1	IPVC End Point Identifier for an IPVC End Point located at the UNI Access Link. Reference MEF 61.1 Table 28.

Table 87-IpUniAccessLinkEgressBwplpvcEp Attributes

## 18.5.4 IpUniAccessLinkEgressBwplpvcEpCos

Attribute Name	Type	Multiplicity	Description
ipvcEpIdIdentifier	String	1	IPVC End Point Identifier.
ipvcEpIdCosName	EndPointIdentifierAndCosName	1..*	IPVC End Point Identifier for an IPVC End Point located at the UNI. Reference MEF 61.1 Table 28.

**Table 88-IpUniAccessLinkEgressBwplpvcEpCos Attributes**

## 18.6 ENNI Access Link Ingress Bandwidth Profile Envelope per ENNI Link Model

The following section details the ENNI Access Link Ingress Bandwidth Profile Envelope model as defined in MEF 61.1 Section 14.4. Note that the tables below do not repeat inherited attributes from superclasses.

### 18.6.1 IpEnniIngressBwpEnvelopePerEnniLink

Is a list (possibly empty) of pairs of (ENNI Service Mapping Identifier, Bandwidth Profile Envelope), where each Bandwidth Profile Envelope consists of parameters and Bandwidth Profile Flow specifications. An Ingress Bandwidth Profile Envelope at an ENNI can be specific for either ENNI Links or an IPVC EP. Reference MEF 61.1 Section 14.4 ENNI Ingress Bandwidth Profile Envelopes Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipEnniIngressBwp	IpEnniIngressBwp	0..1	Reference to IpEnniIngressBwp
ipEnniIngressBwpCos	IpEnniIngressBwpCos	1..*	Reference to IpEnniIngressBwpCos

**Table 89-IpEnniIngressBwpEnvelopePerEnniLink Attributes**

### 18.6.2 IpEnniIngressBwp

All Ingress IP Data Packets at the ENNI Access Link. Reference MEF 61.1 Section 14.4. NOTE: No attributes are needed.

### 18.6.3 IpEnniIngressBwpCos

All Egress-Eligible IP Data Packets at the ENNI that if transmitted, would be transmitted over the ENNI Link, and that were mapped on ingress to any of a given set of CoS Names. Reference MEF 61.1 Section 14.4.



Attribute Name	Type	Multiplicity	Description
cosName	String	1	Class of Service name.

Table 90-IpEnniIngressBwpCos Attributes

## 18.7 ENNI Access Link Egress Bandwidth Profile Envelope per ENNI Model

The following section details the ENNI Access Link Egress Bandwidth Profile Envelope model as defined in MEF 61.1 Section 14.5. Note that the tables below do not repeat inherited attributes from superclasses.

### 18.7.1 IpEnniEgressBwpEnvelopePerEnniLink

Is a list (possibly empty) of pairs of (ENNI Service Mapping Identifier, Bandwidth Profile Envelope), where each Bandwidth Profile Envelope consists of parameters and Bandwidth Profile Flow specifications. An Egress Bandwidth Profile Envelope at an ENNI can be specific for either ENNI Links or an IPVC EP. Reference MEF 61.1 Section 14.5 ENNI Egress Bandwidth Profile Envelopes Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipEnniEgressBwp	IpEnniEgressBwp	0..1	Reference to IpEnniIngressBwp
ipEnniEgressBwpCos	IpEnniEgressBwpCos	0.. *	Reference to IpEnniEgressBwpCos.

Table 91-IpEnniEgressBwpEnvelopePerEnniLink Attributes

### 18.7.2 IpEnniEgressBwp

All Egress IP Data Packets at the ENNI Access Link. Reference MEF 61.1 Section 14.5. NOTE: No attributes are needed.

### 18.7.3 IpEnniEgressBwpCos

All Egress-Eligible IP Data Packets at the ENNI that if transmitted, would be transmitted over the ENNI Link, and that were mapped on ingress to any of a given set of CoS Names. Reference MEF 61.1 Section 14.5.

Attribute Name	Type	Multiplicity	Description
cosName	String	1	Class of Service name.

Table 92-IpEnniEgressBwpCos Attributes

## 18.8 IPVC End Point Ingress Bandwidth Profile Envelope

The following section details the IPVC End Point Ingress Bandwidth Profile Envelope model as defined in MEF 61.1 Section 11.11. Note that the tables below do not repeat inherited attributes from superclasses.

