Draft Standard
MEF 112 Draft (R1)

MEF Services Model: Information Model for IP/IP VPN Release 1

May 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.

- Lumen Technologies
- Amartus
- TATA Communications
- Verizon
- AT&T

2 Abstract

The MEF Services Model (MSM) is an information and data model for MEF defined services. The object definitions, object attributes and relationships specified in the MSM are based on MEF standards that define the given services. This document defines UML classes, data types and enumerations for IP and IPVPN Services, as defined by MEF 61.1[1] and MEF 69.1[2].

This document normatively includes the content of the following Papyrus[3] UML files as if they were contained within this document (GitHub Repository[4]):

- IP_Services.di
- IP_Services.notation
- IP_Services.uml

3 Release Notes

This document is currently open to a Letter Ballot vote. Comments and related updates are not expected to this revision of the document.

4 Terminology and Abbreviations

This section defines the terms used in this document. In many cases, the normative definitions to terms are found in other documents. In these cases, the third column is used to provide the reference that is controlling, in other MEF or external documents. Terms defined in MEF 61.1[1] and MEF 69.1[2] are included in this document by reference and not repeated in the table below.

Term	Definition	Reference
DSCP	Differentiated Services Code Point.	IETF RFC 3260[5]
Information Model	An Information Model models managed objects at a conceptual level, independent of any specific implementations or protocols used to transport the data. MEF uses UML Class Diagrams to model Information Models.	IETF RFC 3444[6]
Unified Modeling Language (UML)	The Unified Modeling Language (UML) is a unified model for object-oriented analysis and design.	OMG[7]

Table 1-Terminology and Abbreviations

5 Introduction

The MEF Services Model (MSM) IP/IP VPN is a service model intended to support management of IP and IP Virtual Private Network services. The model is based on MEF 61.1[1] and MEF 69.1[2]. MEF 61.1[1] defines the IP Service Attributes and MEF 69.1[2] defines Subscriber Internet Access and Subscriber IP VPN Services. The MSM for IP/IP VPN includes defined classes and type definitions and enumerations used by other MEF models.

The MSM is intended to be used at multiple LSO interface reference points as defined in MEF 55.1[8] for multiple API development efforts. Relevant interface reference points include: Sonata, Cantata, Allegro, Interlude and Legato. Each of these interfaces can use the common objects, attributes and relationships defined in the MSM. The MSM can be used by:

- TM Forum[9] APIs, where the JSON payload is derived from the MSM,
- YANG-based APIs (via NETCONF[10] or RESTCONF[11]), where the YANG model is derived from the MSM,
- OpenAPI[12] based APIs, where the OpenAPI specification is derived from the MSM.

5.1 Attribute References

The attribute descriptions in the tables in the following sections refer to definitions found in MEF 61.1[1], MEF 69.1[2] and the Reference section of this document.

6 IP Services Information Model Overview

The service information model consists of a set of object classes, data types, enumerations and their attributes and the relationships among them. The object classes defined in this document are modeled based on the services defined in the service related MEF Standards, for supporting IP Services.

Figure 1-IP Services Overview illustrates the overviews of object classes, data types, enumerations, and their relationships for IP Services. To simplify the overview, some of the minor supporting classes, data types and enumerations are not shown in the figure.

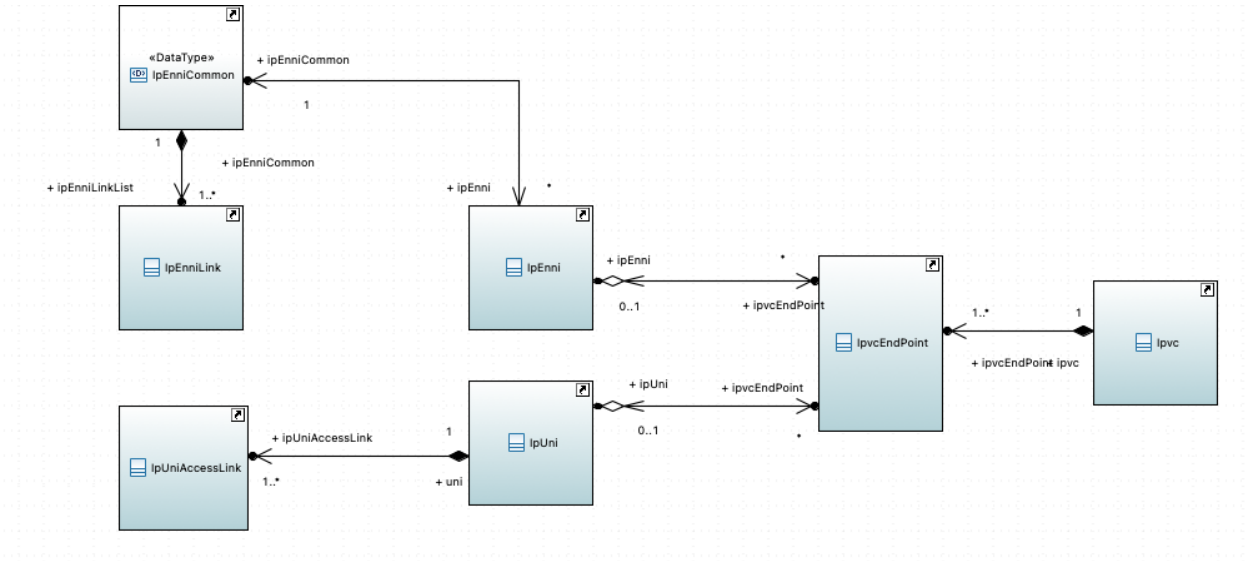

Figure 1-IP Services Overview

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

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 (Ipvc) that links together IPVC End Points (IpvcEndPoints) at External Interfaces (EIs). In the case of a Subscriber IP Service, the IPVC End Points (IpvcEndPoints) are specifically at UNIs (IpUnis).

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

7 MEF Type and MEF-Common

This section details the data types and enumerations imported from MEF-Types[13] that are used by the IP/IP VPN Service model.

7.1 AdminState

This enumeration is for Administrative states. Refer to ITU-T X.731[14].
Contains Enumeration Literals:

- LOCKED:
  - The resource is administratively prohibited from performing services for its users.
- UNLOCKED:
  - The resource is administratively permitted to perform services for its users.

7.2 EnabledDisabled

Enumeration for supporting an Enabled and Disabled state.
Contains Enumeration Literals:

- ENABLED: Enabled state.
- DISABLED: Disabled state.

7.3 OperationalState

This enumeration is for Operational states. Refer to ITU-T X.731[14].
Contains Enumeration Literals:

- DISABLED:
  - The resource is operationally disabled.
- ENABLED:
  - The resource is operationally enabled.

7.4 Percentage

Date type for percentage, 0%-100%.

Attribute Name	Type	Multiplicity	Description
percentage	Real	1	This is a real number between 0 and 100.

Table 2-Percentage Attributes

8 IP-Common Data Types and Enumerations

This section details the data types and enumerations that are used by the IP Service model.

8.1 AccessLinkBfd

The Access Link BFD Service Attribute indicates whether Bidirectional Forwarding Detection (BFD) is enabled on the UNI Access Link. Reference MEF 61.1[1] Section 13.8 UNI Access Link BFD Service Attribute and Section 16.5 ENNI Link BFD Attribute.

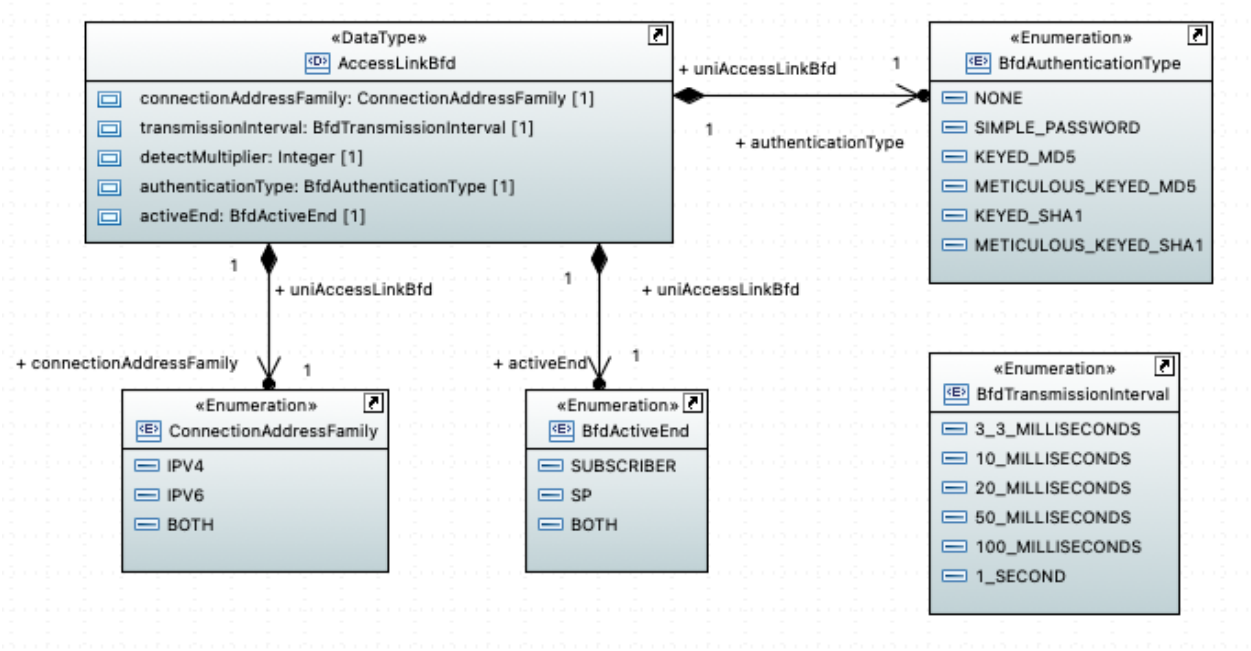

Figure 2-AccessLinkBfd Model

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 3-AccessLinkBfd Attributes

8.2 Addressing

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.

8.3 BfdActiveEnd

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[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.

8.4 BfdAuthenticationType

UNI Access Link BFD authentication type. When Authentication is NOT NONE, RFC5880[20] 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:
  - 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.
- KEYED_SHA1:
  - The Keyed SHA1 and Meticulous Key SHA1 Authentication mechanisms are very similar to those used in other protocols. In these methods of authentication, one or more secret keys (with corresponding key IDs) are configured in each system. Reference RFC5880 Section 6.7.4 Keyed SHA1 and Meticulous Keyed SHA1 Authentication.
- METICULOUS_KEYED_SHA1:
  - The Keyed SHA1 and Meticulous Key SHA1 Authentication mechanisms are very similar to those used in other protocols. In these methods of authentication, one or more secret keys (with corresponding key IDs) are configured in each system. Reference RFC5880 Section 6.7.4 Keyed SHA1 and Meticulous Keyed SHA1 Authentication.

8.5 BfdTransmissionInterval

RFC 7419[21] specifies a set of common intervals which are used to ensure interoperability. Contains Enumeration Literals:

- 3_3_MILLISECONDS:
  - 3.3 milliseconds
- 10_MILLISECONDS:
  - 10 milliseconds
- 20_MILLISECONDS:
  - 20 milliseconds
- 50_MILLISECONDS:
  - 50 milliseconds

- 100_MILLISECONDS:
- 1_SECOND:
  - 1 second

8.6 Bgp

When an entry in the UNI Routing Protocol is for BGP, BGP as specified in RFC 4271[18] is used across the UNI to exchange routing information. Reference MEF 61.1[1] Section 12.7.3 BGP.

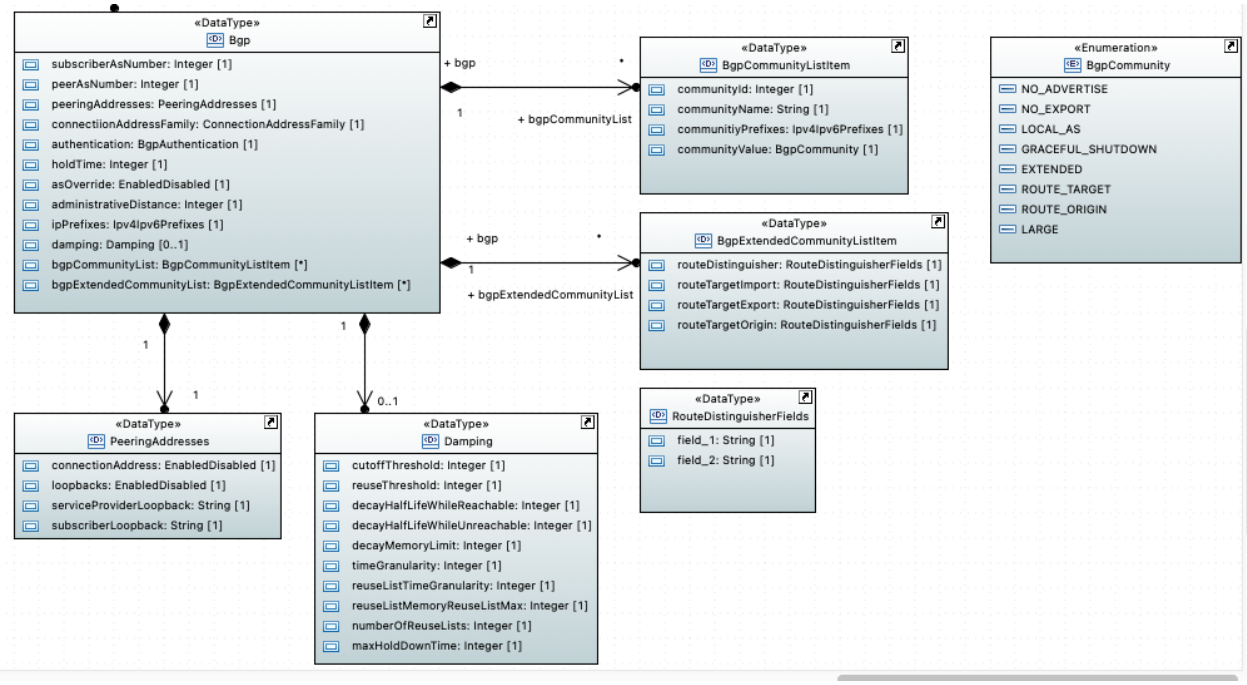

Figure 3-Bgp Model

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	ConnectionAddressFamilty	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 4-Bgp Attributes

8.7 BgpAuthentication

BGP Authentication options as an enumeration. Contains Enumeration Literals:

- NONE:
  - No authentication for BGP.
- MD5_PASSWORD:
  - BGP Authentication is MD5 plus a password.

8.8 BgpCommunity

Set of BGP Community enumerations.

- NO_ADVERTISE:
  - When a No-Advertise community is attached to a route, the BGP speaker won't advertise the route to any internal or external BGP peers.
- NO_EXPORT:
  - When a No-Export community is attached to a route, the router won't advertise the route to external peers--only to internal peers.
- LOCAL_AS:
  - To avoid any BGP routing loops, there is an important rule regarding the internal BGP neighbors: an IBGP neighbor cannot advertise a route to an IBGP neighbor if it received that route from another IBGP neighbor.
- GRACEFUL_SHUTDOWN:
  - The Graceful SHUTDOWN (65535:0) community is used to smoothly shut down paths a router might use when its peer router is about to be intentionally shut down.
- EXTENDED:
  - An Extended community is an 8-byte value that is divided into two main sections: An extended community has three fields: type, administrator, assigned number (type:administrator:assigned-number). Based on the value of the high-order byte in the Type field, the administrator field can be an AS or an IP address.

- ROUTE_TARGET:
  - The Route Target community is used in MPLS VPN environments to separate two customers routing tables.
- ROUTE_ORIGIN:

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

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

8.9 BgpCommunityListItem

BGP Community List.

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 5-BgpCommunityListItem Attributes

8.10 BgpExtendedCommunityListItem

BGP Extended Community List.

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 6-BgpExtendedCommunityListItem Attributes

8.11 BwRate

Enumeration representing bandwidth rate units.
Contains Enumeration Literals:

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

8.12 BurstBehavior

Enumeration used to select the Bandwidth Profile Flow Burst Behavior attribute. Reference MEF 61.1[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.

8.13 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-tupe (scdl, tcdl, ucdl, dcdl). Reference MEF 61.1[1] Section 10.13.3 Cloud Data Limit.

Attribute Name	Type	Multiplicity	Description
startTime	DataTime	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 7-CloudDataLimit Attributes

8.14 CloudDns

Data type representing a Domain Name System.

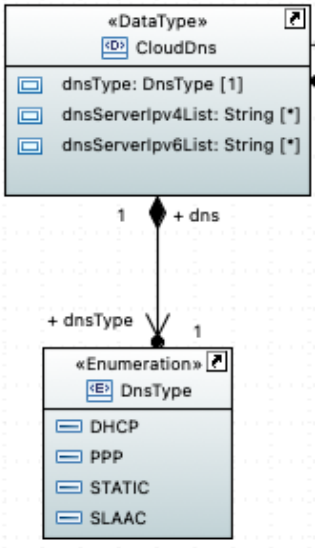

Figure 4-CloudDNS Model

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 8-CloudDns Attributes

8.15 CloudType

Indicates the type of cloud service being accessed. Reference MEF 61.1[1] Table 10-Subscriber IPVC Cloud Service Attribute parameters.
Contains Enumeration Literals:

- INTERNET_ACCESS:
  - Indicates the cloud access IPVC is used to access the public Internet.
- PRIVATE:
  - Indicates the cloud access IPVC provides a direct connection over the Service Provider's network to a cloud service.

8.16 ConnectionAddressFamily

Specifies whether the session is established over IPv4 or IPv6 or whether two separate session are established using IPv4 and IPv6.
Contains Enumeration Literals:

- IPV4:
  - IPv4 is used for establishing the BFD session.
- IPV6:
  - IPv6 is used for establishing the BFD session.
- BOTH:
  - IPv4 and IPv6 are used for establishing the BFD session.

8.17 ConnectionType

An enumeration representing the connection type.
Contains Enumeration Literals:

- P2P:
  - Point-to-Point. Indicates that the link is logically point to point.
- MULTIPOINT:
  - Multipoint. Indicating that the link is logically multipoint.

8.18 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[1] Section 12.6 UNI List of Control Protocols Service Attribute.

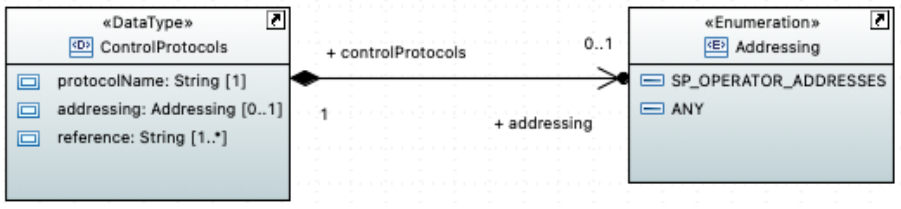

Figure 5-ControlProtocols Model

Attribute Name	Type	Multiplicity	Description
protocolName	String	1	Protocol name.
reference	String	1..*	Protocol reference.
addressing	Addressing	0..1	Enumeration representing the addressing.

Table 9-ControlProtocols Attributes

8.19 Damping

BGP Damping parameters as defined in RFC 2439[17] BGP Route Flap Damping, Section 4.2.

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 if 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 if 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 lists 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 10-Damping Attributes

8.20 DateTime

Data type representing time and date.

