



MEF W100 v0.2

LSO Legato SD-WAN Service Schemas and Developer Guide

June 2023

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1 List of Contributing Members

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

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

2 Abstract

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

This document can be thought of as a developer's guide for the SD-WAN Services Data Model and the schemas provided that embody the Data Model. MEF Services are described by a set of Service Attributes. Each Service Attribute describes an aspect of the service that is agreed between the provider and the user of the service. The document that describes the Service Attributes for SD-WAN Services is MEF 70.1 [7].

This Standard normatively incorporates the following files by reference as if they were part of this document, from GitHub repository https://github.com/MEF-GIT/MEF-LSO/tree/develop_sdwan/schema/serviceSchema/sdwan.

3 Terminology and Abbreviations

This section defines the terms used in this document. In many cases, the normative definitions of terms are found in other documents. In these cases, the third column is used to provide the reference that is controlling, in other MEF or external documents. If the reference includes an asterisk (*), the definition has been adapted from the original.

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

Term	Definition	Reference
SOF	See Service Orchestration Functionality	MEF 55.1 [6]

Table 1-Terminology and Abbreviations

4 Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 (RFC 2119 [2], RFC 8174 [5]) when, and only when, they appear in all capitals, as shown here. All key words must be in bold text.

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

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5 Numerical Prefixes

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

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

Table 2-Numerical Prefix Conventions

6 Introduction

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

An SD-WAN Service provides a virtual overlay network that enables application-aware, policy-driven, and orchestrated connectivity between SD-WAN User Network Interfaces (UNIs) and provides the logical construct of a L3 Virtual Private Router Network for a Subscriber that conveys IP Packets between Subscriber as defined in MEF 70.1[7].

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

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

The Data Model for SD-WAN Services includes resource representations for:

- SD-WAN Virtual Connection End Point: A logical entity at an External Interface (EI), to which a subset of packets that traverse the EI is mapped.
- SD-WAN VC: A SD-WAN Service is formed of an SD-WAN Virtual Connection (SD-WAN VC) that links together SD-WAN VC End Points at EIs.
- SD-WAN UNI: A User Network Interface (UNI) is a demarcation point between the responsibility of the SP and the responsibility of the Subscriber. Note that a given UNI always relates to a single SP and a single Subscriber.

The document contains the following sections:

An overview of LSO Legato (Section 7)

An overview of SD-WAN Services Model (Section 8)

An overview of SD-WAN Services (Section 9)

Data Model Design Principles and Assumptions (Section 10)

Data Modes for SD-WAN Services (Section 11)

Relationship between the Entities (Section 12)

- 439 SD-WAN Service Data Model (Section 13)
- 440 Common Classes and Types (Section 14)

7 Overview of LSO Legato

MEF 55.1 [6] describes the Reference Architecture for Lifecycle Service Orchestration (LSO) of MEF-defined connectivity services. MEF 55 defines seven LSO Reference Points that are abstract interconnection points between different domains - either within the service provider domain (intra-domain) or between service provider and other business entities (inter-domain). One of these LSO Reference Points is LSO Legato which defines the abstract boundary point between a Service Provider's or Partner's Business Application (BA) and Service Orchestration Functionality (SOF) for providing connectivity services provisioning.