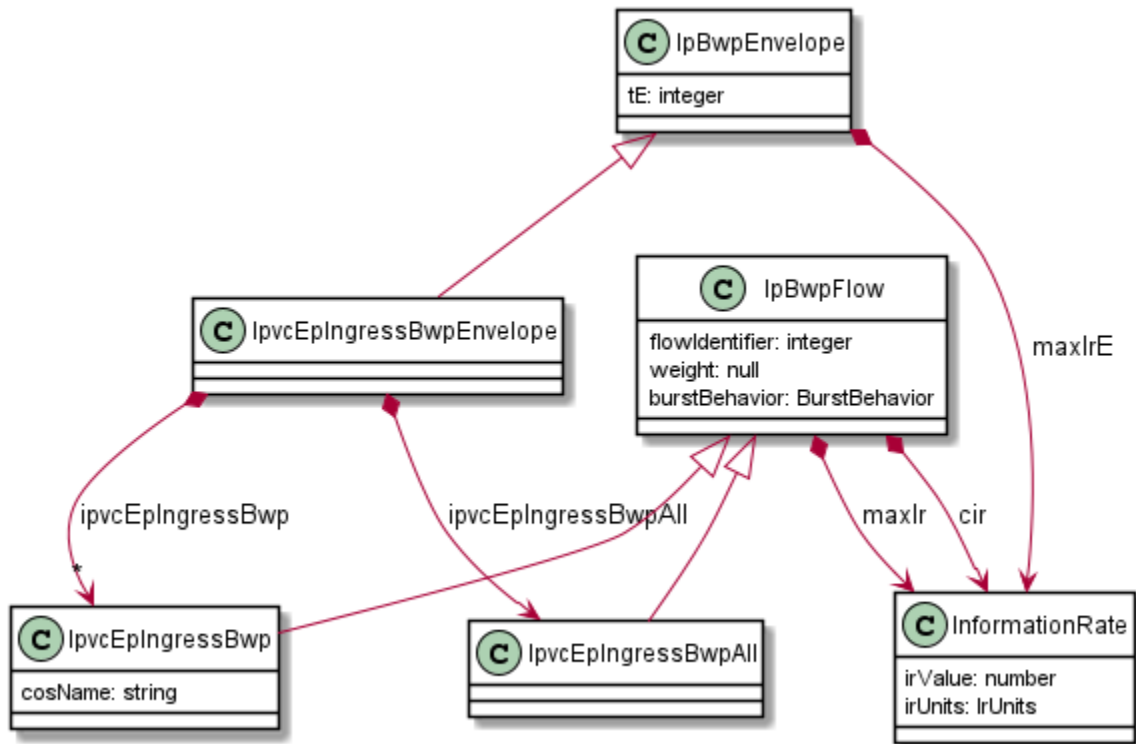


Figure 26-IpvcEplngressBwpEnvelope Model

### 18.8.1 IpvcEplngressBwpEnvelope

A single Bandwidth Profile Envelope consisting of parameters and Bandwidth Profile specifications. An Ingress Bandwidth Profile Envelope can be specified for one of a UNI, a UNI Access Link and ENNI Link or an IPVC End Point. Reference MEF 61.1 Section 11.11 IPVC EP Ingress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipvcEplngressBwpAll	IpvcEplngressBwpAll	0..1	Pointer to IpvcEplngressBwpAll.
ipvcEplngressBwp	IpvcEplngressBwp	1.. *	Pointer to IpvcEplngressBwp.

Table 93-IpvcEplngressBwpEnvelopeAttributes

## 18.8.2 Ipv4EpIngressBwpAll

A single Bandwidth Profile Envelope consisting of parameters and Bandwidth Profile specification applied to all ingress IP Packets. Reference MEF 61.1 Section 11.11. NOTE: No attributes are needed.

## 18.8.3 Ipv4EpIngressBwp

An Ingress Bandwidth for and IPV4 End Point with an associated Class of Service identifier.

Attribute Name	Type	Multiplicity	Description
cosName	String	1..*	Class of Service name.

Table 94-Ipv4EpIngressBwpAttributes

## 18.9 IPV4 End Point Egress Bandwidth Profile Envelope

The following section details the IPV4 End Point Egress Bandwidth Profile Envelope model as defined in MEF 61.1 Section 11.12. Note that the tables below do not repeat inherited attributes from superclasses.

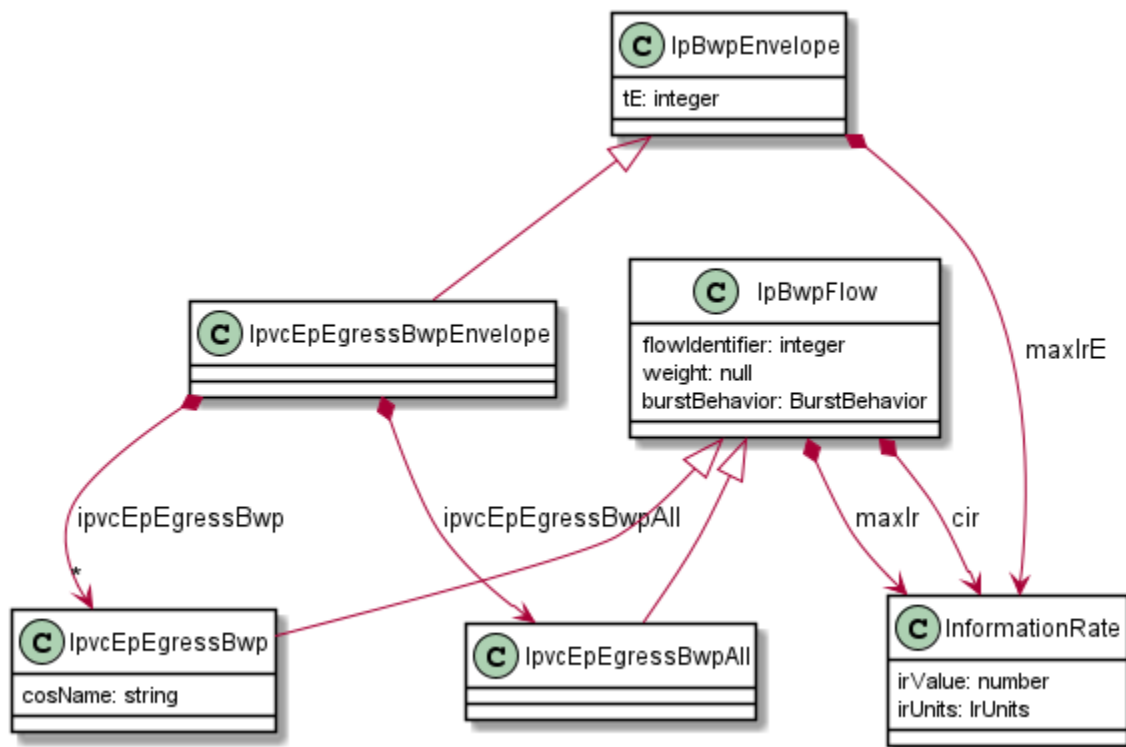


Figure 27-Ipv4EpEgressBwpEnvelope Model

### 18.9.1 IpvceEgressBwpEnvelope

A single Bandwidth Profile Envelope consisting of parameters and Bandwidth Profile specifications. An Egress Bandwidth Profile Envelope can be specified for one of a UNI, a UNI Access Link and ENNI Link or an IPVC End Point. Reference MEF 61.1 Section 11.11 IPVC EP Egress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipvcEpEgressBwpAll	IpvceEgressBwpAll	0..1	Pointer to IpvceEgressBwpAll
ipvcEpEgressBwp	IpvceEgressBwp	1.. *	Pointer to IpvceEgressBwp

Table 95-IpvceEgressBwpEnvelope Attributes

### 18.9.2 IpvceEgressBwpAll

All Egress IP Data Packets at the IPVC End Point. Reference MEF 61.1 Section 11.12. NOTE: No attributes are needed.