Attribute Name	Type	Multiplicity	Description
time	String	1	Time of day as a String
date	String	1	Date as a String.

Table 11-DateTime Attributes

8.21 DhcpRelay

Dynamic Host Configuration Protocol (DHCP) Relay functionality is useful when the Subscriber uses DHCP (per RFC 2131[15] and RFC 8415[24]) 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.

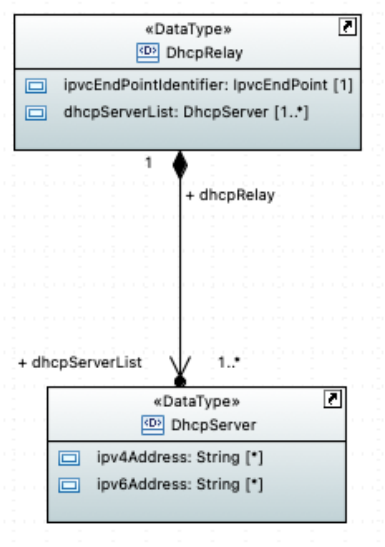

Figure 6-DhcpRelay Model

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 12-DhcpRelay Attributes

8.22 DhcpServer

Data type representing a DHCP Server.

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 13-DhcpServer Attributes

8.23 DnsType

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[23]).

8.24 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[22].

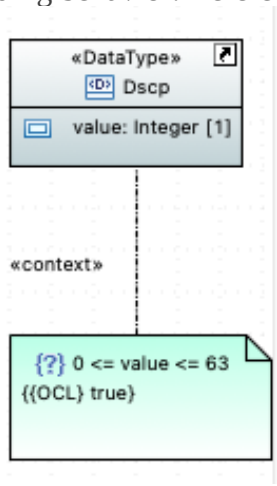

Figure 7-Dscp Model

Attribute Name	Type	Multiplicity	Description
value	Integer	1	0 <= value <= 63.

Table 14-Dscp Attributes

8.25 DscpMapping

Ethernet PCP mapping for CoS name to PCP value.

Attribute Name	Type	Multiplicity	Description
cosName	String	1	Class of Service name.
ipds	Dscp	1	DSCP value (Integer 0 to 63).

Table 15-DscpMapping Attributes

8.26 Duration

Data type representing time duration.

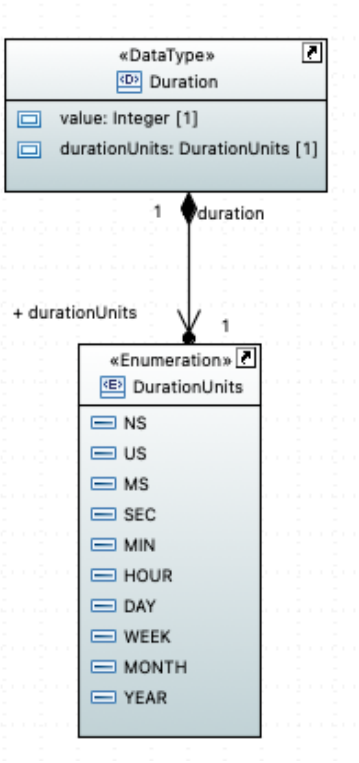

Figure 8-Duration Model

Attribute Name	Type	Multiplicity	Description
value	Integer	1	Time value.
durationUnits	DurationUnits	1	Time duration units.

Table 16-Duration Attributes

8.27 DurationUnits

Enumeration represent time duration
Contains Enumeration Literals:

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

- MONTH
- YEAR

8.28 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[1] Section 11.10 IPVC EP Egress Class of Service Map Service Attribute.

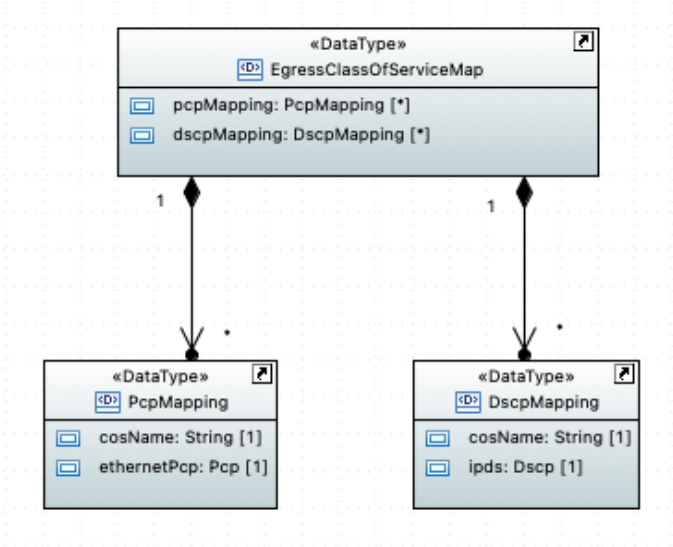

Figure 9-EgressClassOfServiceMap Model

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 17-EgressClassOfServiceMap Attributes

8.29 EndPointIdentifierAndCosName

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

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 18-EndPointIdentifierAndCosName Attributes

8.30 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[1] Section 16.3 ENNI Link IPv4 Connection Addressing Attribute.

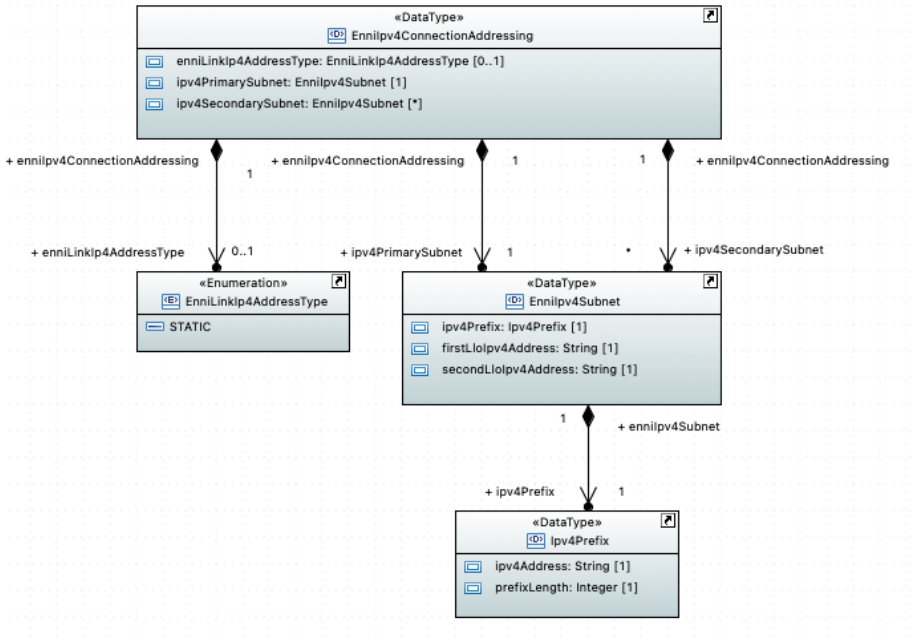

Figure 10-EnniIpv4ConnectionAddressing Model

Attribute Name	Type	Multiplicity	Description
enniLinkIp4AddressType	EnniLinkIp4Address Type	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 19-EnniIpv4ConnectionAddressing Attributes

8.31 EnniIpv4Subnet

Data type representing IPv4 Subnet for ENNI Links. Reference MEF 61.1[1] Section 16.3 ENNI Link IPv4 Connection Addressing Attribute.

Attribute Name	Type	Multiplicity	Description
ipv4Prefix	Ipv4Prefix	1	IPv4 Prefix (IPv4 address prefix and mask length between 0 and 31, in bits).
firstLloIpv4Address	String	1	First LLO (Lowest Level Operator) IPv4 Address.
secondLloIpv4Address	String	1	Second LLO (Lowest Level Operator) IPv4 Address.

Table 20-EnniIpv4Subnet Attributes

8.32 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[1] Section 16.4 ENNI Link IPv6 Connection Addressing Attribute.

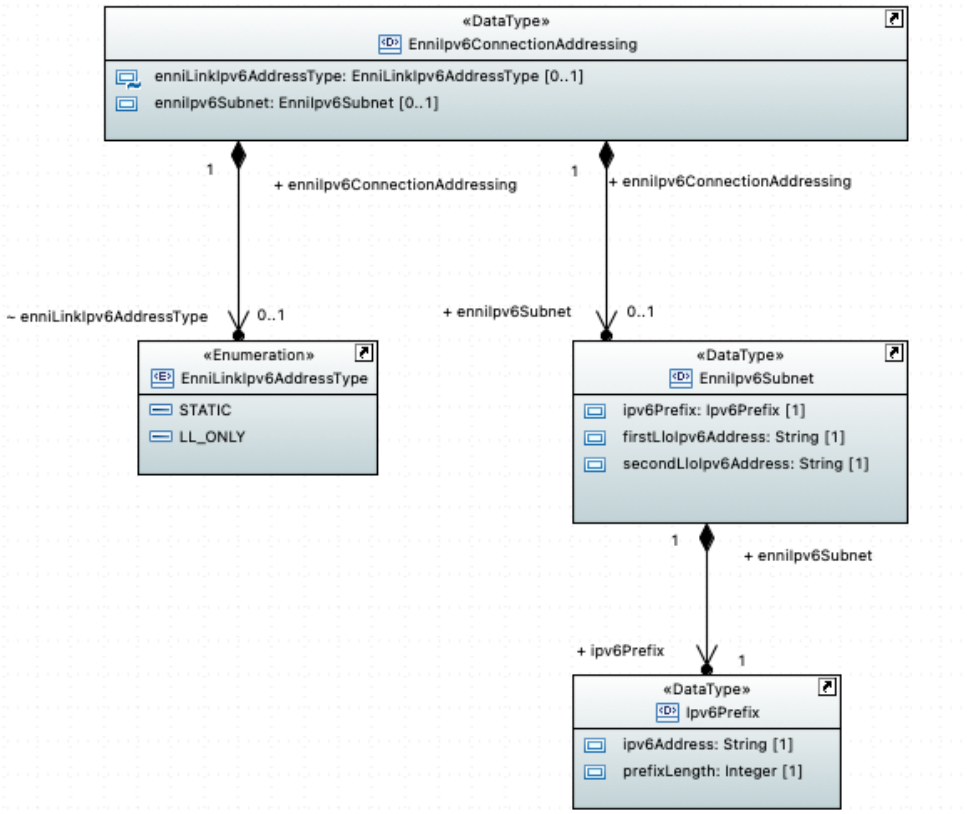

Figure 11-EnniIpv6ConnectionAddressing Model

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 21-EnniIpv6ConnectionAddressing Attributes

8.33 EnniIpv6Subnet

Data type representing IPv6 Subnet for ENNI Links. Reference MEF 61.1[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 22-EnniIpv6Subnet Attributes

8.34 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[1] Section 15.3 ENNI List of ENNI Links Common Attribute.

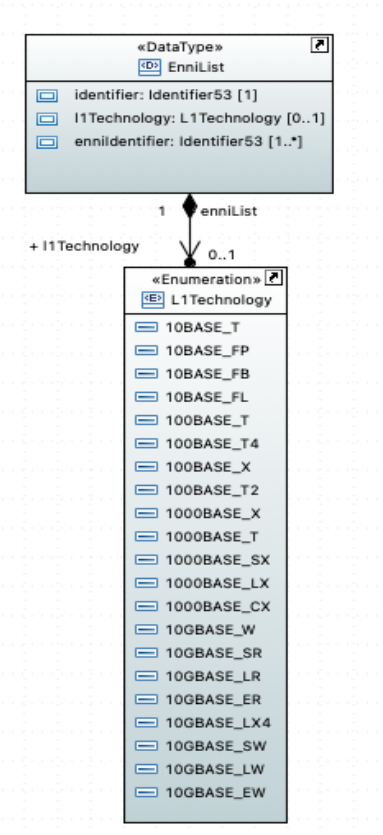

Figure 12-EnniList Model

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 23-EnniList Attributes

8.35 EnniPeeringType

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[19]. Reference MEF 61.1[1] Section 15.2 ENNI Peering Type Common Attribute. For Options reference MEF 61.1[1] Section 8.6 Connecting Services across an ENNI.
Contains Enumeration Literals:

- OPTION_A:
  - A separate eBGP session is used across each ENNI Link and each session carries routes for one service. This results in packets for different services being sent over different ENNI Links. The packets can be plain IP Packets since it is the different links that distinguish them.
- OPTION_B:
  - One or more eBGP sessions are used across the ENNI, each exchanging labelled VPN routes for multiple services. The routes for different services are distinguished by attributes such a Route Distinguishers and Route Targets. This results in IP Packets across the ENNI being encapsulated in MPLS where IP Packets for different services have different MPLS labels. Typically, each packet has a single MPLS label, that identifies both the egress PE and the service.
- OPTION_C:
  - One or more eBGP sessions are used across the ENNI only to distribute labeled unicast routes (and labels) towards each Operator's own routers; furthermore, multi-hop eBGP sessions are used between the ingress PE and the egress PE (or equivalent route reflectors) to exchange labelled VPN routes for each service. This results in IP Packets across the ENNI being encapsulated in MPLS, typically with two MPLS labels, one representing the egress PE, and the second that (roughly speaking) identifies the service.
- OPTIONS_B_AND_C:
  - Combination of Options B and C.

8.36 EnniRoutingInformation

For an ENNI Option A, the ENNI Routing Information Service Attribute is a mapping of ENNI Service Mapping Identifiers to four-tuples of the form (Administrative Distance, Route Flap Damping, AS Override, Static Routes). Each four-tuple applies to the corresponding ENNI Service Mapping Identifier. Reference MEF 61.1[1] Section 14.3.1 ENNI Routing Protocols for Option A.

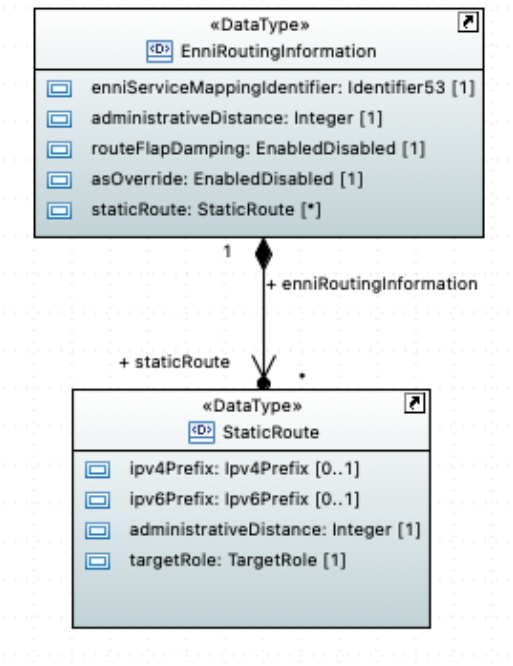

Figure 13-EnniRoutingInformation Model

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	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.
routeFlapDamping	EnabledDisabled	1	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.
asOverride	EnabledDisabled	1	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.
staticRoute	StaticRoute	0..*	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. Reference MEF 61.1 Section 14.3.1.4 Static Routes.

Table 24-EnniRoutingInformation Attributes

8.37 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[1] Section 15.6.1 ENNI Service Map for Option A.

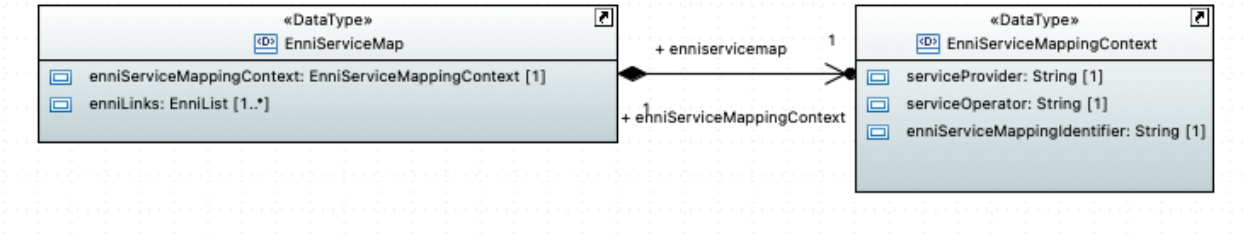

Figure 14-EnniServiceMap Model

Attribute Name	Type	Multiplicity	Description
enniServiceMappingContext	EnniServiceMappingContext	1	Pointer to ENNI Service Mapping Context.
enniLinks	EnniList	1	Pointer to ENNI Link list.

Table 25-EnniServiceMap Attributes

8.38 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[1] Section 15.6.1 ENNI Service Map for Option A.

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 26-EnniServiceMappingContext Attributes

8.39 EnniType

Indication of the type of BGP Peering at the ENNI. Reference MEF 61.1[1] Section 14 ENNI Service Attributes.

Contains Enumeration Literals:

- OPTION_A:

- OPTION_B:
- OPTION_C:

8.40 ExternalInterfaceType

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).

8.41 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).

Attribute Name	Type	Multiplicity	Description
nextHopIpAddress	String	0..1	Next Hop IP Address.
uniAccessLink	Identifier53	0..1	UNI Access Link unique identifier.

Table 27-ForwardingInformation Attributes

8.42 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.

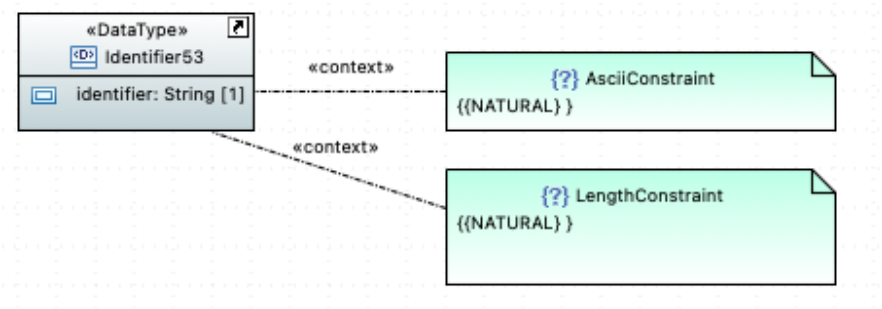

Figure 15-Identifier53 Model

Attribute Name	Type	Multiplicity	Description
identifier	String	1	Unique identifier as a String with length restrictions.

Table 28-Identifier53 Attributes

8.43 HeaderFieldTypes

HeaderFieldTypes is an enumeration for fields defined in MEF 61.1[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.

8.44 InformationRate

Data type representing bandwidth in unit of bits per second.