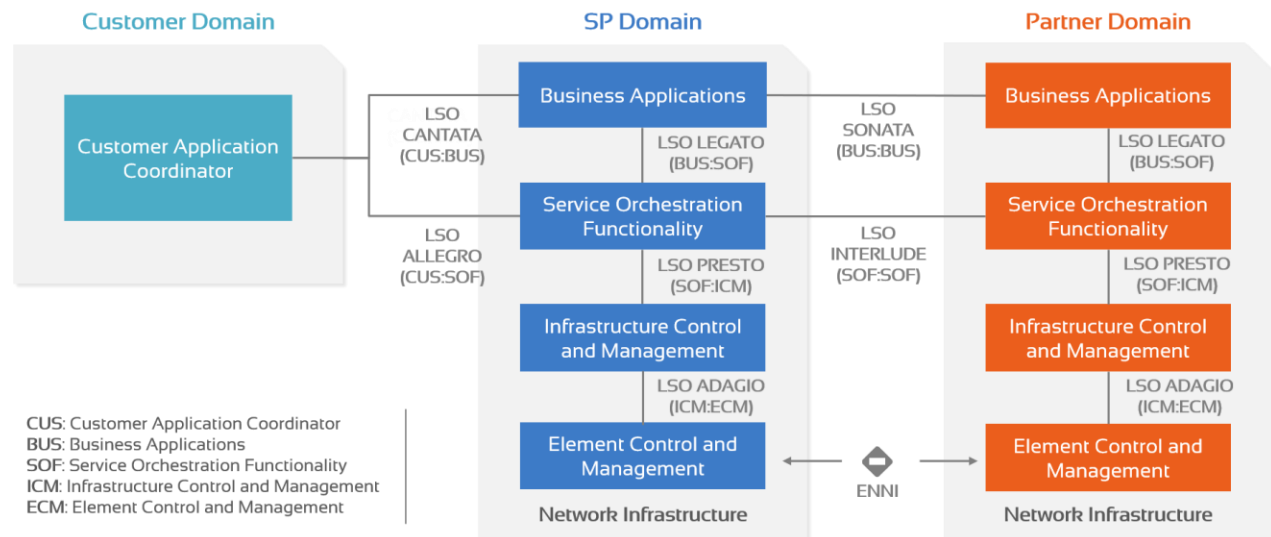


Figure 1-LSO Reference Diagram

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

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

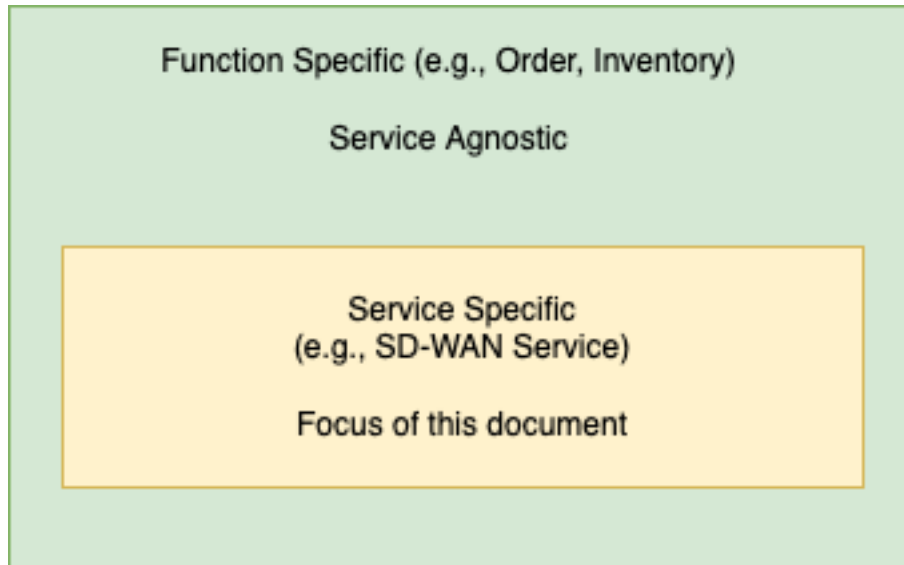


Figure 2-LSO Legato API Structure

This document defines the service-specific payload, shown as JSON Data Model in Figure 2, specifically for SD-WAN Services as defined in MEF 70.2 [7]. The envelope resources of the API and association to specific payload resources will be discussed in detail later in this document.

8 Overview SD-WAN Services Model

The SD-WAN Services model has three main datatypes, SwVc, SdWanUni, and SwVcEndPoint. An SD-WAN Service is an overlay service that operates over one or more Underlay Connectivity Services (UCSs). An SD-WAN Service is defined as having an SwVc and two or more SwVcEndPoints.

A SdWanUni is the demarcation point between the responsibility of the SP and the responsibility of the Subscriber. A SdWanUni is the demarcation point between the responsibility of the SP and the responsibility of the Subscriber. A UCS has three main classes, Ucs, UcsUni and UcsEndPoint. Figure 3 shows the overview SD-WAN Services Model including the main datatypes for SD-WAN and UCS. Further details for SD-WAN and UCS will be provided in this document.