### 18.9.3 IpvceEgressBwp

An Egress Bandwidth for and IPVC End Point with an associated Class of Service identifier.

Attribute Name	Type	Multiplicity	Description
cosName	String	1	Class of Service name.

Table 96-IpvceEgressBwp Attributes

## 19 IP SLS

The IPVC Service Level Specification (SLS) describes the performance objectives for the performance of conformant IP Data Packets that flow over the IPVC. The following section is the model representative of the resources and attributes defined in MEF 61.1 Section 10.9 IPVC Service Level Specification Service Attribute.

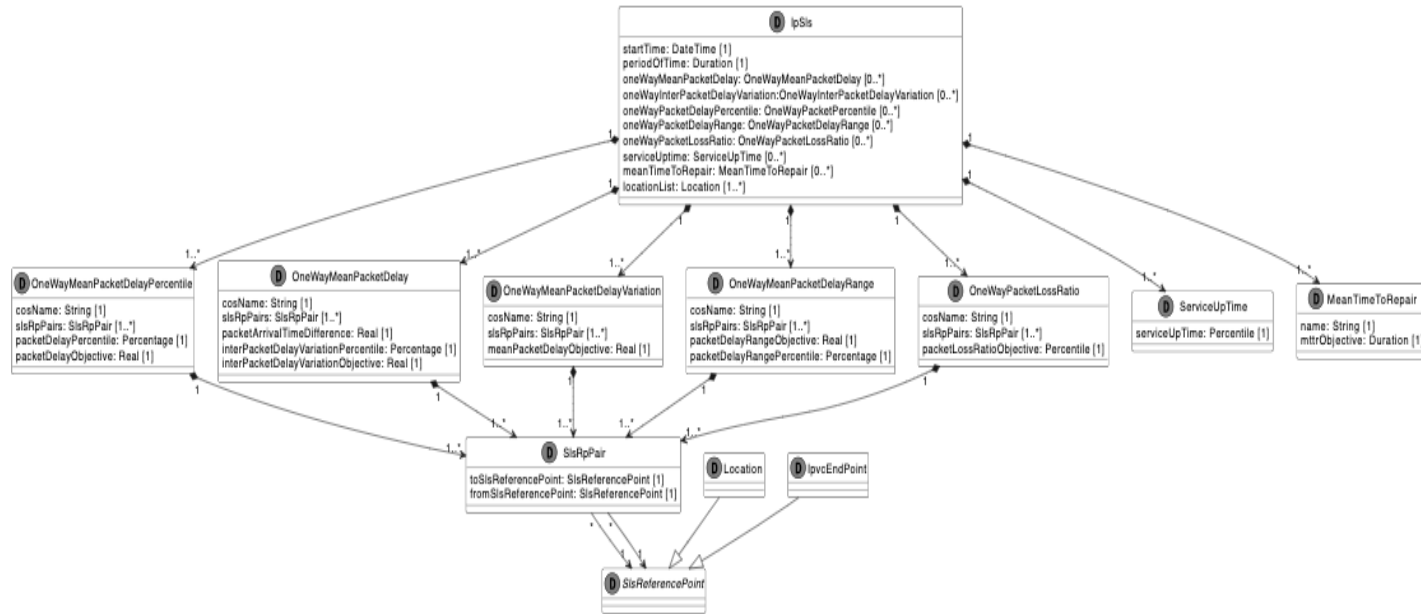


Figure 28-IpSls Model

### 19.1 IpSls

The IPVC Service Level Specification (SLS) describes the performance objectives for the performance of conformant IP Data Packets that flow over the IPVC. The IPVC Service Level Specification Attribute is either None, or a four-tuple of the form (s,T,E,L) where s is the start time, T is a period of time, E is a set of SLS entries and L is a set of the CoS Name and number of other parameters specific to the Performance Metric. Reference MEF 61.1 Section 10.9 IPVC Service Level Specification Service Attribute.

Attribute Name	Type	Multiplicity	Description
startTime	DateTime	1	Start time of IP SLS.
periodOfTime	Duration	1	Period of time over which IP SLS is measured.
oneWayMeanpacketdelay	OneWayMeanPacketDelay	0..*	Pointer to One-way Mean Packet Delay metric.

oneWayInterpacketdelayvariation	OneWayInterPacketDelayVariation	0..*	Pointer to One-way Inter-Packet Delay Variation metric.
oneWayPacketdelayrange	OneWayPacketDelayRange	0..*	Pointer to One-way Packet Delay Range metric.
oneWayPacketLossRatio	OneWayPacketLossRatio	0..*	Pointer to One-way Packet Loss Ratio metric.
oneWayPacketDelayPercentile	OneWayPacketDelayPercentile	0..*	Pointer to One-way Packet Delay Percentile metric.
serviceUptime	ServiceUpTime	0..*	Pointer to Service uptime metric.
meanTimeToRepair	MeanTimeToRepair	0..*	Pointer to Mean Time To Repair metric.
locationList	Location	1..*	Pointer to (L)ocation list.

Table 97-IpSIs Attributes

The following requirements ([R18], [R19], [R20]), specify the required values that apply to CoS Labels:

**[R43]** If the SLS for a Subscriber IP VPN Service contains at least one entry for a CoS Label, the value of T in the SLS MUST be less than or equal to 1 calendar month.

**[R44]** In an SLS for a Subscriber IP VPN Service, each entry for a CoS Label MUST use parameter values that are not in parenthesis conforming with Table 3.

**[R45]** In an SLS for a Subscriber IP VPN Service, each entry for a CoS Label MUST use performance objective values that are not in parenthesis for the appropriate Performance Tier conforming with Table 4 through Table 9.