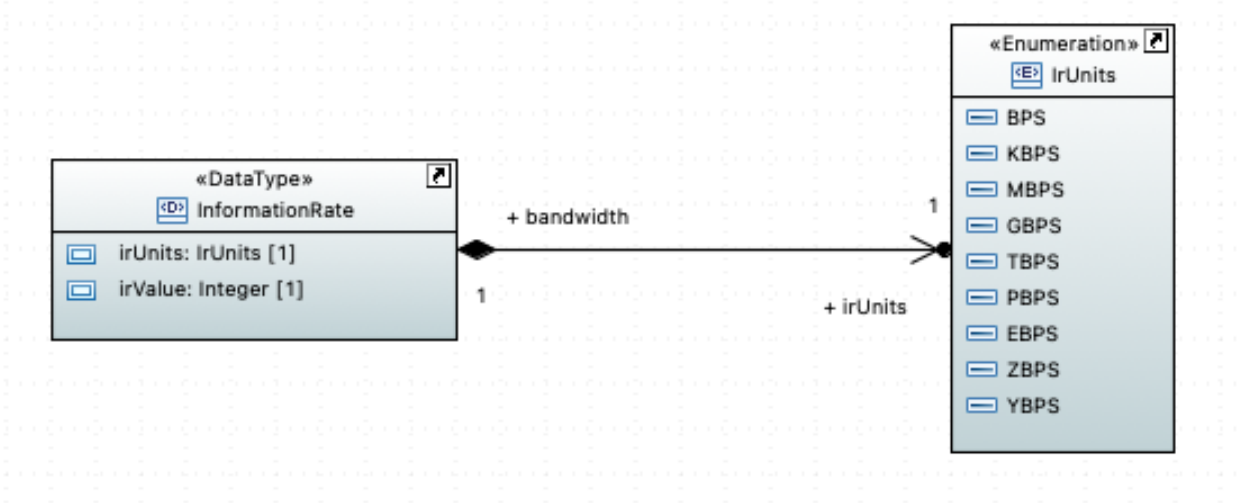

Figure 16-InformationRate Model

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 29-InformationRate Attributes

8.45 IrUnits

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.

8.46 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[1] Section 10.13.2 Cloud Ingress Class of Service Map and Section 11.10 IPVC EP Egress Class of Service Map Service Attribute.

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	HeaderFieldTypes	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 30-IngressClassOfServiceMap Attributes

8.47 IngressClassOfServiceMapEntry

Values for the Cloud Ingress Class of Service Map. Reference MEF 61.1[1] Table 11 - Values for the Cloud Ingress Class of Service Map, 11.0 IPVC EP Ingress Class of Service Map Service Attribute.

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 31-IngressClassOfServiceMapEntry Attributes

8.48 IpvcCloud

The IPVC Cloud Service Attribute is a set of parameters describing the access connectivity to the cloud service. Reference MEF 61.1[1] Section 10.13 IPVC Cloud Service Attribute.

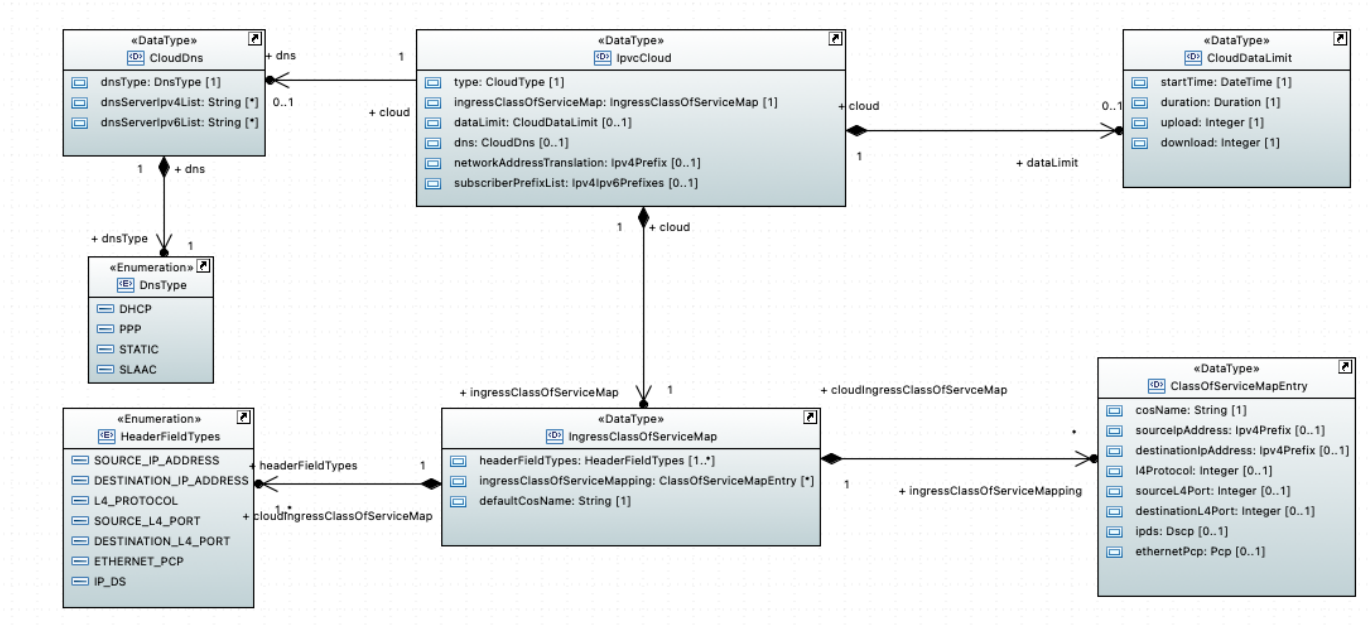

Figure 17-IpvcCloud Model

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-tupe (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 32-IpvcCloud Attributes

8.49 IpvcEndPointRole

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[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.

8.50 Ipv4Prefix

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

Attribute Name	Type	Multiplicity	Description
ipv4Address	String	1	IPv4 address.
prefixLength	Integer	1	IPv4 address prefix. Length 0-31.

Table 33-Ipv4Prefix Attributes

8.51 Ipv4Subnet

Data type representing IPv4 Subnet. Reference MEF 61.1[1] Section 13.4 UNI Access Link IPv4 Connection Addressing Service Attribute.

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 34-Ipv4Subnet Attributes

8.52 Ipv4Ipv6Prefixes

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

Attribute Name	Type	Multiplicity	Description
listOfIpv4ReservedPrefixes	Ipv4Prefix	0.. *	List of IPv4 address prefixes.
listOfIpv6ReservedPrefixes	Ipv6Prefix	0.. *	List of IPv6 address prefixes.

Table 35-Ipv4Ipv6Prefixes Attributes

8.53 Ipv6Prefix

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

Attribute Name	Type	Multiplicity	Description
ipv6Address	String	1	IPv6 address.
prefixLength	Integer	1	IPv6 address prefix. Length 0-127.

Table 36-Ipv6Prefix Attributes

8.54 Ipv6Subnet

Data type representing IPv6 Subnet. Reference MEF 61.1[1] Section 13.5 UNI Access Link IPv6 Connection Addressing Service Attribute.

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 37-Ipv6Subnet Attributes

8.55 Ospf

When an entry in the UNI Routing Protocols is for OSPF, OSPF as specified in RFC 2328[25] (for IPv4) and/or RFC 5340[26] (for IPv6) is used across each UNI Access Link to exchange routing information. Reference MEF 61.1[1] Section 12.7.2 OSPF.

Attribute Name	Type	Multiplicity	Description
ipPrefixes	Ipv4Ipv6Prefixes	1	IPv4/IPv6 Prefixes that are advertised using OSPF.
areaId	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 38-Ospf Attributes

8.56 OspfAuthenticationType

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.

8.57 OspfAreaType

OSPF Area Type enumeration as defined in RFC-3101[28].
Contains Enumeration Literals:

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

8.58 PacketDelivery

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.

Packet Delivery enumeration.
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)

8.59 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.

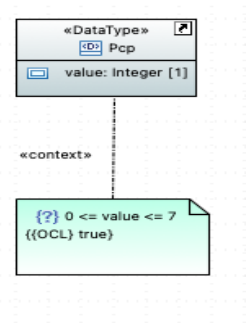

Figure 18-Pcp Data Type

Attribute Name	Type	Multiplicity	Description
value	Integer	1	0 <= value <=7.

Table 39-Pcp Attributes

8.60 PcpMapping

Ethernet PCP mapping for CoS name to PCP value.

Attribute Name	Type	Multiplicity	Description
cosName	String	1	Class of Service name.
ethernetPcp	Pcp	1	PCP value (Integer 0 to 7).

Table 40-PcpMapping Attributes

8.61 PeeringAddress

Peering Addresses. Connection Addresses, or Loopbacks plus a list of pairs of IP addresses. Reference MEF 61.1[1] Section 12.7.3 BGP.

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 41-PeeringAddress Attributes

8.62 RouteDistinguisherFields

BGP Route Distinguisher with two fields.

Attribute Name	Type	Multiplicity	Description
field_1	String	1	Route Distinguisher field 1.
field_2	String	1	Route Distinguisher field 2.

Table 42-RouteDistinguisherFields Attributes

8.63 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[1] Section 12.7 UNI Routing Protocols Service Attributes.

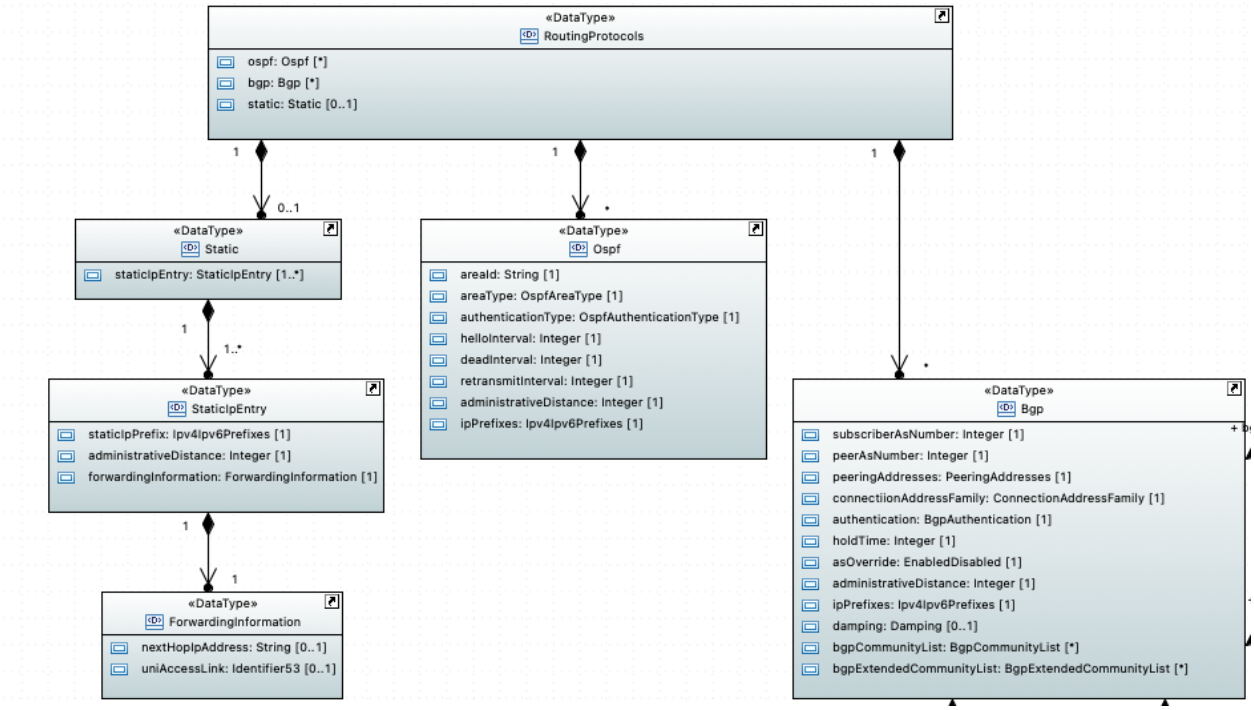

Figure 19-RoutingProtocols Model

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 43-RoutingProtocols Attributes

8.64 ServiceTopology

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_MULTIPOINT:
  - 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.

8.65 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[1] Section 12.7.1 Static.

Attribute Name	Type	Multiplicity	Description
staticIpEntry	StaticIpEntry	1..*	Pointer to StaticIpEntry

Table 44-Static Attributes

8.66 StaticIpEntry

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

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 45-StaticIpEntry Attributes

8.67 StaticRoute

Data type representing IP static routes.

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 46-StaticRoute Attributes

8.68 TargetRole

Enumeration representing the Static Route Target Role. Reference MEF 61.1[1] Section 14.3.1.4 Static Routes.
Contains Enumeration Literals:

- ROOT:
  - Root role.
- LEAF:
  - Leaf role.

8.69 UniAccessLinkIpv4AddressType

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 a given subnet from the SP or Operator.
- STATIC:
  - IPv4 addresses in a given 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.

8.70 UniAccessLinkIpv6AddressType

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 a given 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[27].
- 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.

8.71 UniIpv4ConnectionAddressing

UniIpv4ConnectionAddressing 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.

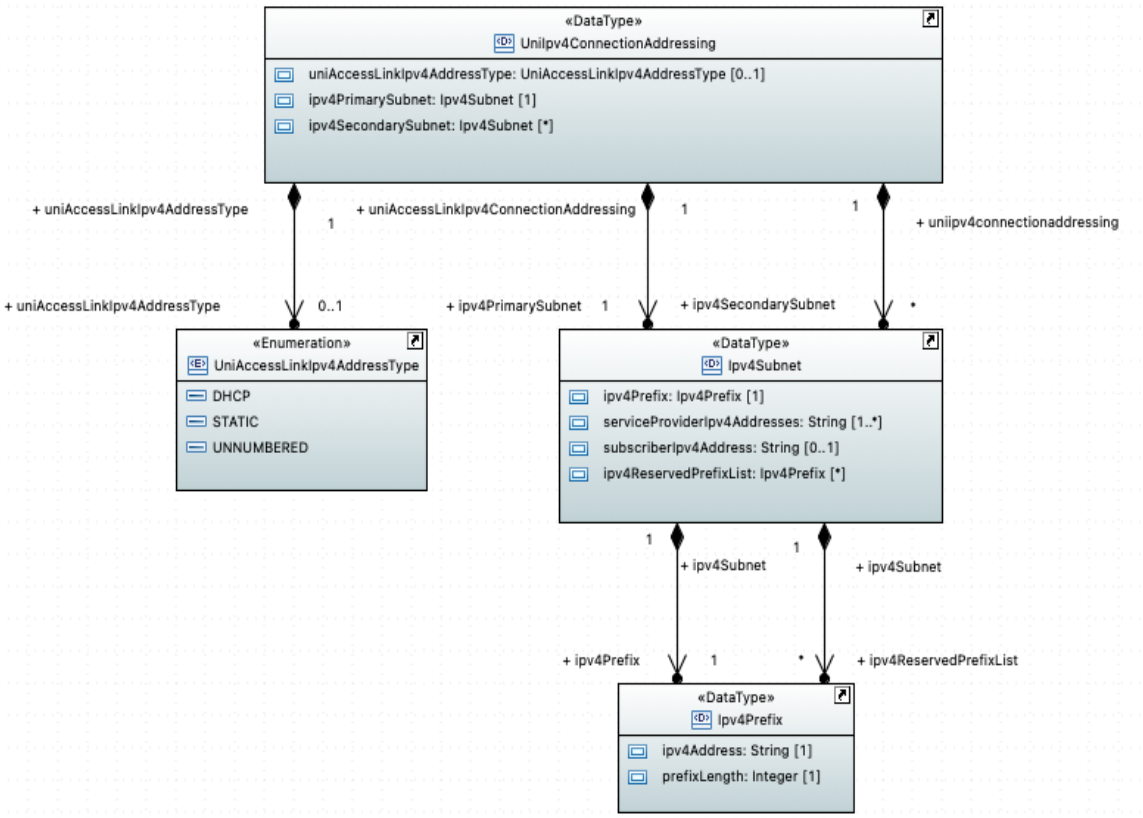

Figure 20-UniIpv4ConnectionAddressing Model

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 47-UniIpv4ConnectionAddressing Attributes

8.72 UniIpv6ConnectionAddressing

UniIpv6ConnectionAddressing 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.

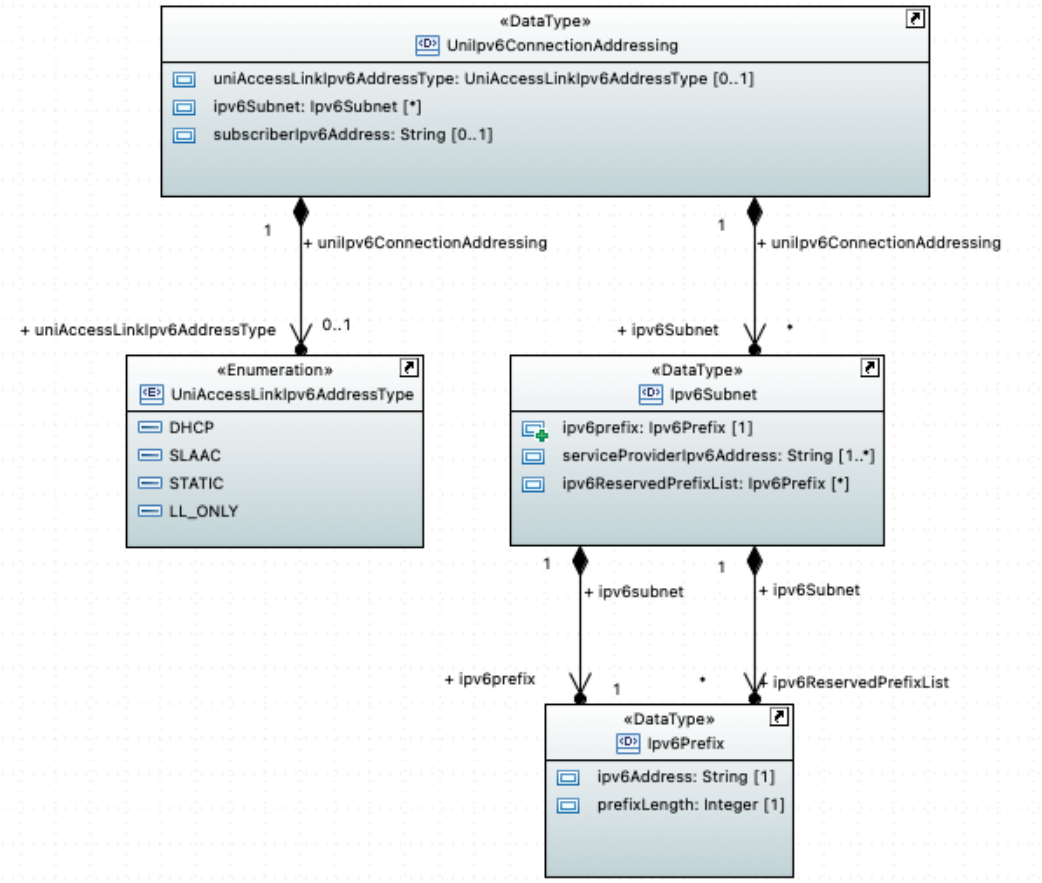

Figure 21-UniIpv6ConnectionAddressing Model

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 48-Ipv6ConnectionAddressing Attributes

8.73 UniManagementType

Enumeration representing the UNI Management Type options. Reference MEF 61.1[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.

8.74 Vrid

Data type representing VRID (Virtual Router ID) as defined in RFC 5798[29] is a number between 1 and 255.

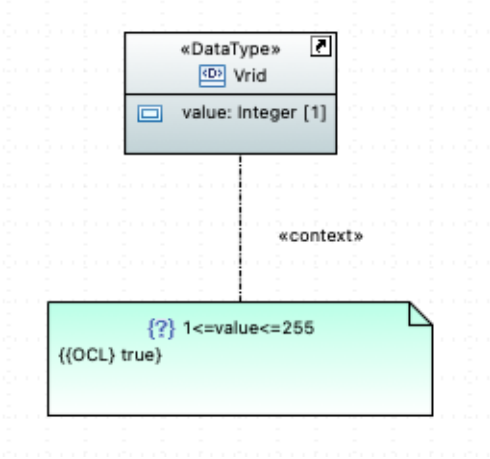

Figure 22-Vrid Model

Attribute Name	Type	Multiplicity	Description
value	Integer	1	VRID value as an Integer.