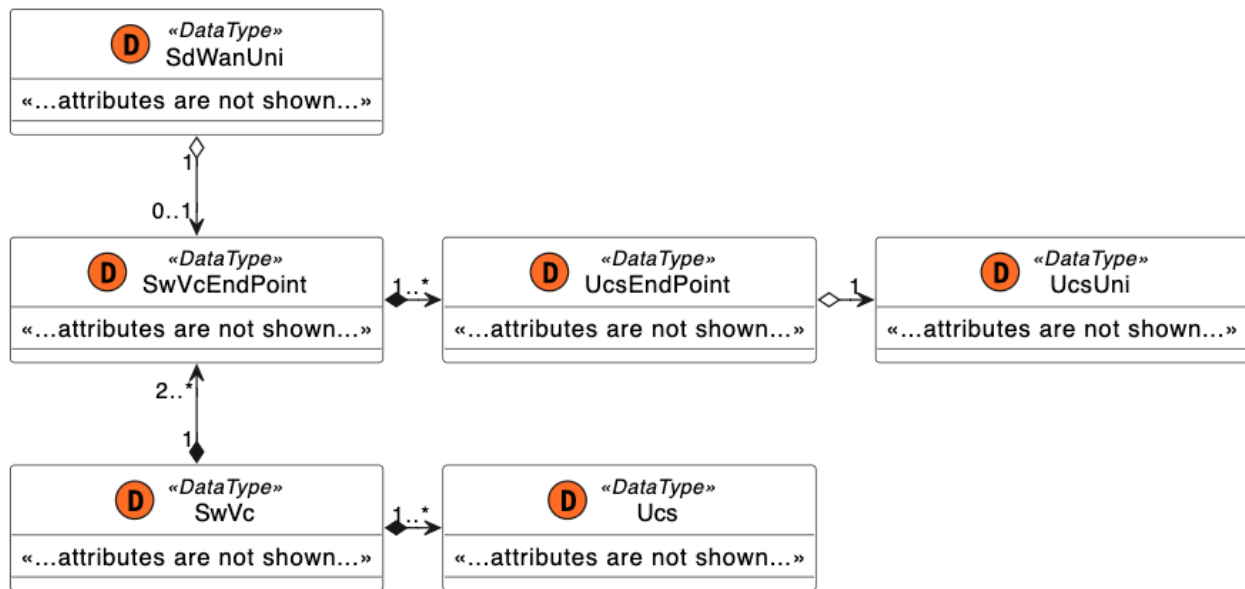


Figure 3-SD-WAN and UCS Service Model Overview

9 Data Model Design Principles and Assumptions

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

- **Mandatory** – attributes that must be provided by the Client in a Service Order request or must be returned by the SOF for an Inventory request as specified in Section 9.1.1414
- **Optional** – attributes that may be provided by the Client in a Service Order request and may be returned by the SOF for an Inventory request as specified in Section 9.2.
- **Fixed** – attributes that are hard coded and may be specified by the Client in a Service Order request and may be returned by the SOF for an Inventory request as specified in Section 9.3.

As noted above, the classification may depend on:

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

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

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

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

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

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

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

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

The SD-WAN Service data model supports both INSTALL and CHANGE actions for Service Order for SD-WAN VC, SD-WAN UNI, and SD-WAN VC End Point. The SD-WAN Service data model supports the RETRIEVE action for Inventory for all Service Order components.

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

9.1 Mandatory Service-Specific Attributes

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

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

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

9.2 Optional Service-Specific Attributes

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

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

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

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

9.3 Fixed Service-Specific Attributes

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

- the SOF supports only a single value, or

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

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

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

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

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

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

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

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

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

10 Data Models for SD-WAN Services

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

10.1 Organization and Structure of the Schemas

The schemas are organized into a file structure as shown in Figure 4-Schema Files Organization.