## 19.2 IpvEndPointIdentifier

IPVC End Point identifier as described in MEF 61.1 Section 11.1. Note, it points to the value of IpvEndPoint.identifier Service Attribute.

Attribute Name	Type	Multiplicity	Description
	String <i>maxLength=53</i>	1	IPVC End Point identifier as described in MEF 61.1 Section 11.1. Note, it points to the value of IpvEndPoint.identifier Service Attribute.

Table 98-IpvEndPointIdentifier Attributes

### 19.3 IpvEndPointRef

A subclass of a SlsReferencePoint point to an instance of IPVC Endpoint.

Attribute Name	Type	Multiplicity	Description
ipvcEndPointIdentifier	IpvcEndPointIdentifier	1	IPVC End Point identifier as described in MEF 61.1 Section 11.1. Note, it points to the value of IpvcEndPoint.identifier Service Attribute. It is not intended to point to the potential Service identifier is IPVC End Point is an instance of a service.

**Table 99-IpvcEndPointRef Attributes**

### 19.4 Location

A subclass of a SlsReferencePoint.

Attribute Name	Type	Multiplicity	Description
name	String	1	Location name.
description	String	1	Location description.
cloudService	Boolean	1	Attribute to indicate if associated with a cloud service.
ipvcEndPointIdentifier	IpvcEndPointRef	1..*	Pointer to IPVC End Point

**Table 100-Location Attributes**

### 19.5 MeanTimeToRepair

The Mean Time To Repair Performance Metric is the arithmetic mean of the durations of all outages that start in a given time period, excluding any pre-agreed maintenance.

Attribute Name	Type	Multiplicity	Description
name	String	1	Name.
mttrObjective	TimeDuration	1	MTTR Objective.

**Table 101-MeanTimeToRepair Attributes**

## 19.6 OneWayInterPacketDelayVariation

The One-way Inter-Packet Delay Variation Performance Metric is the maximum, over all the ordered pairs of SLS-RPs in a given set  $S$ , of the  $v$ th percentile of differences between the one-way packet delays of Qualified Packets that arrive at time separated by a given interval  $\tau$ , for a given ordered pair of SLS-RPs, a given CoS Name, and a given time period  $T_k$ . Reference MEF 61.1 Section 10.9.6 One-way Inter-Packet Delay Variation Performance Metric.

Attribute Name	Type	Multiplicity	Description
cosName	String	1	One of the values in the IPVC List of Class of Service Names Service Attribute. Reference MEF 61.1 Section 10.9.6 One-way Inter-Packet Delay Variation Performance Metric, Table-6.
packetArrivalTimeDifference	Number	1	Difference in the time of arrival of packets. Reference MEF 61.1 Section 10.9.6 One-way Inter-Packet Delay Variation Performance Metric, Table 6.
sIsRpPairs	SIsRpPair	1.. *	Set of ordered SLS-RP pairs. Reference MEF 61.1 Section 10.9.6 One-way Inter-Packet Delay Variation Performance Metric, Table-6.
interPacketDelayVariationPercentile	Percentage	1	Inter-Packet Delay Variation Percentile. Reference MEF 61.1 Section 10.9.6 One-way Inter-Packet Delay Variation Performance Metric, Table 6.
interPacketDelayVariationObjective	Number	1	Inter-Packet Delay Variation Objective. Reference MEF 61.1 Section 10.9.6 One-way Inter-Packet Delay Variation Performance Metric, Table 6.

**Table 102-OneWayInterPacketDelayVariation Attributes**

## 19.7 OneWayMeanPacketDelay

The One-way Mean Packet Delay Performance Metric is the maximum, over all the ordered pairs of SLS-RPs in a given set  $S$ , of the arithmetic mean of one-way packet delay for Qualified Packets for a given ordered pair of SLS-RPs, a given CoS Name, and a given time period  $T_k$ . Reference MEF 61.1 Section 10.9.5 One-way Mean Packet Delay Performance Metric.



2178

Attribute Name	Type	Multiplicity	Description
cosName	String	1	One of the values in the IPVC List of Class of Service Names Service Attribute. Reference MEF 61.1 Section 10.9.5 One-way Mean Packet Delay Performance Metric, Table-5.
meanPacketDelayObjective	Number	1	Mean Packet Delay Objective. Reference MEF 61.1 Section 10.9.5 One-way Mean Packet Delay Performance Metric, Table-5.
slsRpPairs	SlsRpPair	1.. *	Set of ordered SLS-RP pairs. Reference MEF 61.1 Section 10.9.5 One-way Mean Packet Delay Performance Metric, Table-5.

2179

**Table 103-OneWayMeanPacketDelay Attributes**

## 2180 19.8 OneWayPacketDelayPercentile

2181 The One-way Packet Delay Percentile Performance Metric is the maximum, over all the order pairs of  
2182 SLS-RPs in a given set S, of the pth percentile of one-way packet delay for Qualified Packets for a given  
2183 order pair of SLS-RPs, a given CoS Name and a given time period Tk. Reference MEF 61.1 Section 10.9.4  
2184 One-way Packet Delay Percentile Performance Metric.

2185

Attribute Name	Type	Multiplicity	Description
cosName	String	1	One of the values in the IPVC List of Class of Service Names Service Attribute. Reference MEF 61.1 Section 10.9.4 One-way Packet Delay Percentile Performance Metric, Table-4.
packetDelayPercentile	Percentage	1	Packet Delay Percentile. Reference MEF 61.1 Section 10.9.4 One-way Packet Delay Percentile Performance Metric, Table-4.
packetDelayObjective	Number	1	Packet Delay Objective. Reference MEF 61.1 Section 10.9.4 One-way Packet Delay

			Percentile Performance Metric, Table-4.
slsRpPairs	SlsRpPair	1.. *	Set of ordered SLS-RP pairs. Reference MEF 61.1 Section 10.9.4 One-way Packet Delay Percentile Performance Metric, Table-4.