Table 49-Vrid Attributes

9 IP Services Model

This section provides the IP Services model with objects, attributes and relationships. The IP Services model are displayed and detailed in two sections. The first section defines IP Service superclasses that are leveraged by Subscriber and Operator IP Services. The second section is specific to the Subscriber IP Service model. The third and final section is specific to the Operator IP Service model.

9.1 IP Service Superclasses

The following section defines the set of super classes that are used by the IP Services information models. The superclass objects are IpServicesExternalInterfaceLink and IpServicesExternalInterface.

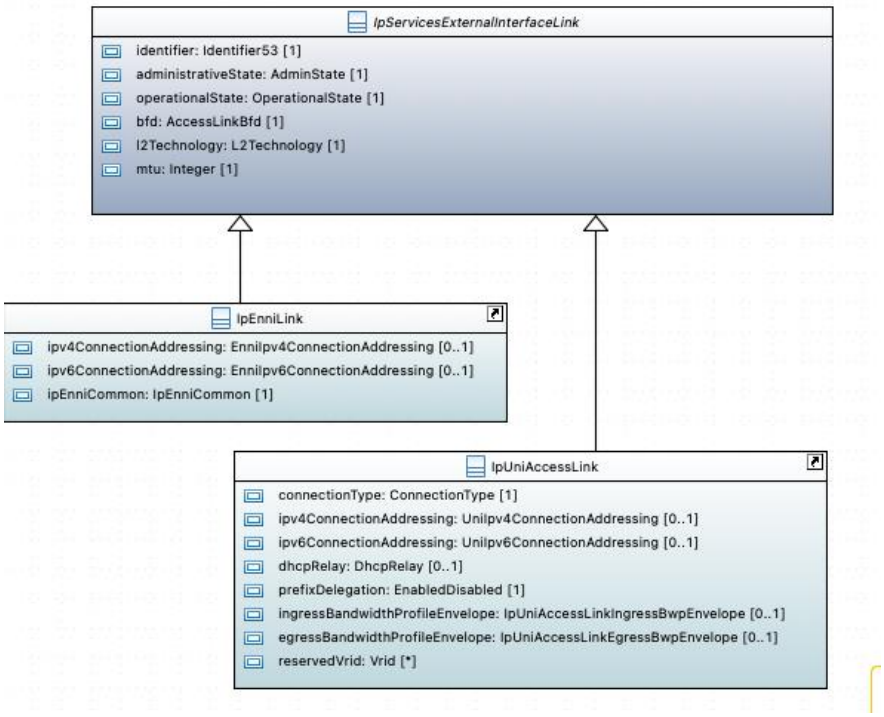

Figure 23-IP Service Superclasses - IpServicesExternalInterfaceLink

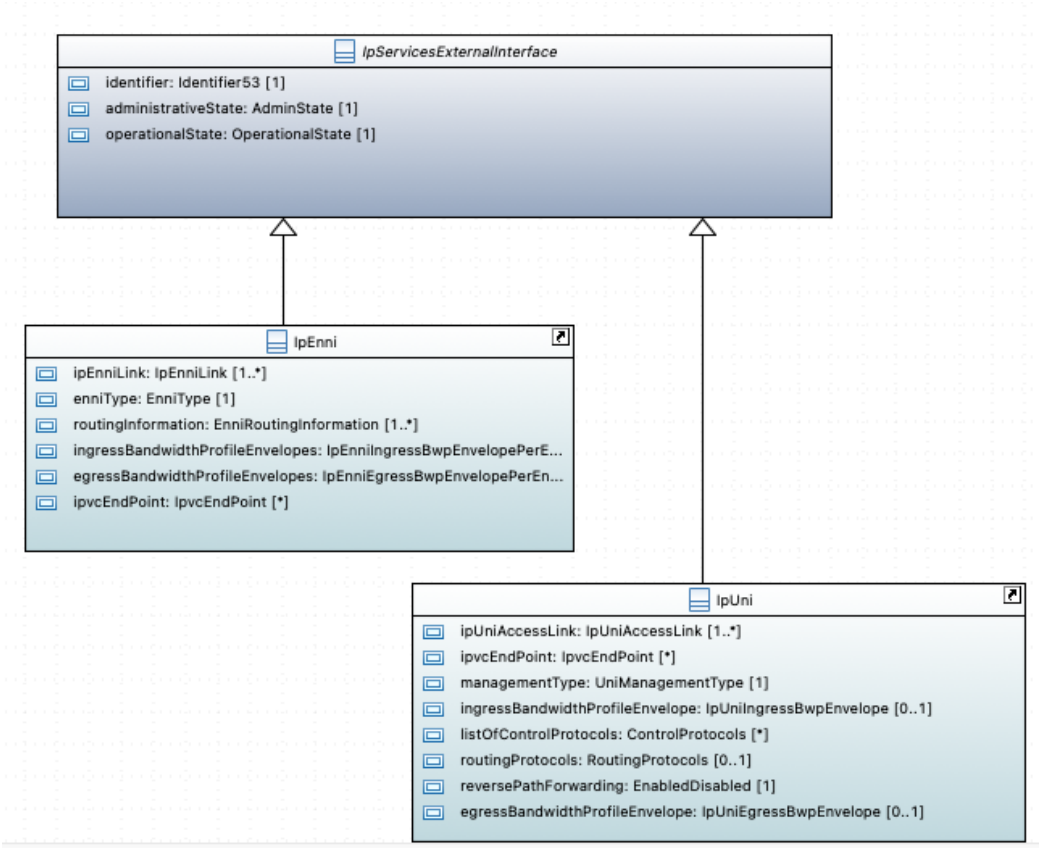

Figure 24-IP Service Superclasses - IpServicesExternalInterface

9.1.1 IpServicesExternalInterface

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.

Attribute Name	Type	Multiplicity	Description
identifier	Identifier53	1	Unique identfier for the ENNI or UNI for management purposes. Reference MEF 61.1 Section 14.1 ENNI Identifier Service Attribute and MEF 61.1 Section 12.1 UNI Identifier Service Attribute.
administrativeState	AdminState	1	This attribute denotes the administrative state of IpServicesExternalInterface. The values supported are LOCKED and UNLOCKED. When set to UNLOCKED, the IP ENNI is enabled and ready to forward traffic. When set to LOCKED, the IP ENNI is disabled and will block (i.e., not forward) traffic.
operationalState	OperationalState	1	This attribute denotes the operational state of the IpServicesExternalInterface, as working ENABLED or not working DISABLED.

Table 50-IpServicesExternalInterface Attributes

9.1.2 IpServicesExternalInterfaceLink

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.

Attribute Name	Type	Multiplicity	Description
identifier	Identifier53	1	Unique identifier for the UNI Access Link or ENNI Link for management purposes. Reference MEF 61.1 Section 16.1 ENNI Link Identifier Attribute or MEF 61.1 Section 13.1 UNI Access Link Identifier Service Attribute.
administrativeState	AdminState	1	This attribute denotes the administrative state of IpServicesExternalInterfaceLink. The values supported are LOCKED and UNLOCKED. When set to UNLOCKED, the IP ENNI Link is enabled and ready to forward traffic. When set to LOCKED, the IP ENNI Link is disabled and will block (i.e., not forward) traffic.
operationalState	OperationalState	1	This attribute denotes the operational state of the IpServicesExtrernalInterfaceLink, as working ENABLED or not working DISABLED.
bfd	AccessLinkBfd	1	Indication of whether BFD is used on the IpServicesExternalInterfaceLink. Reference MEF 61.1 Section 16.5 ENNI Link BFD Attribute and MEF 61.1 Section 13.8 UNI Access Link BFD Service Attribute.
l2Technology	L2Technology	1	Describes the underlying L2 technology for the IpServicesExternalInterfaceLink. Reference MEF 61.1 Section 16.2 ENNI Link L2 Technology Attribute and MEF 61.1 Section 13.3 UNI Access Link L2 Technology Service Attribute. ***NOTE: This attribute is not well defined in MEF 61.1 and should not be used at this time.***
mtu	Integer	1	Maximum size, in octets of an IP Packet that can traverse the IpServicesExternalInterfaceLink. Reference MEF 61.1 Section 16.6 ENNI Link IP MTU Attribute and MEF 61.1 Section 13.9 UNI Access Link IP MTU Service Attribute.

Table 51-IpServicesExternalInterfaceLink Attributes

9.2 Subscriber IP Service Model

This section provides a detailed mapping of the MEF 61.1[1] IP Services specification to an information model. This section is specifically about the Subscriber IP Services part of the model. A Subscriber IP Service model is illustrated following by each object/data type with corresponding attributes.

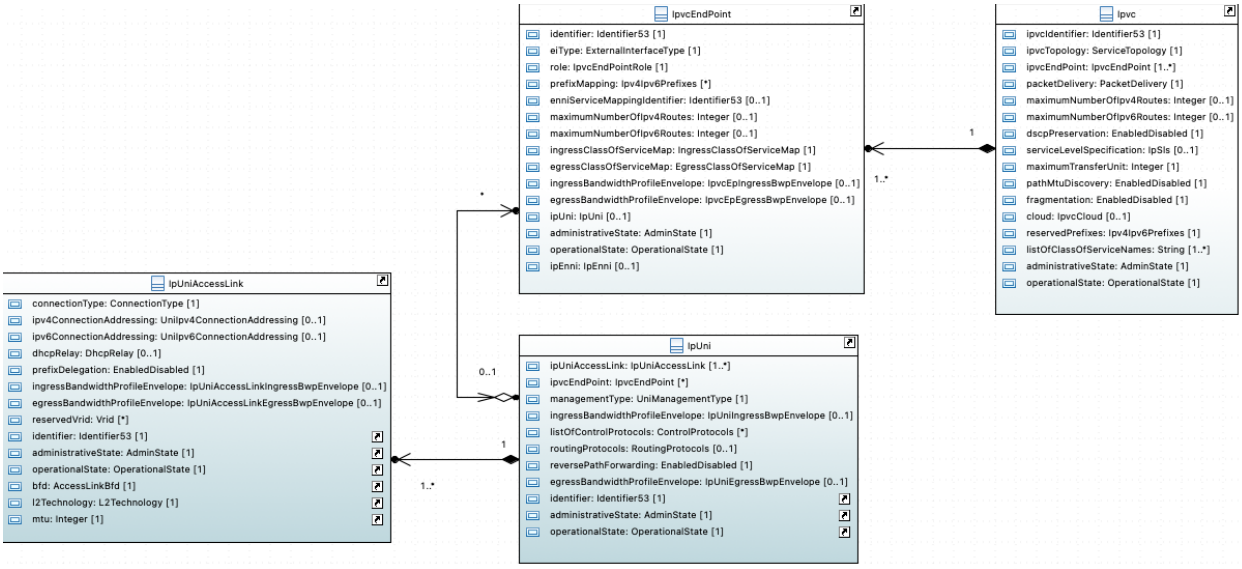

Figure 25-Subscriber IP Service Model

9.2.1 Ipvc

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[1] Section 7.4 IP Virtual Connections and IPVC End Points.

Attribute Name	Type	Multiplicity	Description
ipvcIdentifier	Identifier53	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.
ipvcEndPoint	IpvcEndPoint	1.. *	Reference to IPVC End Points. Reference MEF 61.1 Section 10.3 IPVC End Point List 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.
maximumNumberOfIpv4 Routes	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".
maximumNumberOfIpv6 Routes	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.
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	CosName	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.
administrativeState	AdminState	1	This attribute denotes the administrative state of IPVC. The values supported are LOCKED and UNLOCKED. When set to UNLOCKED, the IPVC is enabled and ready to forward traffic. When set to LOCKED, the IPVC is disabled and will block (i.e., not forward) traffic.
operationalState	OperationalState	1	This attribute denotes the operational state of the IPVC, as working ENABLED or not working DISABLED.

Table 52-Ipvc Attributes

9.2.2 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[1] Section 7.4 IP Virtual Connections and IPVC End Points.

Attribute Name	Type	Multiplicity	Description
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	EndPointType	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.
role	IpvcEndPointRole	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 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.
ipEnni	IpEnni	0..1	Reference to IpEnni. Note that one, not both, of IpEnni or IpUni must be specified, depending on whether the IPVC End Point is at a UNI or an ENNI.
ipUni	IpUni	0..1	Reference to IpUni. Note that one, not both, of IpEnni or IpUni must be specified, depending on whether the IPVC End Point is at a UNI or an ENNI.
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.

Table 53-IpvcEndPoint Attributes

9.2.3 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[1] Section 7.3 UNIs and UNI Access Links.

Attribute Name	Type	Multiplicity	Description
ipUniAccessLink	IpUniAccessLink	1.. *	Reference to IP UNI Access Link(s). Reference MEF 61.1 Section 12.3 UNI List of UNI Access Links Service Attribute.
ipvcEndPoint	IpvcEndPoint	0.. *	Reference to IPVC End Point(s)
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.
ingressBandwidthProfileEnvelope	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 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.
egressBandwidthProfileEnvelope	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".

Table 54-IpUni Attributes

9.2.4 IpUniAccessLink

An individual connection between the Subscriber and the SP that forms part of a UNI. Reference MEF 61.1[1] Section 7.3 UNIs and UNI Access Link.

Attribute Name	Type	Multiplicity	Description
identifier	Identifier53	1	Unique identifier for the UNI Access Link for management purposes. Reference MEF 61.1 Section 13.1 UNI Access Link Identifier Service Attribute.
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	UniIpv4ConnectionAddressing	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	UniIpv6ConnectionAddressing	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. 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.

ingressBandwidthProfileEnvelope	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".
egressBandwidthProfileEnvelope	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 55-IpUniAccessLink Attributes

9.3 Operator IP Service Model

The following section provides a detailed mapping of the MEF 61.1[1] IP Services specification to an information model. This section is specifically the Operator (ENNI) part of the model. A UML model is illustrated followed by each object/data type with corresponding attributes.

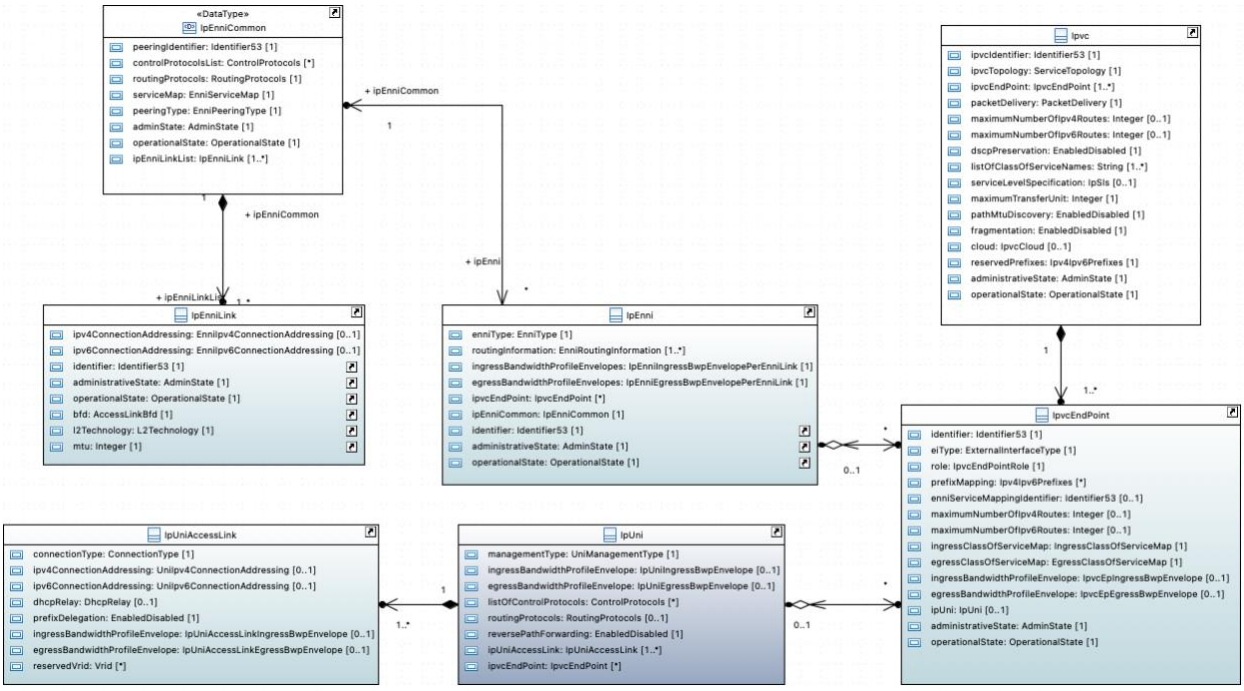

Figure 26-Operator IP Service Model

The IpUniAccessLink, IpUni, IpvcEndPoint and Ipvc are as specified in Section 8.2.

9.3.1 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 61.1[1] Section 8.2 ENNI and ENNI Links.

Attribute Name	Type	Multiplicity	Description
ipvcEndPoint	IpvcEndPoint	0.. *	Reference to IPVC End Point(s).
ipEnniCommon	IpEnniCommon	1	Reference to IP ENNI Common.
identifier	Identifier53	1	Unique identifier for the ENNI for management purposes. Reference MEF 61.1 Section 14.1 ENNI Identifier Service Attribute.
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.

Table 56-IpEnni Attributes

9.3.2 IpEnniCommon

ENNI Common Attributes that apply to each ENNI agreed between two LLOs (Lowest Level Operators). Reference MEF 61.1[1] Section 15 ENNI Common Attributes.

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.
ipEnniLinksList	IpEnniLink	1..*	List of ENNI Links in the ENNI. Reference MEF 61.1 Section 15.3 ENNI List of ENNI Links 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 57-IpEnniCommon Attributes

9.3.3 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[1] Section 8.2 ENNIs and ENNI Links.

Attribute Name	Type	Multiplicity	Description
ipv4ConnectionAddressing	EnniIpv4ConnectionAddressing	0..1	IPv4 Connection Addressing. Reference MEF 61.1 Section 16.3 ENNI Link IPv4 Connection Addressing Attribute.
ipv6ConnectionAddressing	EnniIpv6ConnectionAddressing	0..1	IPv6 Connection Addressing. Reference MEF 61.1 Section 16.4 ENNI Link IPv6 Connection Addressing Attribute.

Table 58-IpEnniLink Attributes

10 Subscriber Internet Access Services

The modeling detailed in the following section is based on MEF 69.1[2] Section 7 Internet Access Service. A Service Provider (SP) offers connectivity to the public Internet to a Subscriber with this service. The SP that offers this service is defined as an Internet Service Provider (ISP). An IPVC used for an Internet Access Service provides the Subscriber with connectivity to the global Internet. If there is a single UNI attached to the IPVC, then the IPVC provides Internet access for the Subscriber Network connected at that UNI. If there are multiple UNIs attached to the IPVC, the IPVC provides Internet access for the part of the Subscriber Network connected at each UNI.