**Table 104-OneWayPacketDelayPercentile Attributes**

## 19.9 OneWayPacketDelayRange

The One-way Packet Delay Range Performance Metric is the maximum, over all the ordered pairs of SLS-RPs in a given set S, of the difference between the rth percentile of one-way packet delay and the minimum one-way packet delay, for Qualified Packets for a given ordered pair of SLS-RPs, a given CoS Name, and a given time period Tk. Reference MEF 61.1 Section 10.9.7 One-way Packet Delay Range Performance Metric.

Attribute Name	Type	Multiplicity	Description
slsRpPairs	SlsRpPair	1.. *	Set of ordered SLS-RP pairs. Reference MEF 61.1 Section 10.9.7 One-way Packet Delay Range Performance Metric, Table-7.
packetDelayRangePercentile	Percentage	1	Packet Delay Range Percentile. Reference MEF 61.1 Section 10.9.7 One-way Packet Delay Range Performance Metric, Table 7.
packetDelayRangeObjective	Number	1	Packet Delay Range Objective. Reference MEF 61.1 Section 10.9.7 One-way Packet Delay Range Performance Metric, Table 7.
cosName	String	1	One of the values in the IPVC List of Class of Service Names Service Attribute. Reference MEF 61.1 Section 10.9.7 One-way Mean Packet Delay Performance Metric, Table-7.

**Table 105-OneWayPacketDelayRange Attributes**

## 19.10 OneWayPacketLossRatio

The One-way Packet Loss Ratio Performance Metric is the maximum, over the ordered pairs of SLS-RPs in a given set S, of the ratio of lost packets to transmitted packets for a given ordered pair of SLS-RPs, a given CoS Name and a given time period Tk. Reference MEF 61.1 Section 10.9.8 One-way Packet Loss Ratio Performance Metric.

Attribute Name	Type	Multiplicity	Description
slsRpPairs	SlsRpPair	1.. *	Set of ordered SLS-RP pairs. Reference MEF 61.1 Section 10.9.8 One-way Packet Loss Ratio Performance Metric, Table-8.
cosName	String	1	One of the values in the IPVC List of Class of Service Names Service Attribute. Reference MEF 61.1 Section 10.9.8 One-way Packet Loss Ratio Performance Metric, Table-8.
packetLossRatioObjective	Percentage	1	Packet Loss Ratio Objective. Reference MEF 61.1 Section 10.9.8 One-way Packet Loss Ratio Performance Metric, Table 8.

**Table 106-OneWayPacketLossRatio Attributes**

## 19.11 ServiceUptime

The Service Uptime Performance Metric is the proportion of time, during a given time period Tk, that the service is working from the perspective of the Subscriber (for a Subscriber IP Service) or the perspective of the SP/SO (for an Operator IP Service), excluding any pre-agreed exceptions, for example maintenance intervals. Reference MEF 61.1[1] Section 10.9 Service Uptime Performance Metric.

Attribute Name	Type	Multiplicity	Description
serviceUptimeObjective	Percentage	1	Service Uptime Objective. Reference MEF 61.1 Section 10.9.9 Service Uptime Performance Metric, Table 9.

**Table 107-ServiceUptime Attributes**

**19.12 SlsReferencePoint**

SlsReferencePoint is an abstract data type that can be subclassed to IpvEndPoint and Location.  
Reference MEF 61.1 Section 10.9.1 SLS Reference Points.

**19.13 SlsRpPair**

Service Level Specification Reference Point Pair. In a multipoint or rooted multipoint IPVC, performance objectives are ideally specified as applying between pairs of IPVC EPs - in other words, they apply to the performance that IP Data Packets experience as they flow from one EI to another. The SlsRpPair is a representation of this association. Reference MEF 61.1 Section 10.9.1.

Attribute Name	Type	Multiplicity	Description
toSlsReferencePoint	SlsReferencePoint	1	Pointer to the "to" SLS Reference Point.
fromSlsReferencePoint	SlsReferencePoint	1	Pointer to the "from" SLS Reference Point.

**Table 108-SlsRpPair Attributes**

## 20 References

- [1] IETF JSON Schema draft 7, *JSON Schema: A Media Type for Describing JSON Documents* and associated documents, by Austin Wright and Henry Andrews, March 2018. Copyright © 2018 IETF Trust and the persons identified as the document authors. All rights reserved.
- [2] IETF RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, by Scott Bradner, March 1997
- [3] IETF RFC 3444, *On the Difference between Information Models and Data Models*, January 2003
- [4] IETF RFC 8174, *Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words*, by Barry Leiba, May 2017. Copyright © IETF Trust and the persons identified as the document authors (2017). All Rights Reserved
- [5] IETF RFC 4271, *A Border Gateway Protocol 4 (BGP-4)*, by Dr. Yakov Rekhter, January 2006. Copyright © The Internet Society (2006). All Rights Reserved.
- [6] MEF 61.1, *IP Service Attributes*, May 2019
- [7] MEF 61.1.1, *Amendment to MEF 61.1: UNI Access Link Trunks, IP Addresses, Mean Time to Repair Performance Metric*, July 2022.
- [8] MEF 69.1, *Subscriber IP Service Definitions*, February 2022
- [9] MEF 55.1, *Lifecycle Service Orchestration (LSO): Reference Architecture and Framework*, January 2021
- [10] MEF 112, *MEF Services Model: Information Model for IP/IP VPN*, July 2022.

## Appendix A Usage examples (Informative)

This appendix aims to provide an extensive set of examples to cover:

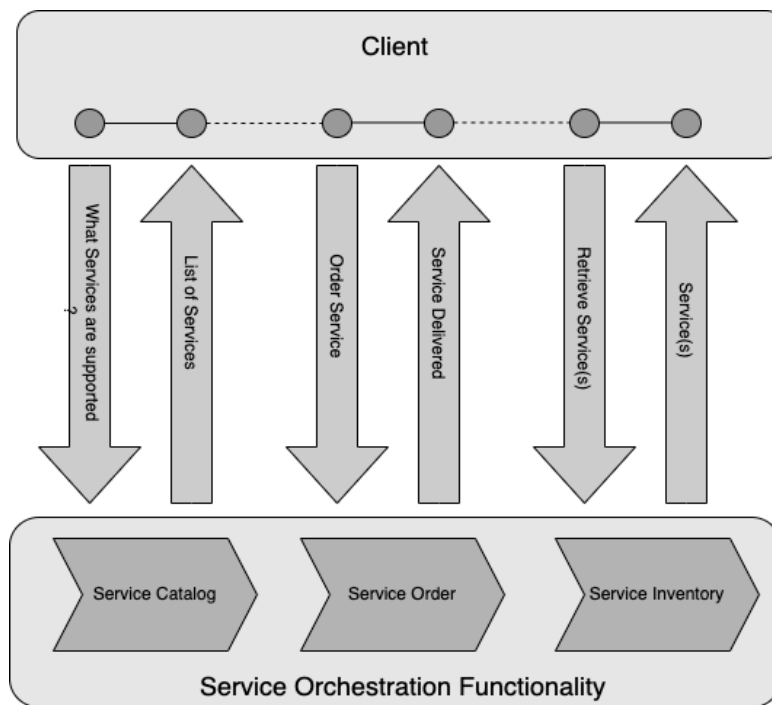
- Different Service Order configuration variants,
- Basic Service Order API walkthrough to order an IP Service,
- Common modifications,
- Deletion of a Service

The examples are delivered in two forms:

- As part of this document – to allow comments and rich explanation.
- As a Postman collection – for ease of use in testing.

### A.1 High-level Flow

The Legato Interface Reference Point is formed from a set of APIs that service different functions in the end-to-end flow. shows all the functions and their sequence.



**Figure 29-Legato End-to-End Function Flow**

Service Catalog – allows the Client to query SOF for available Services as well as what attributes are fixed and/or elastics with values/ranges.

Service Order – allows the Client to request the SOF to initiate and complete the fulfillment process of installation of a Service Offering, an update to an existing Service, or a disconnect of an existing Service.

Service Inventory – allows the Client to retrieve information about existing Service instances from the SOF's Service Inventory.

All the above-mentioned APIs are provided in the SDK together with accompanying Developer Guides. Please refer to those documents for more details and examples of functional APIs.

## A.2 Integration of Service Specification into the Service Order API

The Service Order API is service-agnostic in the meaning that they serve as an interaction between the Client and the Server (SOF) and they do not contain any service-specific information in their specifications. To pass the service-specific information, an extension pattern is used. This applies to any of the Legato Service APIs that carry service-specific information: Service Catalog, Service Order and Service Inventory.

The extension hosting type in the API data model is `MefServiceConfiguration`. The `@type` attribute of that type must be set of a value that uniquely identifies the service specification. See Figure 30 to Figure 33. A unique identifier for MEF standard service specifications is in URN format and is assigned by MEF. This identifier is provided as root schema `$id` and in service specification documentation. In this case, this will be in format of examples below:

- `urn:mef:lso:spec:legato:IpUni:v0.0.1:all`
- `urn:mef:lso:spec:legato:IpvC:v.0.0.1:all`
- `urn:mef:lso:spec:legato:IpvCEndPoint:v.0.0.1:all`

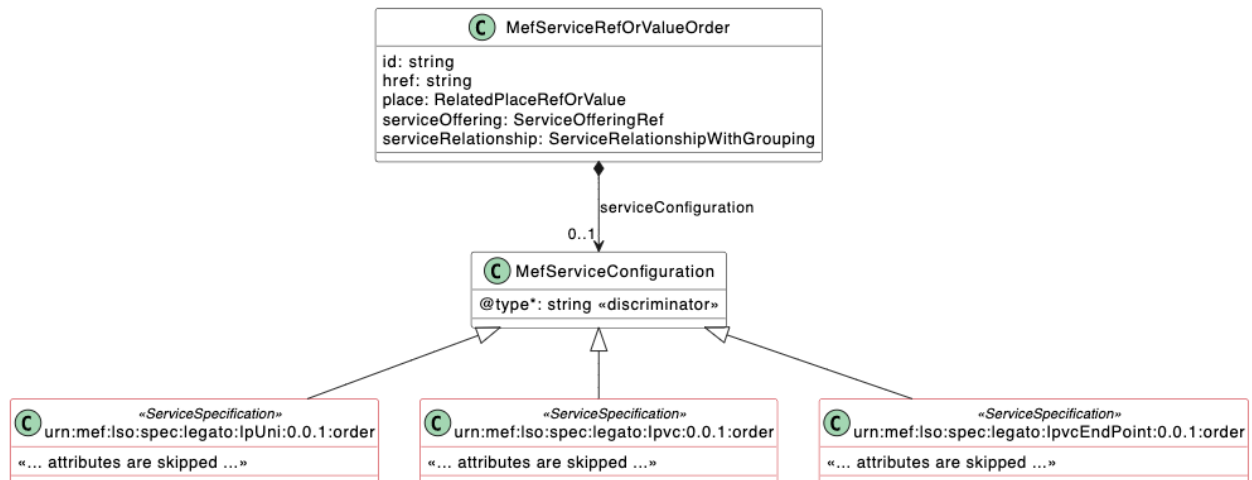


Figure 30-The Extension Pattern: Subscriber IP (1 of 2)

- 2279 • urn:mef:lso:spec:legato:IpUniAccessLink:v0.0.1:all
- 2280 • urn:mef:lso:spec:legato:IpUniAccessLinkTrunk:v.0.0.1:all