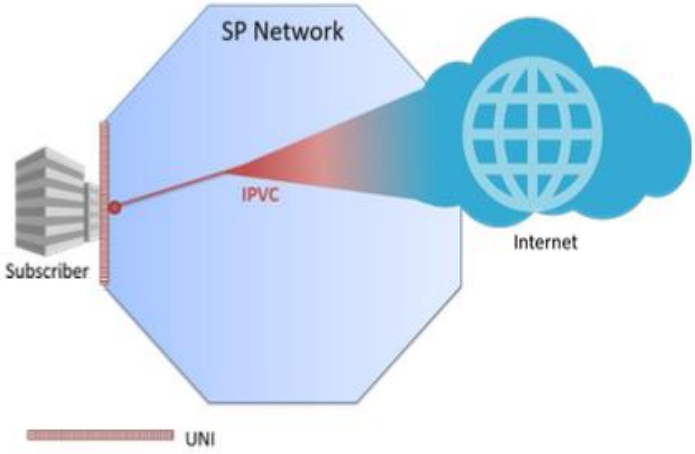

Figure 27- Internet Access Service

The following section details the model of Internet Access Service as defined in MEF 69.1[2]. Two types of Internet Access Service can be offered: Basic and Advanced. The possible values for certain Service Attributes differ between these two types. Basic Internet Access is typically delivered to Subscriber dwellings. It may also be offered to small/medium businesses. Advanced Internet Access is typically delivered to business locations.

10.1 Basic Internet Access Service Model

The following section details the Basic Internet Access Service Model as defined in MEF 69.1[2]. The model will be a subset of the overall IP Service Model as defined in MEF 61.1[1]. Its service characteristics typically include:

- plug-and-play ease of use
- low-cost
- few (or shared) publicly routed IPv4 Addresses

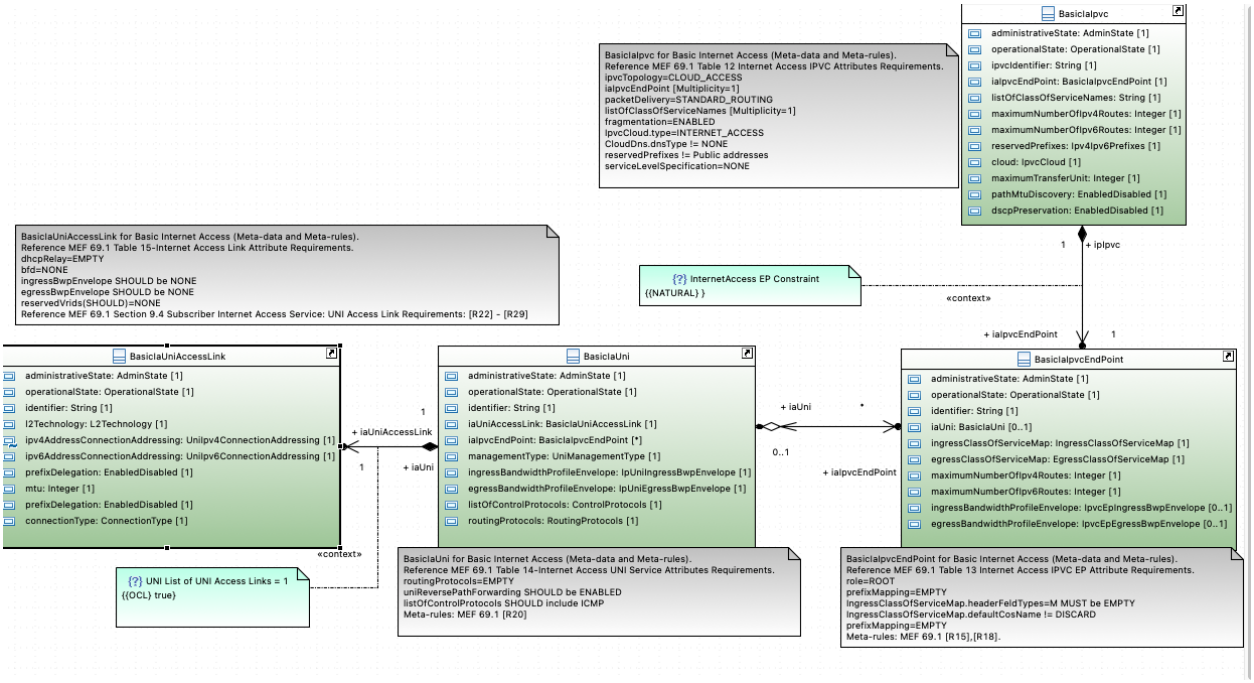

Figure 28-Basic Internet Access Service Model

10.1.1 BasicIaIpvc

The Basic Internet Access IPVC defined in MEF 69.1[2] Section 9.1 Internet Access: IPVC Requirements is based on MEF 61.1[1] IPVC with some attributes fixed and some specific rules for the definition of Basic Internet Access.

Refer to Ipvc for complete set of attributes. The BasicIaIpvc will have several of the Ipvc attributes set to specific values based on the Basic Internet Access definition. The BasicIaIpvc has the following attributes specifically defined and can be treated as meta-data by the SOF:

- ipvcTopology=CLOUD_ACCESS
- iaIpvcEndPoint [Multiplicity=1]
- packetDelivery=STANDARD_ROUTING
- listOfClassOfServiceNames [Multiplicity=1]
- fragmentation=ENABLED
- IpvcCloud.type=INTERNET_ACCESS
- IpvcCloud.CloudDns.dnsType MUST NOT be NONE
- *Additional Rules:*
    - For an Internet Access Service, if the Cloud DNS parameter of the IPVC Cloud Service Attribute is Static, the associated list of DNS Servers MUST have at least one entry. Reference MEF 61.1[1] Section 9.1 Subscriber Internet Access Service: IPVC Requirements [R13].
- reservedPrefixes != Public addresses
- serviceLevelSpecification=NONE

10.1.2 BasicIaIpvcEndPoint

The Basic Internet Access IPVC End Point defined in MEF 69.1[2] Section 9.2 Internet Access: IPVC End Point Requirements is based on MEF 61.1[1] IPVC End Point with some attributes fixed and some specific rules specific for the definition of Basic Internet Access.

Refer to IpvcEndPoint for complete set of attributes. The BasicIaIpvcEndPoint will have several of the IpvcEndPoint attribute set to specific values based on Basic Internet Access definition. The BasicIaIpvcEndPoint has the following attributes specifically defined and can be treated as meta-data by the SOF:

- role=ROOT
- eiType=UNI
- prefixMapping=EMPTY
- IngressClassOfServiceMap.headerFieldTypes=M MUST be EMPTY
- IngressClassOfServiceMap.defaultCosName MUST NOT be DISCARD
- prefixMapping=EMPTY
- *Additional Rules:*
    - For a Basic Internet Access Service, the UNI Identifier specified in the IPVC EP EI Service Attribute MUST NOT exist in the IPVC EP EI Service Attribute of any other IP Service. Reference MEF 69.1[2] [R15].
    - For an Internet Access Service, IPVC Ingress EP Class of Service Map (F, M, D), default CoS name, D, MUST NOT be Discard. Reference MEF 69.1[2] [R18].

10.1.3 BasicIaUni

The Basic Internet Access UNI defined in MEF 69.1[2] Section 9.3 Internet Access: UNI Requirements is based on MEF 61.1[1] UNI with some attributes fixed and some with specific rules for the definition of Basic Internet Access.

The BasicIaUni will have several of the IpUni attribute set to specific values based on Basic Internet Access definition. The BasicIaUni has the following attributes specifically defined and can be treated as meta-data by the SOF:

- routingProtocols=EMPTY
- uniReversePathForwarding SHOULD be ENABLED
- *Additional Rules:*
    - At a UNI with an IPVC EP for an Internet Access Ser- vice with at least one UNI Access Link where the UNI Access Link IPv6 Connection Addressing is not None, the UNI List of Control Protocols SHOULD include ICMPv6 with a list of applicable SP IP addresses.
    - At a UNI with an IPVC EP for a Basic Internet Access Service, the UNI List of UNI Access Links MUST contain exactly one entry. Reference MEF 69.1[2] [R20].

10.1.4 BasicIaUniAccessLink

The Basic Internet Access UNI Access Link defined in MEF 69.1[2] Section 9.4 Internet Access: UNI Access Link Requirements is based on MEF 61.1[1] UNI Access Link with some attributes fixed and some specific rules for the definition of Basic Internet Access.

The BasicIaUniAccessLink has the following attributes specifically defined and can be treated as meta-data by the SOF:

- dhcpRelay=EMPTY
- bfd=NONE
- ingressBwpEnvelope SHOULD be NONE
- egressBwpEnvelope SHOULD be NONE
- reservedVrids SHOULD be NONE
- *Additional Rules:*
    - At a UNI Access Link in a UNI with an IPVC EP for a Basic Internet Access Service, UNI Access Link IPv4 Connection Addressing MUST be DHCP or None. Reference MEF 61.1[1] Section 9.4 Subscriber Internet Access Service: UNI Access Link Requirements [R22].
    - At a UNI Access Link in a UNI with an IPVC EP for a Basic Internet Access Service, if the UNI Access Link IPv4 Connection Addressing is DHCP, the UNI Access Link IPv4 Connection Addressing Secondary Subnet List parameter MUST be empty. Reference MEF 61.1[1] Section 9.4 Subscriber Internet Access Service: UNI Access Link Requirements [R23].
    - At a UNI Access Link in a UNI with an IPVC EP for a Basic Internet Access Service, if the UNI Access Link IPv4 Connection Addressing is DHCP, the UNI Access Link IPv4 Connection Addressing Primary Subnet parameter MUST contain only a single Service Provider IPv4 Address. Reference MEF 61.1[1] Section 9.4 Subscriber Internet Access Service: UNI Access Link Requirements [R24].
    - At a UNI Access Link in a UNI with an IPVC EP for a Basic Internet Access Service, if the UNI Access Link IPv4 Connection Addressing is DHCP, the UNI Access Link IPv4 Connection Addressing Primary Subnet parameter MUST contain only a single Service Provider IPv4 Address. Reference MEF 61.1[1] Section 9.4 Subscriber Internet Access Service: UNI Access Link Requirements [R25].
    - At a UNI Access Link in a UNI with an IPVC EP for an Advanced Internet Access Service, UNI Access Link IPv6 Connection Addressing MUST be Static or None. Reference MEF 61.1[1] Section 9.4 Subscriber Internet Access Service: UNI Access Link Requirements [R26].
    - At a UNI Access Link in a UNI with an IPVC EP for a Basic Internet Access Service, UNI Access Link IPv6 Connection Addressing MUST be DHCP or SLAAC or None. Reference MEF 61.1[1] Section 9.4 Subscriber Internet Access Service: UNI Access Link Requirements [R27].

- At a UNI Access Link in a UNI with an IPVC EP for a Basic Internet Access Service, if the UNI Access Link IPv6 Connection Addressing is DHCP or SLAAC, the UNI Access Link IPv6 Connection Address Subnet List parameter MUST contain a single entry. Reference MEF 61.1[1] Section 9.4 Subscriber Internet Access Service: UNI Access Link Requirements [R28].
- At a UNI Access Link in a UNI with an IPVC EP for a Basic Internet Access Service, if the UNI Access Link IPv6 Connection Addressing is DHCP or SLAAC, the UNI Access Link IPv6 Connection Addressing Subnet List parameter MUST contain only a single Service Provider IPv6 Address. Reference MEF 61.1[1] Section 9.4 Subscriber Internet Access Service: UNI Access Link Requirements [R29].

10.2 Advanced Internet Access Service Model

The following section details the Advanced Internet Access Service Model as defined in MEF 69.1[2]. The model will be a subset of the overall IP Service Model as defined in MEF 61.1[1]. Advanced Internet Access is typically delivered to business locations. Its service characteristics include:

- redundancy features
- options for Subscriber-supplied IP addressing
- proactive monitoring to support a Service Level Specification (SLS)

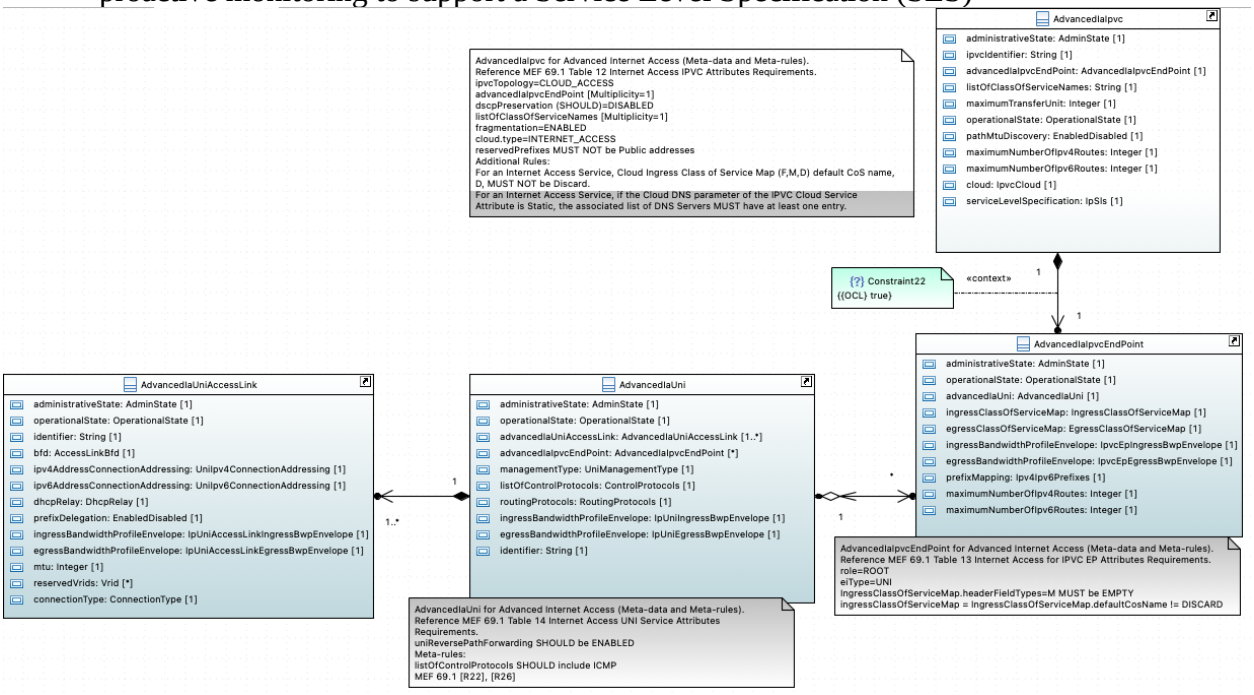

Figure 29-Advanced Internet Access Service Model

10.2.1 AdvancedIaIpvc

The Advanced Internet Access IPVC is a MEF 69.1[2] defined version of MEF 61.1[1] IPVC. Reference MEF 69.1[2] Section 9.1 Internet Access: IPVC Requirements. Refer to Ipvc for complete set of attributes. The AdvancedIaIpvc will have several of the Ipvc attribute set to specific values based on Advanced Internet Access definition. The AdvancedIaIpvc has the following attributes specifically defined and can be treated as meta-data by the SOF:

- ipvcTopology=CLOUD_ACCESS
- advanceIaIpvcEndPoint [Multiplicity=1]
- dscpPreservation SHOULD be DISABLED
- listOfClassOfServiceNames [Multiplicity=1]
- fragmentation=ENABLED
- cloud.type=INTERNET_ACCESS
- reservedPrefixes MUST NOT be Public addresses
- *Additional Rules:*
    - For an Internet Access Service, Cloud Ingress Class of Service Map (F, M, D), default CoS name, D, MUST NOT be Discard.
    - For an Internet Access Service, if the Cloud DNS parameter of the IPVC Cloud Service Attribute is Static, the associated list of DNS Servers MUST have at least one entry.

10.2.2 AdvancedIaIpvcEndPoint

The Advanced Internet Access IPVC End Point is a MEF 69.1[2] defined version of MEF 61.1[1] IPVC End Point. Reference MEF 69.1[2] Section 9.2 Internet Access: IPVC End Point Requirements. Refer to IpvcEndPoint for complete set of attributes. The AdvancedIaIpvcEndPoint will have several of the IpvcEndPoint attribute set to specific values based on Advanced Internet Access definition. The AdvancedIaIpvcEndPoint has the following attributes specifically defined and can be treated as meta-data by the SOF:

- role=ROOT
- eiType=UNI
- IngressClassOfServiceMap.headerFieldTypes=M MUST be EMPTY
- IngressClassOfServiceMap.defaultCosName MUST NOT be DISCARD

10.2.3 AdvancedIaUni

The Advanced Internet Access UNI is a MEF 69.1[2] defined version of MEF 61.1[1] UNI. Reference MEF 69.1[2] Section 9.3 Internet Access: UNI Requirements. The AdvancedIaUni will have several of the IpUni attribute set to specific values based on Advanced Internet Access definition. The AdvancedIaUni has the following attributes specifically defined and can be treated as meta-data by the SOF:

- uniReversePathForwarding SHOULD be ENABLED

- *Additional Rules:*
  - At a UNI with an IPVC EP for an Internet Access Ser- vice with at least one UNI Access Link where the UNI Access Link IPv6 Connection Addressing is not None, the UNI List of Control Protocols SHOULD include ICMPv6 with a list of applicable SP IP addresses.
  - At a UNI Access Link in a UNI with an IPVC EP for an Advanced Internet Access Service, UNI Access Link IPv4 Connection Addressing MUST be Static or None. Reference MEF 69.1[2] [R22].
  - At a UNI Access Link in a UNI with an IPVC EP for an Advanced Internet Access Service, UNI Access Link IPv6 Connection Addressing MUST be Static or None. Reference MEF 69.1[2] [R26].

10.2.4 AdvancedIaUniAccessLink

The Advanced Internet Access UNI Access Link is a MEF 69.1 defined version of MEF 61.1[1] UNI Access Link. Reference MEF 69.1[2] Section 9.4 Internet Access: UNI Access Link Requirements.The AdvancedIaUniAccessLink will have several of the IpUniAccessLink attribute set to specific values based on Advanced Internet Access definition.

11 Subscriber IP VPN Services

The modeling detailed in the following section is based on MEF 69.1[2] Section 8 Subscriber IP VPN Services. There are models for two Subscriber IP VPN Services:

- Subscriber IP VPN Intranet
- Subscriber IP VPN Extranet

A Subscriber IP VPN Intranet Service is a connectivity service where a single IPVC is used to interconnect an agreed set of IP UNIs of a single Subscriber. With this service, a Service Provider (SP) offers connectivity between several parts of a Subscriber Network, typically in different physical locations, to create a single virtual network. It is a private service, where traffic is segregated from other Subscribers and the Internet.

A Subscriber IP VPN Extranet Service is a connectivity service where a single IPVC is used to interconnect an agreed set of IP UNIs belonging to different Subscribers. With this service an SP offers connectivity between two different Subscriber networks. It is a private service, where traffic is segregated from other Subscribers and the Internet.

11.1 Subscriber IP VPN Intranet Service Model

The following section provides a more detailed UML model for the IP VPN Service model and its associated attributes and object relationships. The four main objects for Subscriber IP VPN Intranet service model are SubscriberIntranetIpVpnUniAccessLink, SubscriberIntranetIpVpnUni, SubscriberIntranetIpVpnIpvcEndPoint and SubscriberIntranetIpVpnIpvc.