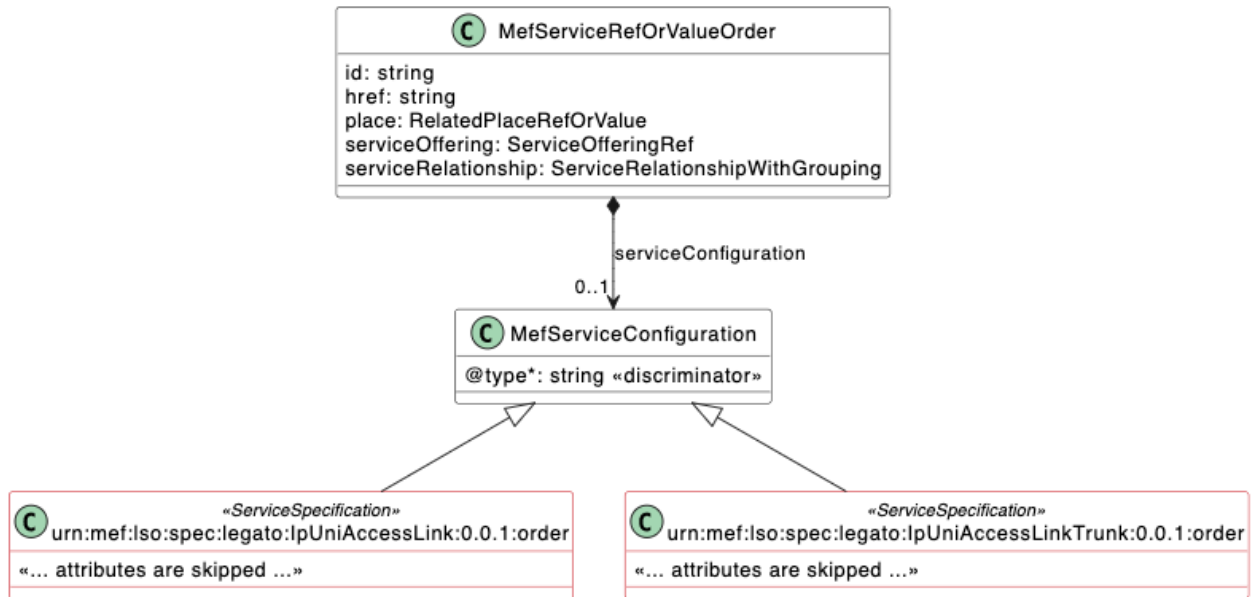


Figure 31-The Extension Pattern: Subscriber IP (2 of 2)

- 2283 • urn:mef:lso:spec:legato:IpUni:v0.0.1:all
- 2284 • urn:mef:lso:spec:legato:Ipv4:v.0.0.1:all
- 2285 • urn:mef:lso:spec:legato:Ipv4EndPoint:v.0.0.1:all
- 2286 • urn:mef:lso:spec:legato:IpUniAccessLink:v.0.0.1:all

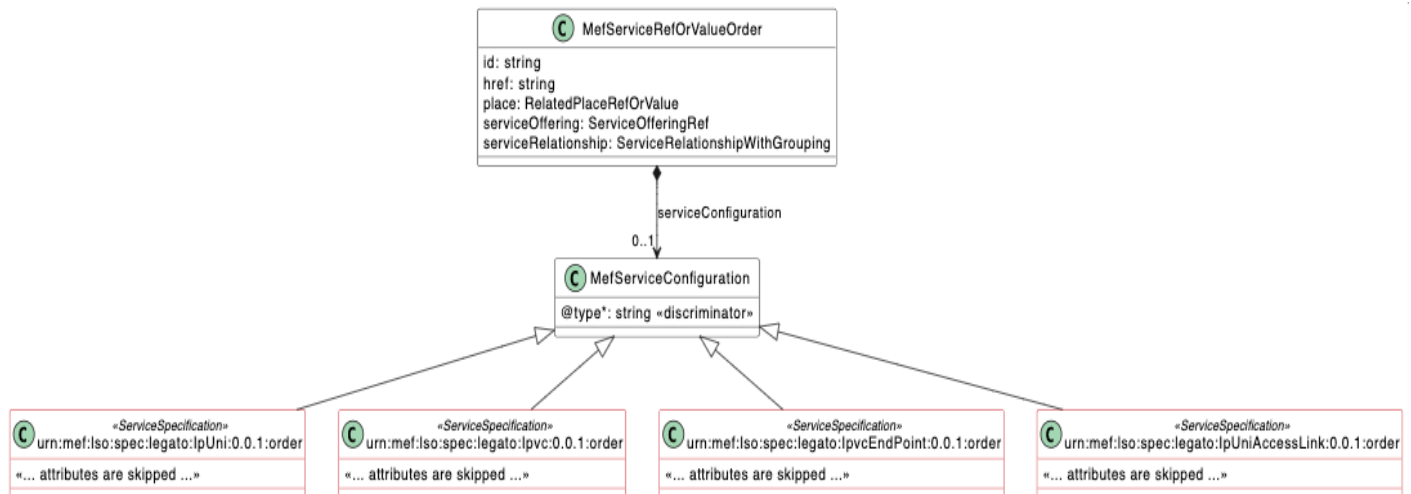


Figure 32-The Extension Pattern: Operator IP (1 of 2)

- 2289 • urn:mef:lso:spec:legato:IpUniAccessLinkTrunk:v0.0.1:all
- 2290 • urn:mef:lso:spec:legato:IpEnni:v.0.0.1:all



- urn:mef:lso:spec:legato:IpEnniLink:v.0.0.1:all
- urn:mef:lso:spec:legato:IpEnniCommon:v.0.0.1:all

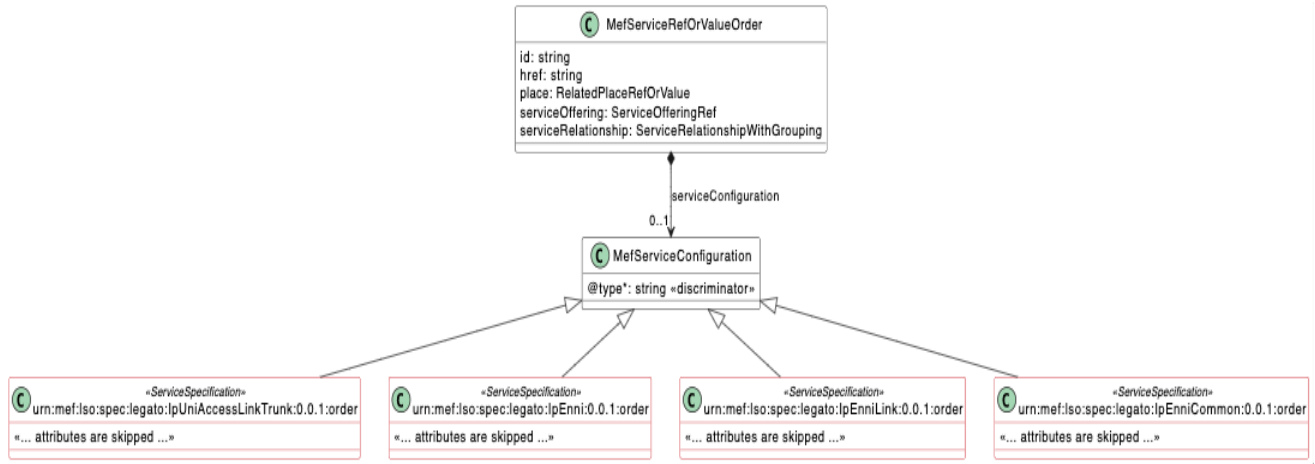


Figure 33-The Extension Pattern: Operator IP (2 of 2)

Use of non-MEF standard service definitions is allowed. In such a case the schema identifier must be agreed upon between the Client and the SOF.

Service specifications are provided as JSON/YAML schemas without the MefServiceConfiguration context. Service-specific attributes are introduced via the MefServiceRefOrValue (defined by the Client). This entity has the serviceConfiguration attribute of type MefServiceConfiguration which is used as an extension point for service-specific attributes. The example result of such a binding in a request payload may look like this for Service Order.

*Editor Note 4: Add JSON example*

Figure 34-Service Order with Subscriber IP Example

### A.3 Action: Add

This section guides through all the steps of Legato Service Order API that is needed to be performed to successfully order a Subscriber IP UNI service.

NOTE: SOF is free to mandate some of these steps.

NOTE: As the examples of steps in many cases will replicate the service-specific information, in some of the snippets some parts of it will be omitted for better readability.

There are rules for all request items for creation requests (Service Order):

- item.action must be set to add

- `item.service.id` must not be provided
- `service.serviceConfiguration` must contain all desired configurations

### A.3.1 Use Case 1: Service Order

*Editor Note 5: Add Service Order Request*

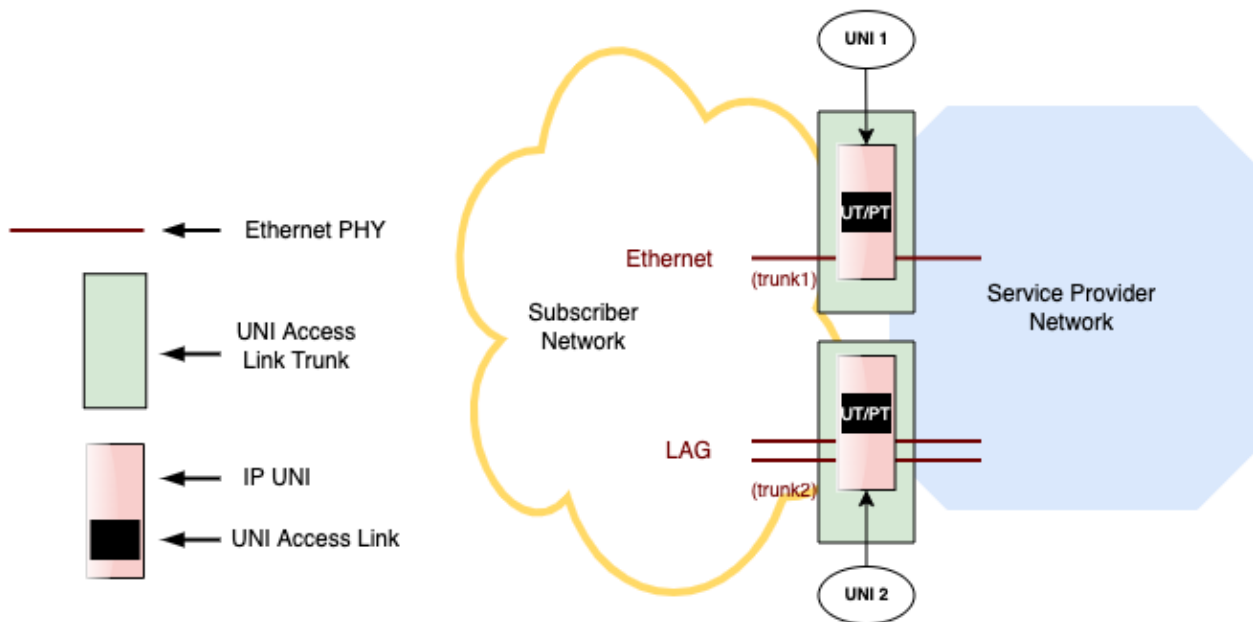
**Figure 35-UC1: Service Order Request**

*Editor Note 6: Add Service Order Response*

**Figure 36-UC1: Service Order Response**

*Editor Note 7: Add Service Order Sequence Diagram*

**Figure 37-UC1: Service Order Sequence Diagram**



**Figure 38-UC1: Setup Diagram**

This setup involves:

- Creation of the Subscriber IP UNI(s):
  - place: Minneapolis (Location)
  - place: St. Paul (Location)
- Creation of the IPVC, including End Points:
  - Configuration of a new Subscriber IP UNI End Point with id

- 2331 **A.4 Action: Modify**
- 2332
- 2333 **A.4.1 Use Case 2: Service Order: Bandwidth change**
- 2334
- 2335 **A.4.2 Use Case 3: Service Order: IPv4 Static IP Address change at the Subscriber IP UNI**
- 2336
- 2337 **A.5 Action: Delete**
- 2338
- 2339 **A.5.1 Use Case 4: Service Order: Delete Subscriber IP UNI(s), IPVC and associated IP VC End**
- 2340 **Points**
- 2341
- 2342 **A.5.2 Use Case 5: Move Subscriber IP UNI to a different Location**
- 2343
- 2344