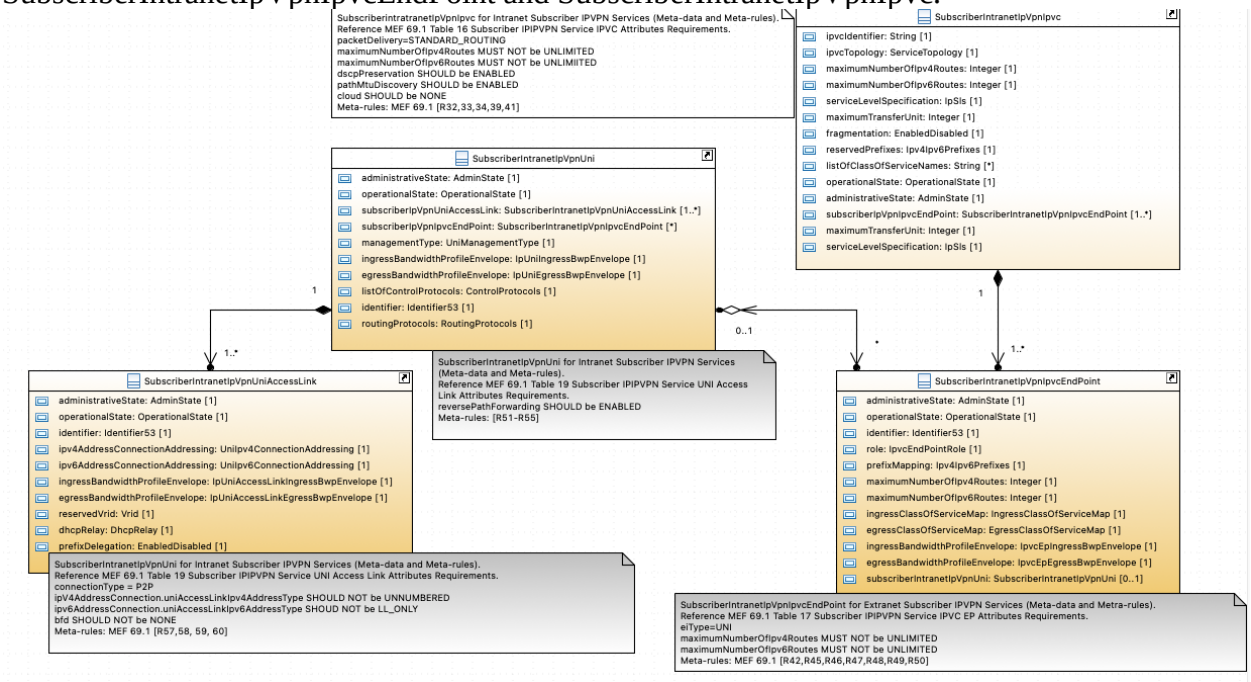

Figure 30-Subscriber Intranet IP VPN Service Model

11.1.1 SubscriberIntranetIpVpnIpvc

An IPVC as defined in MEF 61.1[1] Section 7.4, but specific to operation in a Subscriber Intranet VPN. Reference MEF 69.1[2] Section 10.1 Subscriber IP VPN Service: IPVC Requirements. The SubscriberIntranetIpVpnIpvc has the following attributes specifically defined and can be treated as meta-data by the SOF:

- packetDelivery=STANDARD_ROUTING
- maximumNumberOfIpv4Routes MUST NOT be UNLIMITED
- maximumNumberOfIpv6Routes MUST NOT be UNLIMITED
- *Additional Rules:*
    - For a Subscriber IP VPN Service, IPVC Maximum Number of IPv4 Routes and IPVC Maximum Number of IPv6 Routes MUST NOT both be equal to zero. Reference MEF 69.1 Section 10.1 Subscriber IP VPN Service: IPVC Requirements [R39].
- dscpPreservation = SHOULD be ENABLED
- pathMtuDiscovery = SHOULD be ENABLED
- cloud SHOULD be NONE
- *Additional Rules:*
    - For a Subscriber IP VPN Service, IPVC Topology MUST be either Multipoint or Rooted Multipoint. Reference MEF 69.1[2] [R32].
    - If an Extranet IPVC has two or more IPVC EPs for the same Subscriber, and one or more of them is at a UNI that also has an IPVC EP for an Intranet IPVC, the IPVC Topology Service Attribute for the Extranet IPVC MUST be set to Rooted Multipoint. Reference MEF 69.1[2] [R33].
    - For a Subscriber IP VPN Intranet Service, the IPVC End Point List MUST contain only IPVC EPs that reside on UNIs belonging to a single Subscriber. Reference MEF 69.1[2] [R34].
    - For a Subscriber IP VPN Service, IPVC Maximum Number of IPv4 Routes and IPVC Maximum Number of IPv6 Routes MUST NOT both be equal to zero. Reference MEF 69.1[2] [R39].
    - For a Subscriber IP VPN Service, IPVC Reserved Pre- fixes MUST include all IP prefixes used by the SP to manage the service. Reference MEF 69.1[2] [R41].

11.1.2 SubscriberIntranetIpVpnIpvcEndPoint

An IPVC End Point as defined in MEF 61.1[1] Section 7.4, but specific to operation in a Subscriber Intranet VPN. Reference MEF 69.1[2] Section 10.2 Subscriber IP VPN Service: IPVC End Point Requirements. The SubscriberIntranetIpVpnIpvcEndPoint has the following attributes specifically defined and can be treated as meta-data by the SOF:

- eiType=UNI
- maximumNumberOfIpv4Routes MUST NOT be UNLIMITED.
- maximumNumberOfIpv6Routes MUST NOT be UNLIMITED.
- *Additional Rules:*

- For a Subscriber IP VPN Service, IPVC EP Role MUST be Root or Leaf. Reference MEF 69.1[2] [R42].
- For a Subscriber IP VPN Service, IPVC EP Maximum Number of IPv4 and IPVC EP Maximum Number of IPv6 Routes MUST NOT both be equal to zero. Reference MEF 69.1[2] [R45].
- For a Subscriber IP VPN Service, if the IPVC EP Ingress Bandwidth Profile Envelope contains a Band- width Profile Flow that uses CoS Label H, the Band-width Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R48].
- For an IP VPN IPVC EP, exactly one of the following statements MUST hold Reference MEF 69.1[2] [R49]:
  - The value of the IPVC EP Egress Bandwidth Profile Envelope Service Attribute is not None.
  - The value of the UNI Egress Bandwidth Profile Envelope Service Attribute is not None for the UNI where the IPVC EP is located.
  - The value of the UNI Access Link Egress Bandwidth Profile Envelope Service Attribute is not None for all of the UNI Access Links in the UNI where the IPVC EP is located.
- For a Subscriber IP VPN Service, if the IPVC EP Egress Bandwidth Profile Envelope contains a Bandwidth Profile Flow that uses CoS Label H, the Bandwidth Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R49].

11.1.3 SubscriberIntranetIpVpnUni

An IP UNI as defined in MEF 61.1[1] Section 7.3, but specific to operation in a Subscriber Intranet VPN. Reference MEF 69.1[2] Section 10.3 Subscriber IP VPN Service: UNI Requirements. The SubscriberIntranetIpVpnUni has the following attributes specifically defined and can be treated as meta-data by the SOF:

- reversePathForwarding SHOULD be ENABLED
- *Additional Rules:*
  - At a UNI with an IPVC EP for a Subscriber IP VPN Service, if there is an ingress Bandwidth Profile Flow for that IPVC EP that uses CoS Label H, within the UNI Ingress Bandwidth Profile Envelope, the ingress Band- width Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R51].
  - At a UNI with an IPVC EP for a Subscriber IP VPN Service, if there is an egress Bandwidth Profile Flow for that IPVC EP that uses CoS Label H, within the UNI Egress Bandwidth Profile Envelope, the egress Bandwidth Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R52].
  - At a UNI with an IPVC EP for a Subscriber IP VPN Service, if the UNI has at least one UNI Access Link where the UNI Access Link IPv4 Connection Addressing is not None, the UNI List of Control Protocols MUST include

ICMPv4 with addressing information of SP/Operator Addresses. Reference MEF 69.1[2] [R53].

- At a UNI with an IPVC EP for a Subscriber IP VPN Service, if the UNI has at least one UNI Access Link where the UNI Access Link IPv6 Connection Addressing is not None, the UNI List of Control Protocols MUST include ICMPv6 with addressing information of SP/Operator Addresses. Reference MEF 69.1[2] [R54].
- At a UNI with an IPVC EP for a Subscriber IP VPN Service, if the UNI Routing Protocols Service Attribute includes BGP, the UNI Routing Protocols BGP Subscriber AS Number MUST be a Private AS Number or a Public AS Number assigned to the Subscriber. Reference MEF 69.1[2] [R55].

11.1.4 SubscriberIntranetIpVpnUniAccessLink

An IP UNI Access Link as defined in MEF 61.1[1] Section 7.3, but specific to operation in a Subscriber Intranet VPN. Reference MEF 69.1[2] Section 10.4 Subscriber IP VPN Service: UNI Access Link Requirements. The SubscriberIntranetIpVpnUniAccessLink has the following attributes specifically defined and can be treated as meta-data by the SOF:

- connectionType MUST support P2P
- ipV4AddressConnection.uniAccessLinkIpv4AddressType SHOULD NOT be UNNUMBERED
- ipv6AddressConnection.uniAccessLinkIpv6AddressType SHOULD NOT be LL_ONLY
- bfd SHOULD not be NONE
- *Additional Rules:*
  - At a UNI AccessLink in a UNI with an IPVC EP for a Subscriber IP VPN Service, the SP MUST process any ICMPv4 Echo packets addressed to one of the Service Provider Addresses listed in the UNI Access Link IPv4 Connection Addressing Service Attribute and generate an ICMPv4 echo reply as specified in RFC 792[30]. Reference MEF 69.1[2] [R57].
  - At a UNI AccessLink in a UNI with an IPVC EP for a Subscriber IP VPN Service, the SP MUST process any ICMPv6 Echo Request packets addressed to one of the Service Provider Addresses listed in the UNI Access Link IPv6 Connection Addressing Service Attribute and generate an ICMPv6 echo reply as specified in RFC 4443. Reference MEF 69.1[2] [R58].
  - At a UNI AccessLink in a UNI with an IPVC EP for a Subscriber IP VPN Service, if there is an ingress Bandwidth Profile Flow for that IPVC EP that uses CoS Label H within the UNI Access Link Ingress Bandwidth Profile Envelope, the ingress Bandwidth Profile Flow MUST have the Burst Behavior parameter set to a value of "Optimize-Delay". Reference MEF 69.1[2] [R59].
  - At a UNI AccessLink in a UNI with an IPVC EP for a Subscriber IP VPN Service, if there is an egress Band- width Profile Flow for that IPVC EP that uses CoS Label H within the UNI Access Link Egress Bandwidth Profile Envelope, the egress Bandwidth Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R60].

11.2 Subscriber IP VPN Extranet Service Model

The following section provides a more detailed UML model for the IPVPN Extranet Service model and its associated attributes and object relationships. The four main objects for Subscriber IP VPN Extranet service model are SubscriberExtranetIpVpnUniAccessLink, SubscriberExtranetIpVpnUni, SubscriberExtranetIpVpnIpvcEndPoint and SubscriberExtranetIpVpnIpvc.

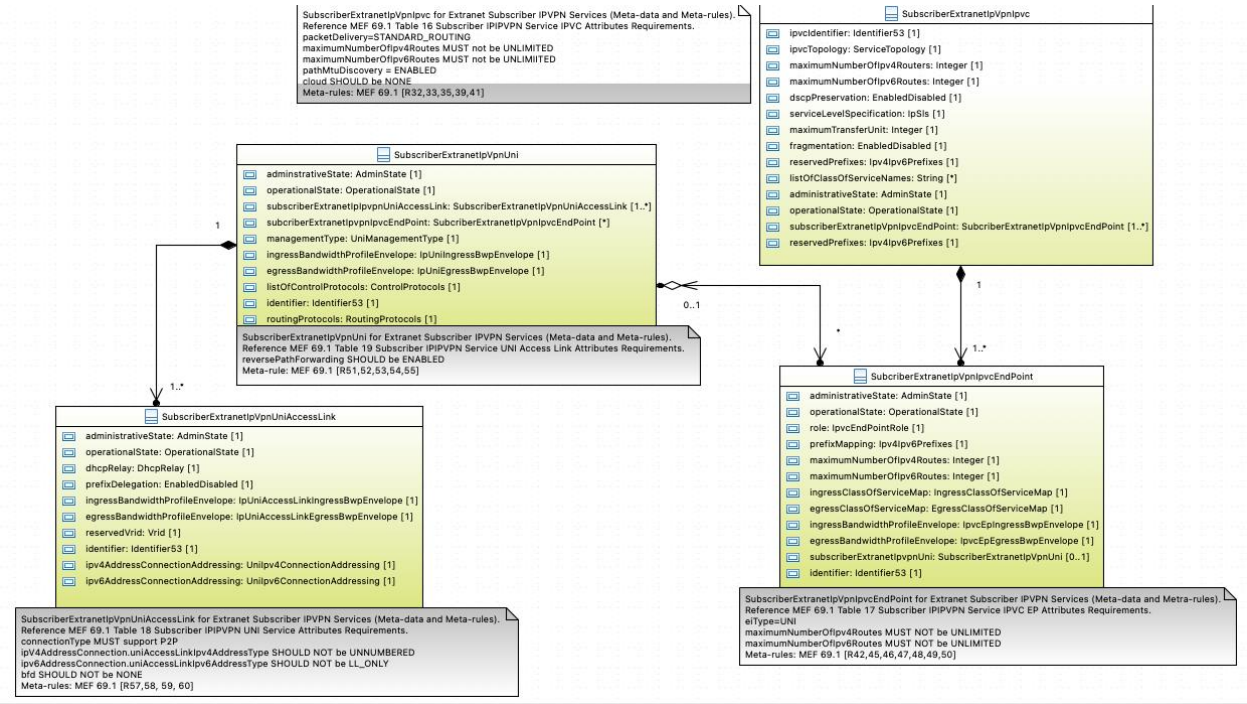

Figure 31-Subscriber Extranet IP VPN Service Model

11.2.1 SubscriberExtranetIpVpnIpvc

An IPVC as defined in MEF 61.1[1] Section 7.4, but specific to operation in a Subscriber Extranet VPN. Reference MEF 69.1[2] Section 10.1 Subscriber IP VPN Service: IPVC Requirements. The SubscriberExtranetIpVpnIpvc has the following attributes specifically defined and can be treated as meta-data by the SOF:

- packetDelivery=STANDARD_ROUTING
- maximumNumberOfIpv4Routes MUST NOT be UNLIMITED
- maximumNumberOfIpv6Routes MUST NOT be UNLIMIITED
- pathMtuDiscovery = ENABLED
- cloud SHOULD be NONE
- *Additional Rules:*
    - For a Subscriber IP VPN Service, IPVC Topology MUST be either Multipoint or Rooted Multipoint. Reference MEF 69.1[2] [R32].
    - If an Extranet IPVC has two or more IPVC EPs for the same Subscriber, and one or more of them is at a UNI that also has an IPVC EP for an Intranet IPVC, the

IPVC Topology Service Attribute for the Extranet IPVC MUST be set to Rooted Multipoint. Reference MEF 69.1[2] [R33].

- For a Subscriber IP VPN Extranet Service, the IPVC End Point List MUST contain IPVC EPs that reside on UNIs belonging to at least two Subscribers.
- Reference MEF 69.1[2] [R35].
- For a Subscriber IP VPN Service, IPVC Maximum Number of IPv4 Routes and IPVC Maximum Number of IPv6 Routes MUST NOT both be equal to zero. Reference MEF 69.1[2] [R39].
- For a Subscriber IP VPN Service, IPVC Reserved Pre- fixes MUST include all IP prefixes used by the SP to manage the service. Reference MEF 69.1[2] [R41].

11.2.2 SubscriberExtranetIpVpnIpvcEndPoint

An IPVC End Point as defined in MEF 61.1[1] Section 7.4, but specific to operation in a Subscriber Extranet VPN. Reference MEF 69.1[2] Section 10.2 Subscriber IP VPN Service: IPVC End Point Requirements. The SubscriberExtranetIpVpnIpvcEndPoint has the following attributes specifically defined and can be treated as meta-data by the SOF:

- eiType=UNI
- maximumNumberOfIpv4Routes MUST NOT be UNLIMITED
- maximumNumberOfIpv6Routes MUST NOT be UNLIMITED
- *Additional Rules:*
  - For a Subscriber IP VPN Service, IPVC EP Role MUST be Root or Leaf. Reference MEF 69.1[2] [R42].
  - For a Subscriber IP VPN Service, IPVC EP Maximum Number of IPv4 and IPVC EP Maximum Number of IPv6 Routes MUST NOT both be equal to zero. Reference MEF 69.1[2] [R45].
  - For a Subscriber IP VPN Service, if the IPVC EP Ingress Bandwidth Profile Envelope contains a Band- width Profile Flow that uses CoS Label H, the Band-width Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R48].
  - For an IP VPN IPVC EP, exactly one of the following statements MUST hold Reference MEF 69.1[2] [R49]:
    - The value of the IPVC EP Egress Bandwidth Profile Envelope Service Attribute is not None.
    - The value of the UNI Egress Bandwidth Profile Envelope Service Attribute is not None for the UNI where the IPVC EP is located.
    - The value of the UNI Access Link Egress Bandwidth Profile Envelope Service Attribute is not None for all of the UNI Access Links in the UNI where the IPVC EP is located.
  - For a Subscriber IP VPN Service, if the IPVC EP Egress Bandwidth Profile Envelope contains a Bandwidth Profile Flow that uses CoS Label H, the Bandwidth Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R49].

11.2.3 SubscriberExtranetIpVpnUni

An IP UNI as defined in MEF 61.1[1] Section 7.3, but specific to operation in a Subscriber Extranet VPN. Reference MEF 69.1[2] Section 10.3 Subscriber IP VPN Service: UNI Requirements. The SubscriberExtranetIpVpnUni has the following attributes specifically defined and can be treated as meta-data by the SOF:

- reversePathForwarding SHOULD be ENABLED
- *Additional Rules:*
  - At a UNI with an IPVC EP for a Subscriber IP VPN Service, if there is an ingress Bandwidth Profile Flow for that IPVC EP that uses CoS Label H, within the UNI Ingress Bandwidth Profile Envelope, the ingress Bandwidth Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R51].
  - At a UNI with an IPVC EP for a Subscriber IP VPN Service, if there is an egress Bandwidth Profile Flow for that IPVC EP that uses CoS Label H, within the UNI Egress Bandwidth Profile Envelope, the egress Bandwidth Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R52].
  - At a UNI with an IPVC EP for a Subscriber IP VPN Service, if the UNI has at least one UNI Access Link where the UNI Access Link IPv4 Connection Addressing is not None, the UNI List of Control Protocols MUST include ICMPv4 with addressing information of SP/Operator Addresses. Reference MEF 69.1[2] [R53].
  - At a UNI with an IPVC EP for a Subscriber IP VPN Service, if the UNI has at least one UNI Access Link where the UNI Access Link IPv6 Connection Addressing is not None, the UNI List of Control Protocols MUST include ICMPv6 with addressing information of SP/Operator Addresses. Reference MEF 69.1[2] [R54].
  - At a UNI with an IPVC EP for a Subscriber IP VPN Service, if the UNI Routing Protocols Service Attribute includes BGP, the UNI Routing Protocols BGP Subscriber AS Number MUST be a Private AS Number or a Public AS Number assigned to the Subscriber. Reference MEF 69.1[2] [R55].

11.2.4 SubscriberExtranetIpVpnUniAccessLink

An IP UNI Access Link as defined in MEF 61.1[1] Section 7.3, but specific to operation in a SubscriberExtranet VPN. Reference MEF 69.1[2] Section 10.4 Subscriber IP VPN Service: UNI Access Link Requirements. The SubscriberExtranetIpVpnUniAccessLink has the following attributes specifically defined and can be treated as meta-data by the SOF:

- connectionType MUST support P2P
- ipV4AddressConnection.uniAccessLinkIpv4AddressType SHOULD NOT be UNNUMBERED
- ipv6AddressConnection.uniAccessLinkIpv6AddressType SHOULD NOT be LL_ONLY

- bfd SHOULD NOT be NONE.
- *Additional Rules:*
    - At a UNI AccessLink in a UNI with an IPVC EP for a Subscriber IP VPN Service, the SP MUST process any ICMPv4 Echo packets addressed to one of the Service Provider Addresses listed in the UNI Access Link IPv4 Connection Addressing Service Attribute and generate an ICMPv4 echo reply as specified in RFC 792. Reference MEF 69.1[2] [R57].
    - At a UNI AccessLink in a UNI with an IPVC EP for a Subscriber IP VPN Service, the SP MUST process any ICMPv6 Echo Request packets addressed to one of the Service Provider Addresses listed in the UNI Access Link IPv6 Connection Addressing Service Attribute and generate an ICMPv6 echo reply as specified in RFC 4443. Reference MEF 69.1[2] [R58].
    - At a UNI AccessLink in a UNI with an IPVC EP for a Subscriber IP VPN Service, if there is an ingress Bandwidth Profile Flow for that IPVC EP that uses CoS Label H within the UNI Access Link Ingress Bandwidth Profile Envelope, the ingress Bandwidth Profile Flow MUST have the Burst Behavior parameter set to a value of "Optimize-Delay". Reference MEF 69.1[2] [R59].
    - At a UNI AccessLink in a UNI with an IPVC EP for a Subscriber IP VPN Service, if there is an egress Bandwidth Profile Flow for that IPVC EP that uses CoS Label H within the UNI Access Link Egress Bandwidth Profile Envelope, the egress Bandwidth Profile Flow MUST have the Burst Behavior parameter set to the value of "Optimize-Delay". Reference MEF 69.1[2] [R60].

12 IP Bandwidth Profile and Bandwidth Profile Envelope Model

The following section provides a detailed information model for the IP Bandwidth Profile and IP Bandwidth Profile Envelope as specified in MEF 61.1[1] Section 17.1 Structure of Bandwidth Profiles. The following section will provide the complete set of IP Bandwidth Profile/Bandwidth Profile Envelope models.

12.1 IP Bandwidth Profile and Envelope

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

12.1.1 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[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.
maxIr	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 59-IpBwpFlow Service Attributes

12.1.2 IpBwpEnvelope

A BWP Envelope is a list of Bandwidth Profile Flows, plus additional parameters for the BWP. 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[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 60-IpBwpEnvelope Service Attributes

12.2 UNI Ingress Bandwidth Profile Envelope Model

The following section details the UNI Ingress Bandwidth Profile Envelope model as defined in MEF 61.1[1] Section 12.4. Note that the tables below do not repeat inherited attributes from superclasses.

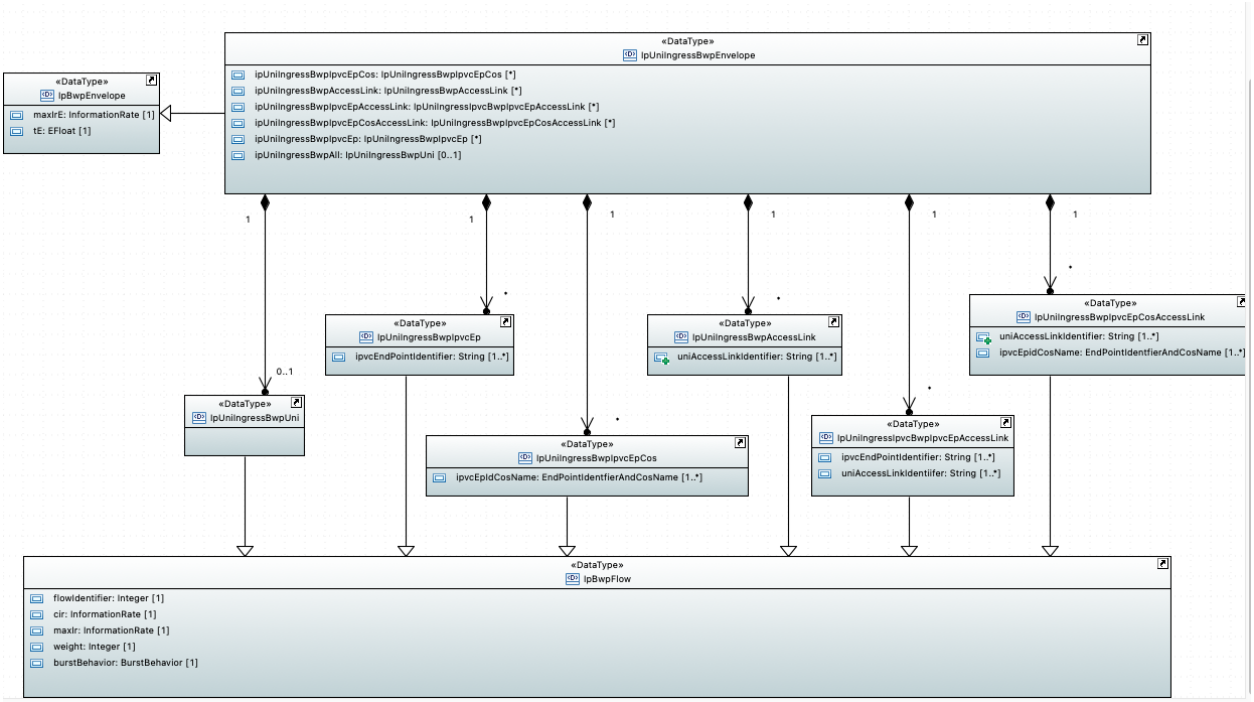

Figure 32-UNI Ingress BWP Envelope Model

12.2.1 IpUniIngressBwpEnvelope

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[1] Section 12.4 UNI Ingress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipUniIngressBwpIpvcEpCos	IpUniIngressBwpIpvcEpCos	0.. *	Pointer to IpUniIngressBwpIpvcEpCos.
ipUniIngressBwpAccessLink	IpUniIngressBwpAccessLink	0.. *	Pointer to IpUniIngressBwpAccessLink.
ipUniIngressBwpIpvcEpAccessLink	IpUniIngressIpvcEpBwpAccessLink	0.. *	Pointer to IpUniIngressIpvcEpBwpAccessLink.
ipUniIngressBwpIpvcEpCosAccessLink	IpUniIngressBwpIpvcEpCosAccessLink	0.. *	Pointer to IpUniIngressBwpIpvcEpCosAccessLink
ipUniIngressBwpIpvcEp	IpUniIngressBwpIpvcEp	0.. *	Pointer to IpUniIngressBwpIpvcEp.
ipUniIngressBwpUni	IpUniIngressBwp	0..1	Pointer to IpUniIngressBwpUni

Table 61-IpUniIngressBwpEnvelope Service Attributes

12.2.2 IpUniIngressBwp

All Ingress IP Data Packets at the UNI. Reference MEF 61.1[1] Section 12.4 UNI Ingress BWP Envelope. NOTE: No attributes are needed.

12.2.3 IpUniIngressBwpIpvcEp

All Ingress IP Data Packets at the UNI that are mapped to any of a given set of IPVC EPs. Reference MEF 61.1[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 62-IpUniIngressBwpIpvcEp Service Attributes

12.2.4 IpUniIngressBwpIpvcEpCos

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[1] Section 12.4 UNI Ingress BWP Envelope.

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

Table 63-IpUniIngressBwpIpvcEpCos Service Attributes

12.2.5 IpUniIngressBwpAccessLink

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[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 64-IpUniIngressBwpAccessLink Service Attributes

12.2.6 IpUniIngressBwpIpvcEpAccessLink

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[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 65-IpUniIngressIpvcEpBwpAccessLink Service Attributes

12.2.7 IpUniIngressBwpIpvcEpCosAccessLink

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[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	EndPointIdentifierAnd CosName	1..*	IPVC End Point and CoS Identifier. Reference MEF 61.1 Table 28.

Table 66-IpUniIngressBwpIpvcEpCosAccessLink Service Attributes

12.3 UNI Egress Bandwidth Profile Envelope Model

The following section details the UNI Egress Bandwidth Profile Envelope model as defined in MEF 61.1[1] Section 12.5. Note that the tables below do not repeat inherited attributes from superclasses.

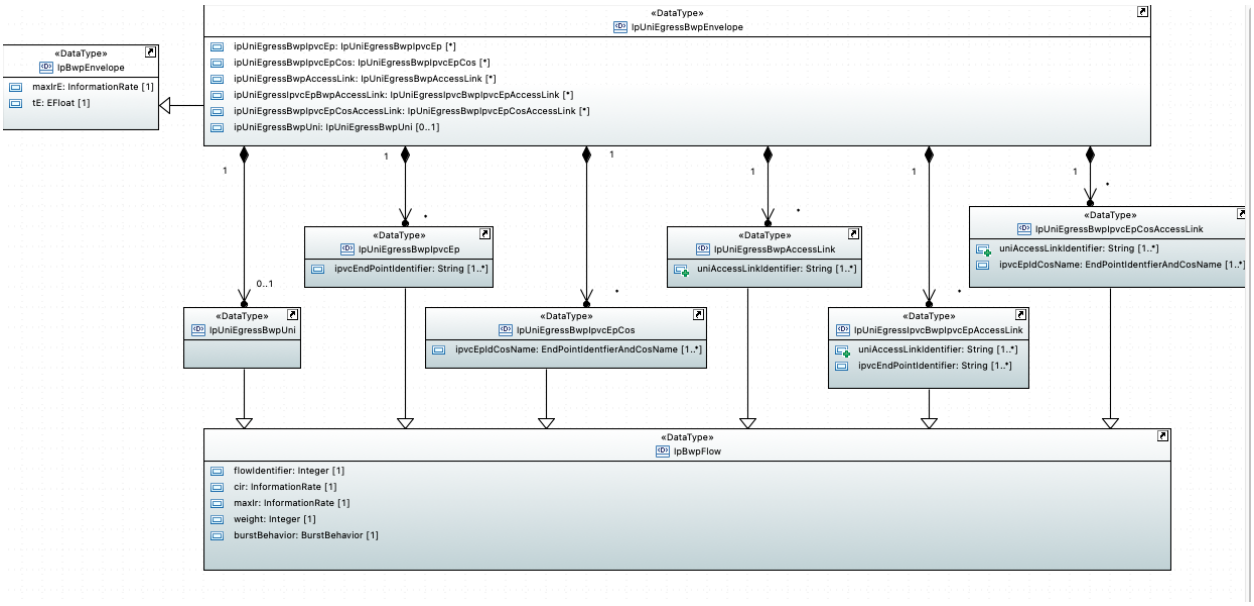

Figure 33-UNI Egress BWP Envelope Model

12.3.1 IpUniEgressBwpEnvelope

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[1] Section 12.5 UNI Egress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipUniEgressBwpUni	IpUniEgressBwpUni	0..1	Pointer to IpUniEgressBwpUni
ipUniEgressBwpIpvcEp	IpUniEgressBwpIpvcEp	0.. *	Pointer to IpUniEgressBwpIpvcEp
ipUniEgressBwpIpvcEpCos	IpUniEgressBwpIpvcEpCos	0.. *	Pointer to IpUniEgressBwpIpvcEpCos
ipUniEgressBwpAccessLink	IpUniEgressBwpAccessLink	0.. *	Pointer to IpUniEgressBwpAccessLink
ipUniEgressIpvcBwpEpAccessLink	IpUniEgressIpvcEpBwpAccessLink	0.. *	Pointer to IpUniEgressIpvcEpBwpAccessLink
ipUniEgressBwpIpvcEpCosAccessLink	IpUniEgressBwpIpvcEpCosAccessLink	0.. *	Pointer to IpUniEgressBwpIpvcEpCosAccessLink

Table 67-IpUniEgressBwpEnvelope Service Attributes

12.3.2 IpUniEgressBwp

All Egress IP Data Packets at the UNI. Reference MEF 61.1[1] Section 12.4 UNI Egress BWP Envelope. NOTE: No attributes are needed.

12.3.3 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[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 68-IpUniEgressBwpIpvcEp Service Attributes

12.3.4 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[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 69-IpUniEgressBwpIpvcEpCos Service Attributes

12.3.5 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[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 70-IpUniEgressAccessLink Service Attributes

12.3.6 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[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 71-IpUniEgressIpvcEpBwpAccessLink Service Attributes

12.3.7 IpUniEgressBwpIpvcEpCosAccessLink

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[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 72-IpUniEgressBwpIpvcEpCosAccessLink Service Attributes

12.4 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[1] Section 13.10. Note that the tables below do not repeat inherited attributes from superclasses.

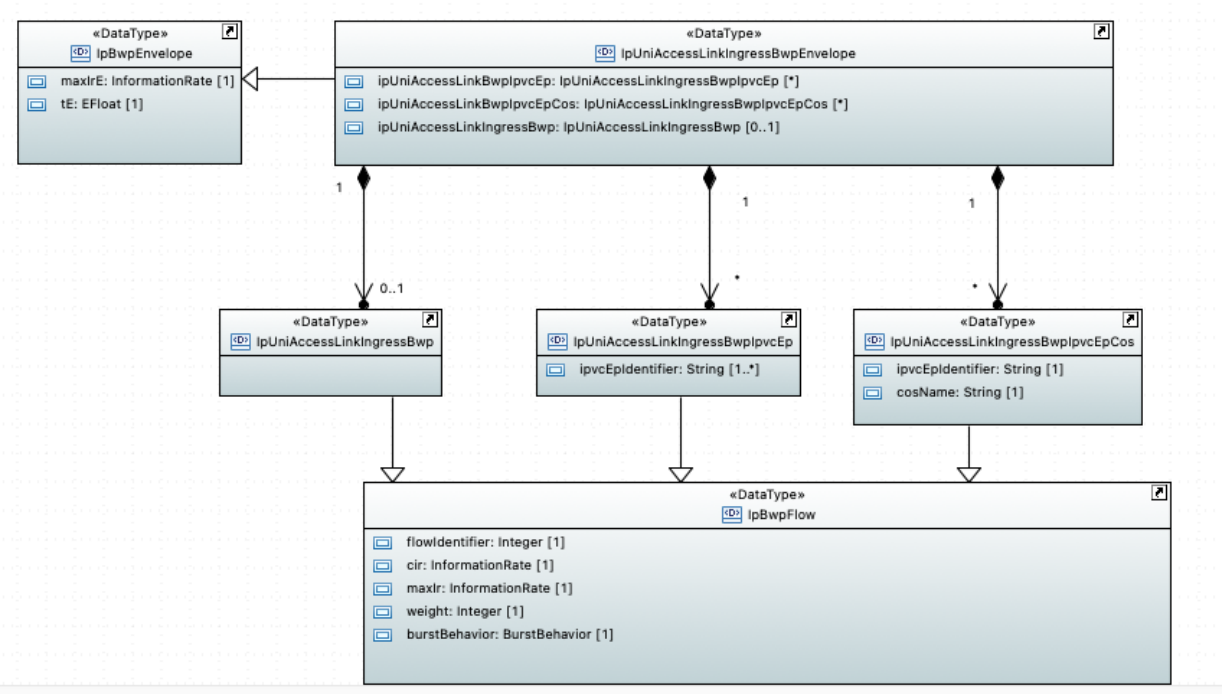

Figure 34-UNI Access Link Ingress BWP Envelope Model

12.4.1 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[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.
ipUniAccessLinkBwpIpvcEp	IpUniAccessLinkIngressBwpIpvcEp	0.. *	Pointer to IpUniAccessLinkBwpIpvcEp
ipUniAccessLinkBwpIpvcEpCos	IpUniAccessLinkIngressBwpIpvcEpCos	0.. *	Pointer to IpUniAccessLinkBwpIpvcEpCos

Table 73-IpUniAccessLinkIngressBwpEnvelope Service Attributes

12.4.2 IpUniAccessLinkIngressBwp

All Ingress IP Data Packets at the UNI Access Link. Reference MEF 61.1 Reference MEF 61.1[1] Section 13.10 UNI Access Link Ingress BWP Envelope. NOTE: No attributes are needed.

12.4.3 IpUniAccessLinkIngressBwpIpvcEp

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 74-IpUniAccessLinkIngressBwpIpvcEp Service Attributes

12.4.4 IpUniAccessLinkIngressBwpIpvcEpCos

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[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.

Table 75-IpUniAccessLinkIngressBwpIpvcEpCos Service Attributes

12.5 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[1] Section 13.11. Note that the tables below do not repeat inherited attributes from superclasses.

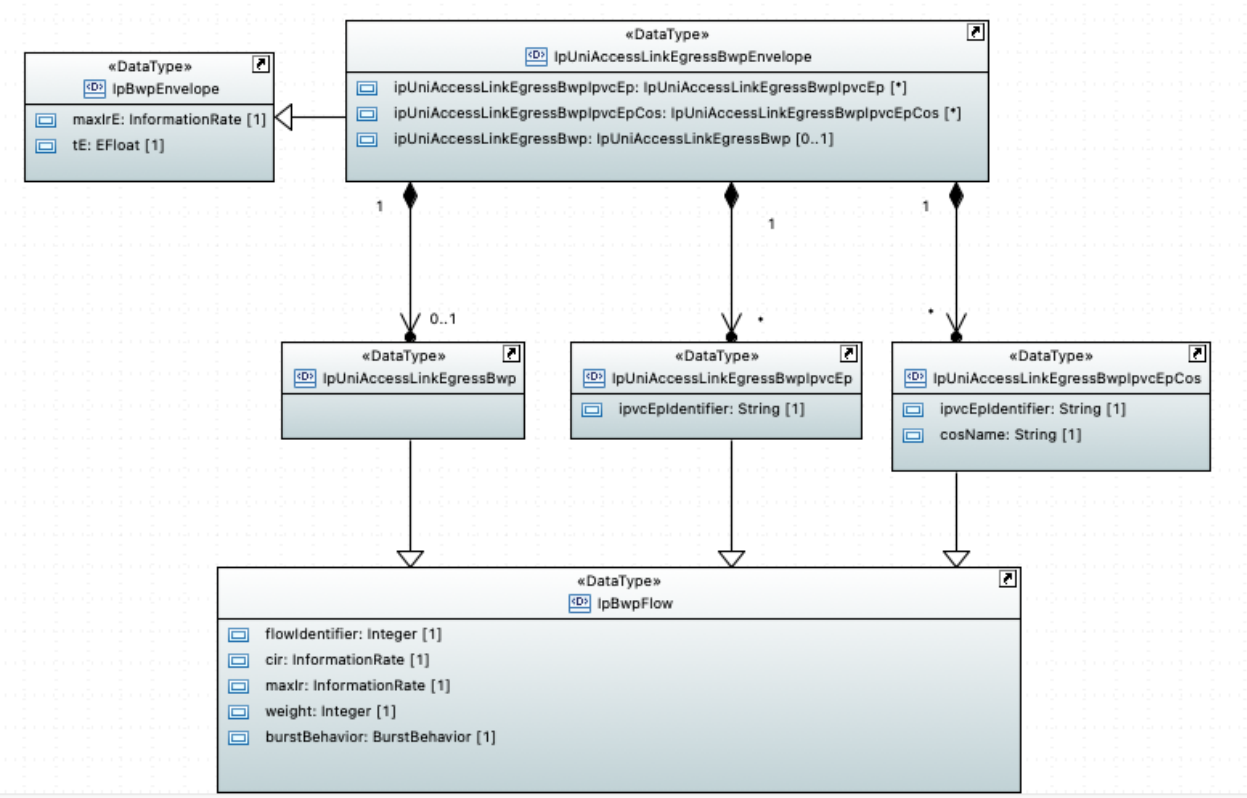

Figure 35-UNI Access Link Egress BWP Envelope Model

12.5.1 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[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.
ipUniAccessLinkEgressBwpIpvcEp	IpUniAccessLinkEgressBwpIpvcEp	0.. *	Pointer to IpUniAccessLinkEgressBwpIpvcEp.
ipUniAccessLinkEgressBwpIpvcEpCos	IpUniAccessLinkEgressBwpIpvcEpCos	0.. *	Pointer to IpUniAccessLinkEgressBwpIpvcEpCos

Table 76-IpUniAccessLinkEgressBwpEnvelope Service Attributes

12.5.2 IpUniAccessLinkEgressBwp

All Egress IP Data Packets at the UNI Access Link. Reference MEF 61.1[1] Reference MEF 61.1[1] Section 13.11 UNI Access Link Egress BWP Envelope. NOTE: No attributes are needed.

12.5.3 IpUniAccessLinkEgressBwpIpvcEp

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 77-IpUniAccessLinkEgressBwpIpvcEp Service Attributes

12.5.4 IpUniAccessLinkEgressBwpIpvcEpCos

Attribute Name	Type	Multiplicity	Description
ipvcEpIdentifier	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 78-IpUniAccessLinkEgressBwpIpvcEpCos Service Attributes

12.6 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[1] Section 14.4. Note that the tables below do not repeat inherited attributes from superclasses.

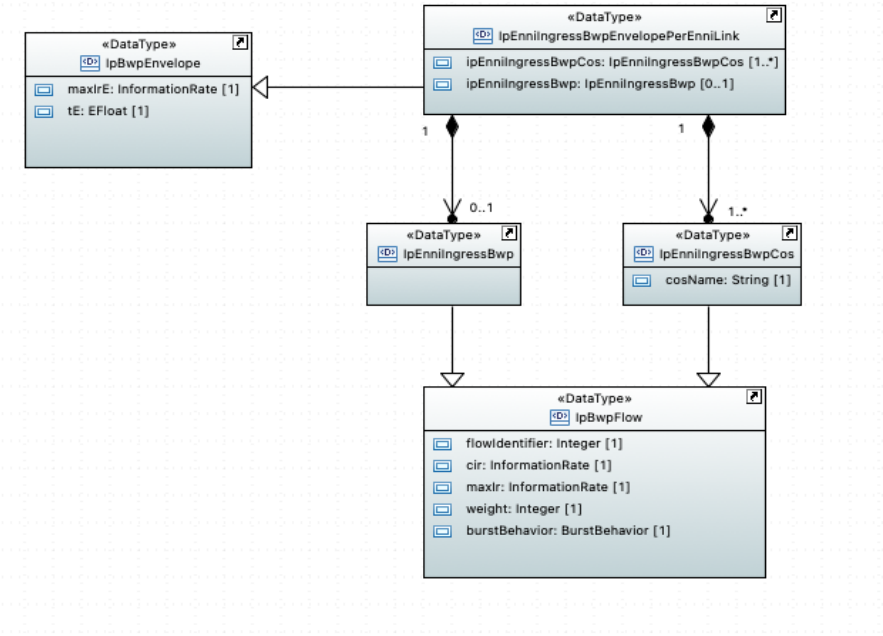

Figure 36-ENNI Ingress BWP Envelope per ENNI Link Model

12.6.1 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[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 79-IpEnniIngressBwpEnvelopePerEnniLink Service Attributes

12.6.2 IpEnniIngressBwp

All Ingress IP Data Packets at the ENNI Access Link. Reference MEF 61.1[1] Section 14.4. NOTE: No attributes are needed.

12.6.3 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[1] Section 14.4.

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

Table 80-IpEnniIngressBwpCos Attributes

12.7 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[1] Section 14.5. Note that the tables below do not repeat inherited attributes from superclasses.

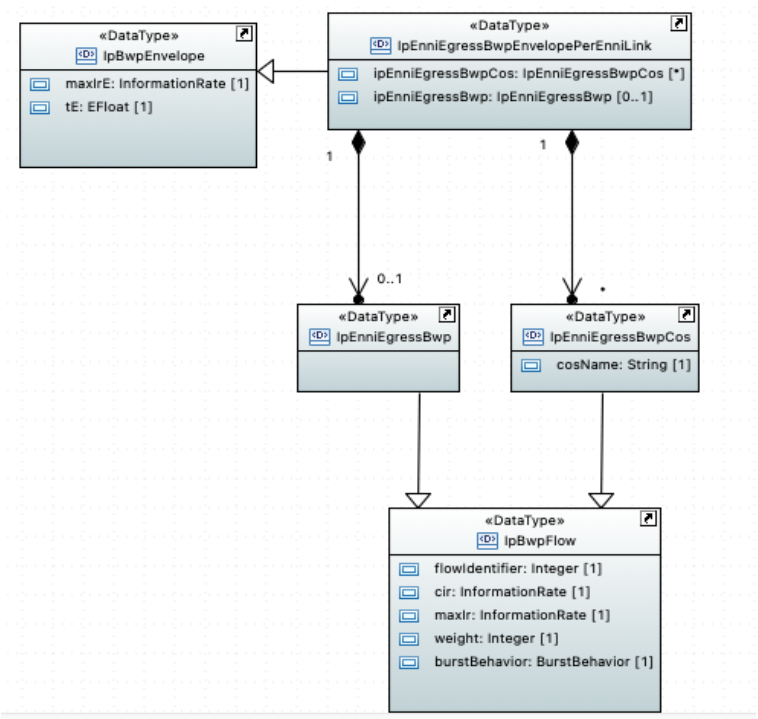

Figure 37-ENNI Egress BWP Envelope per ENNI Link Model

12.7.1 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[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 81-IpEnniEgressBwpEnvelopePerEnniLink Attributes

12.7.2 IpEnniEgressBwp

All Egress IP Data Packets at the ENNI Access Link. Reference MEF 61.1[1] Section 14.5. NOTE: No attributes are needed.

12.7.3 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[1] Section 14.5.

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

Table 82-IpEnniEgressBwpCos Attributes

12.8 IPVC End Point Ingress Bandwidth Profile Envelope Model

The following section details the IPVC End Point Ingress Bandwidth Profile Envelope model as defined in MEF 61.1[1] Section 11.11. Note that the tables below do not repeat inherited attributes from superclasses.

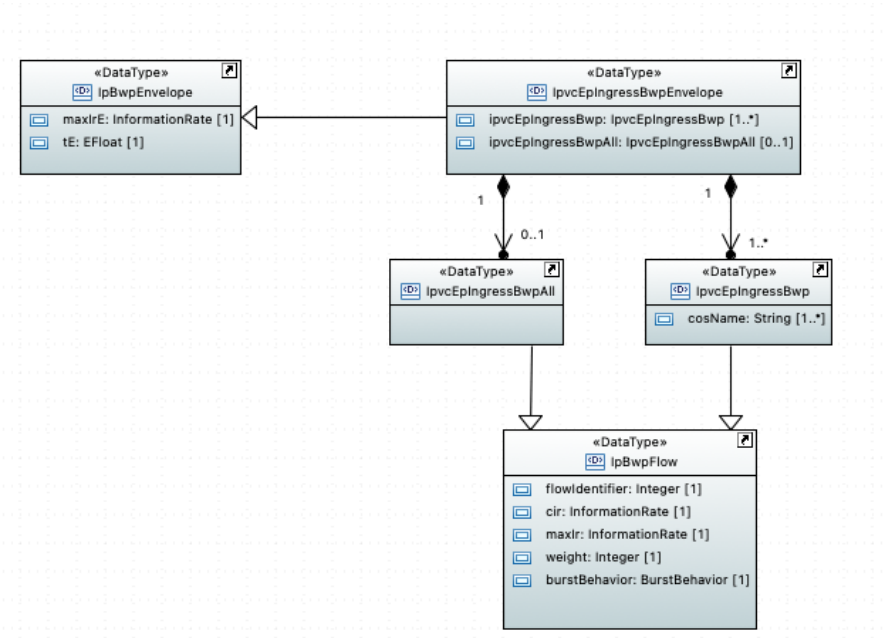

Figure 38-IPVC EP Ingress BWP Envelope Model

12.8.1 IpvcEpIngressBwpEnvelope

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[1] Section 11.11 IPVC EP Ingress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipvcEpIngressBwpAll	IpvcEpIngressBwpAll	0..1	Pointer to IpvcEpIngressBwpAll.
ipvcEpIngressBwp	IpvcEpIngressBwp	1.. *	Pointer to IpvcEpIngressBwp.

Table 83-IpvcEpIngressBwpEnvelopeAttributes

12.8.2 IpvcEpIngressBwpAll

A single Bandwidth Profile Envelope consisting of parameters and Bandwidth Profile specification applied to all ingress IP Packets. Reference MEF 61.1[1] Section 11.11. NOTE: No attributes are needed.

12.8.3 IpvcEpIngressBwp

An Ingress 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 84-IpvcEpIngressBwpAttributes

12.9 IPVC End Point Egress Bandwidth Profile Envelope Model

The following section details the IPVC End Point Egress Bandwidth Profile Envelope model as defined in MEF 61.1[1] Section 11.12. Note that the tables below do not repeat inherited attributes from superclasses.

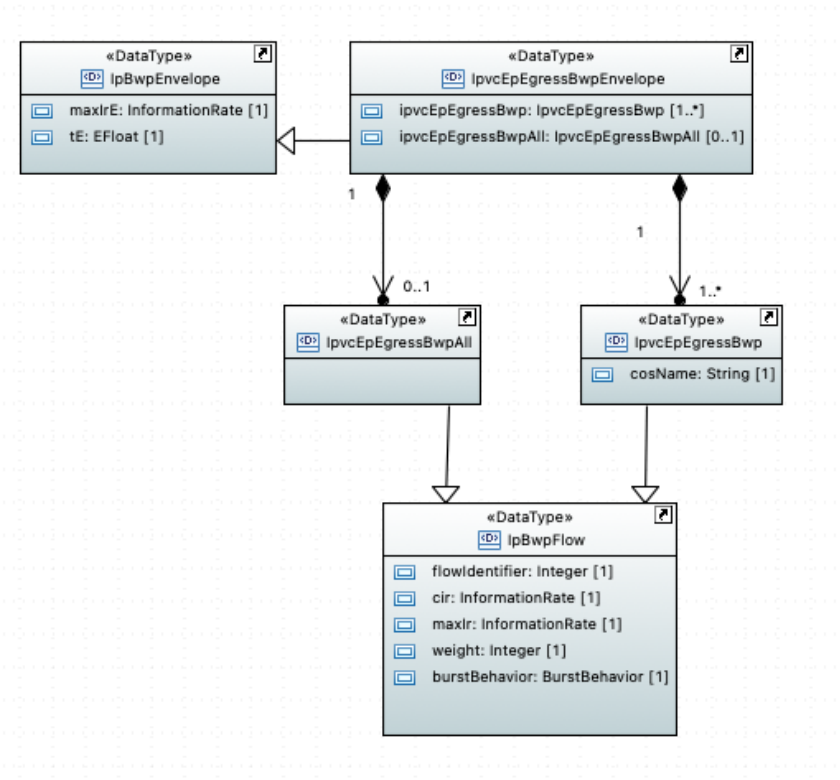

Figure 39-IPVC EP Egress BWP Envelope Model

12.9.1 IpvcEpEgressBwpEnvelope

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[1] Section 11.11 IPVC EP Egress Bandwidth Profile Envelope Service Attribute.

Attribute Name	Type	Multiplicity	Description
ipvcEpEgressBwpAll	IpvcEpEgressBwpAll	0..1	Pointer to IpvcEpEgressBwpAll
ipvcEpEgressBwp	IpvcEpEgressBwp	1.. *	Pointer to IpvcEpEgressBwp

Table 85-IpvcEpEgressBwpEnvelope Attributes

12.9.2 IpvcEpEgressBwpAll

All Egress IP Data Packets at the IPVC End Point. Reference MEF 61.1[1] Section 11.12. NOTE: No attributes are needed.

12.9.3 IpvcEpEgressBwp

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 86-IpvcEpEgressBwp Attributes

13 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[1] Section 10.9 IPVC Service Level Specification Service Attribute.

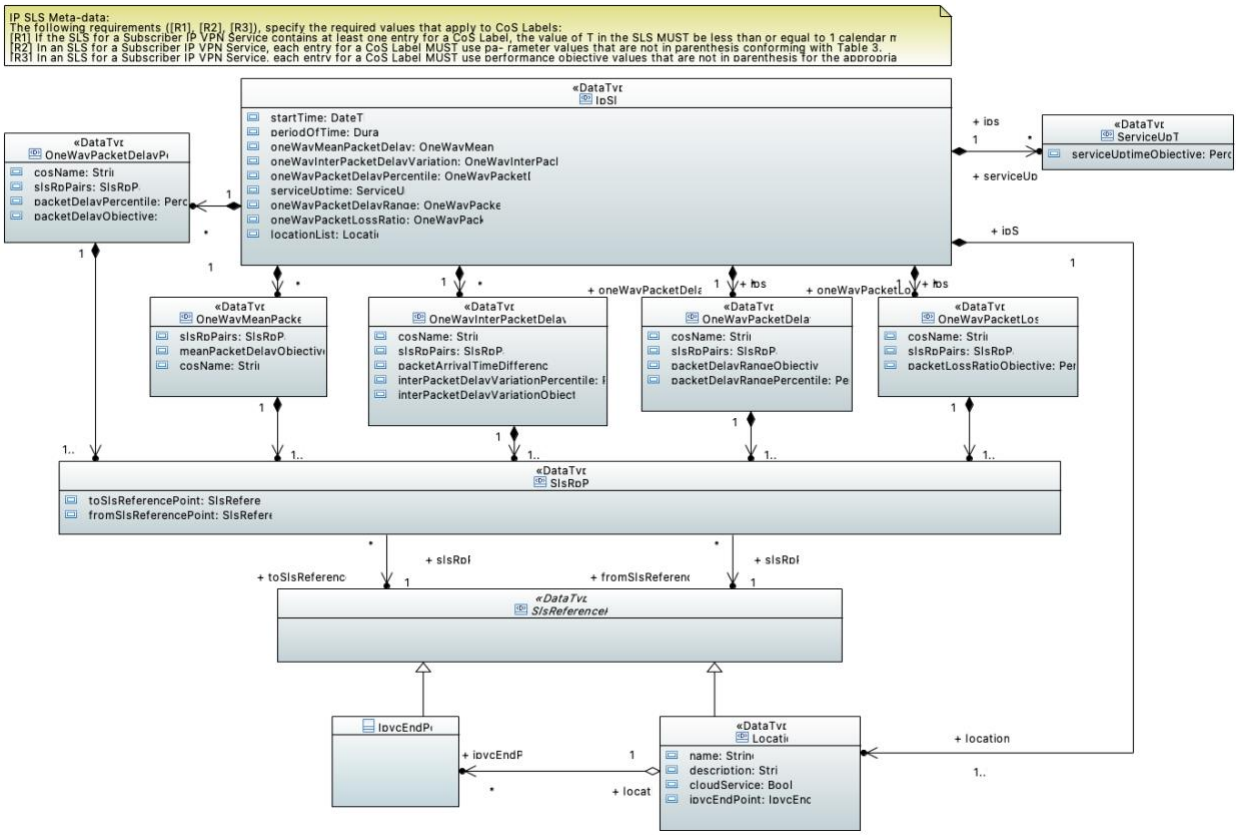

Figure 40-IP Service Level Specification Model

13.1 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[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.
locationList	Location	1..*	Pointer to (L)ocation list.

Table 87-IpSls Attributes

13.2 Additional Rules:

The following requirements ([R1], [R2], [R3]), specify the required values that apply to CoS Labels:

1. [R1] 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.
2. [R2] 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.
3. [R3] 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.

13.3 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.
ipvcEndPoint	IpvcEndPoint	0..*	Pointer to IPVC End Point

Table 88-Location Service Attributes

13.4 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 vth 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 Tk. Reference MEF 61.1[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	Real	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.
slsRpPairs	SlsRpPair	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	Real	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 89-OneWayInterPacketDelay Variation Service Attributes

13.5 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 Tk. Reference MEF 61.1[1] Section 10.9.5 One-way Mean Packet Delay 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 10.9.5 One-way Mean Packet Delay Performance Metric, Table-5.
meanPacketDelayObjective	Real	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.

Table 90-OneWayMeanPacketDelay Service Attributes

13.6 OneWayPacketDelayPercentile

The One-way Packet Delay Percentile Performance Metric is the maximum, over all the order pairs of SLS-RPs in a given set S, of the pth percentile of one-way packet delay for Qualified Packets for a given order pair of SLS-RPs, a given CoS Name and a given time period Tk. Reference MEF 61.1[1] Section 10.9.4 One-way Packet Delay Percentile 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 10.9.4 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	Real	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 91-OneWayPacketDelayPercentile Service Attributes

13.7 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[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	Real	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 92-OneWayPacketDelayRange Service Attributes

13.8 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[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 93-OneWayPacketLossRatio Service Attributes

13.9 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 94-ServiceUpTime Service Attributes

13.10 SlsReferencePoint

SlsReferencePoint is an abstract data type that can be subclassed to IpvcEndPoint and Location. Reference MEF 61.1[1] Section 10.9.1 SLS Reference Points.

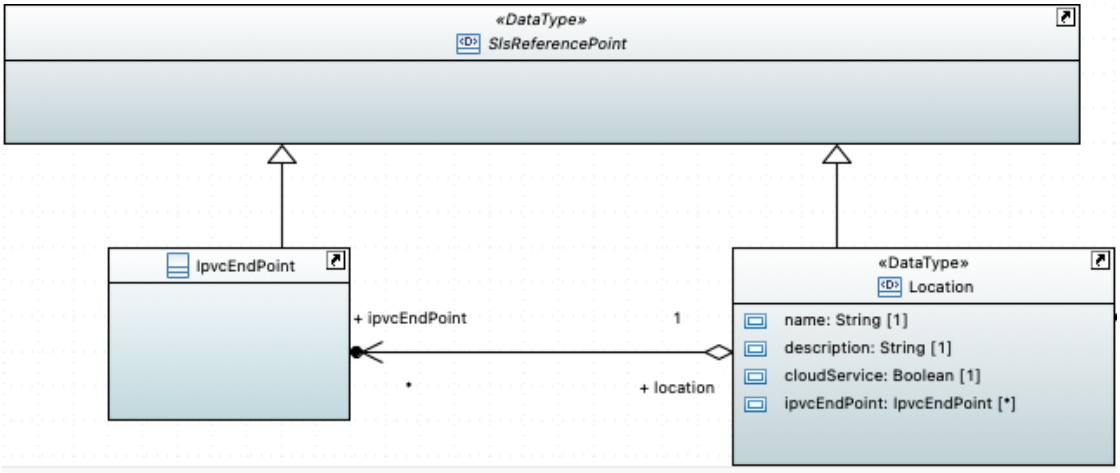

Figure 41-SlsReferencePoint Model

13.11 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 EP to another. The SlsRpPair is a representation of this association. Reference MEF 61.1[1] Section 10.9.1 SLS Reference Points.

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 95-SlsRpPair Service Attributes

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