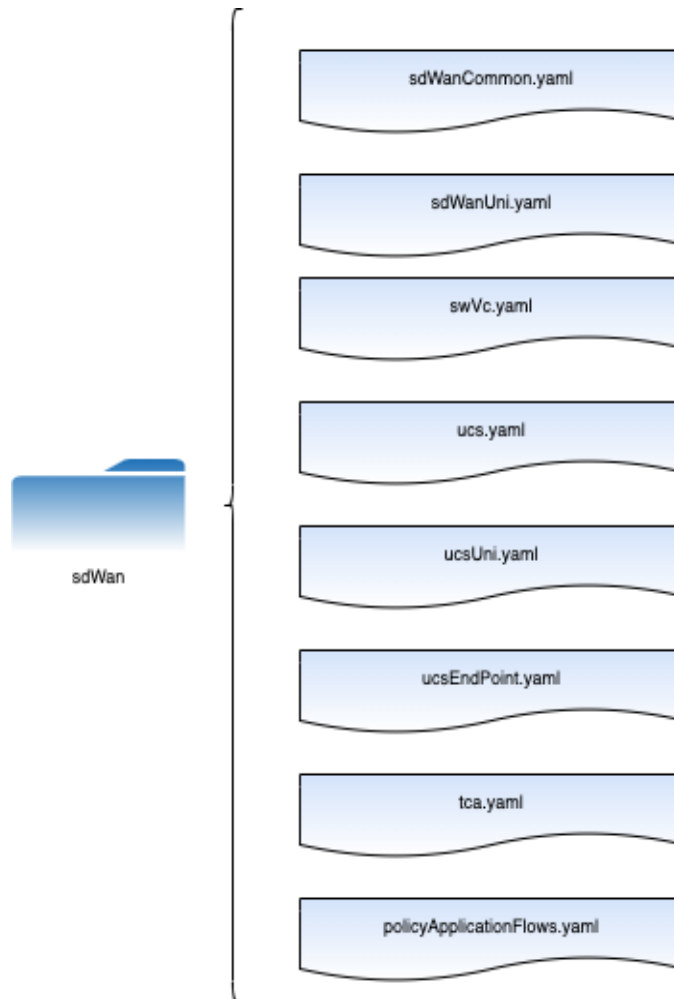


Figure 4-Schema Files Organization

SD-WAN schemas are put into a common directory. In the case of the IP – all components are manageable as a single service. Ipvc, IpUni, and IpUniAccessLink are considered separate Subscriber IP services thus ordering a full configuration would require providing 3 separate Service Order Items in the request.

There is 1 file that provide common classes that are shared with multiple products:

- ip/sdWanCommon.yaml – provides classes shared among all SD-WAN services.

These common classes are referenced in the relevant product component schema files. For example the **Ipv4.reservedPrefixes** attribute specified in Ipv4.yaml file refers to common **Ipv4Ipv6Prefixes** definition:

```
reservedPrefixes:
```

```
  description: >-
```

```
    Reference MEF 61.1 Section 10.14 IPVC Reserved Prefixes Service Attribute.
```

```
    For Advanced Internet Access the prefixes must be either empty, or free
```

```
    from any public address pre-fixes. (Reference MEF 69.1 Section 9.1 [R14])
```

```
  $ref: "./ipCommon.yaml#/definitions/Ipv4Ipv6Prefixes"
```

On a CHANGE request a single Service Attribute cannot be changed. The Buyer must send a full service configuration including all Mandatory Service Attributes (0) and all Optional Service Attributes (9.2) that were previously specified by the Client (in an INSTALL request or previous CHANGE request). Any Optional Service Attributes that are not specified in a CHANGE request are reset to their default value.

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

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

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

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

10.2 Additional Details

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

10.2.1 Naming Conventions

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

11 Relationships Between Entities

This section describes the constraints and relationships between the primary Service Order Items (SD-WAN Virtual Connection, SD-WAN Virtual Connection EndPoint and SD-WAN UNI) for SD-WAN services. Secondly, additional Service Order Items include Underlay Connectivity Service, Underlay Connectivity Service EndPoint and Underlay UNI which provide the Underlay Connectivity Service(s) for SD-WAN Services. Additional Service Order Item candidates associated with SD-WAN Virtual Connection include Application Flows and Policy Maps.

The SD-WAN Service is associated with exactly one IPVC, The IPVC is associated with two or more SD-WAN Virtual Connection End Points. The SD-WAN UNI is associated with an SD-WAN Virtual Connection End Point. Figure 5 illustrates the Service-agnostic Service Order with several Service Order Items and their Service-specific relationship to a SD-WAN Service.

A Service Order is composed of one or more Service Order Items. This is supported in the service-agnostic part of the Service Order API. The service-specific payload (SD-WAN Services) is where the main components are supported as part of SD-WAN Service Schemas. Each Service Order Item is then associated with a service-specific orderable component (i.e., SwVc) which is within the payload. **Błąd! Nie można odnaleźć źródła odwołania.**

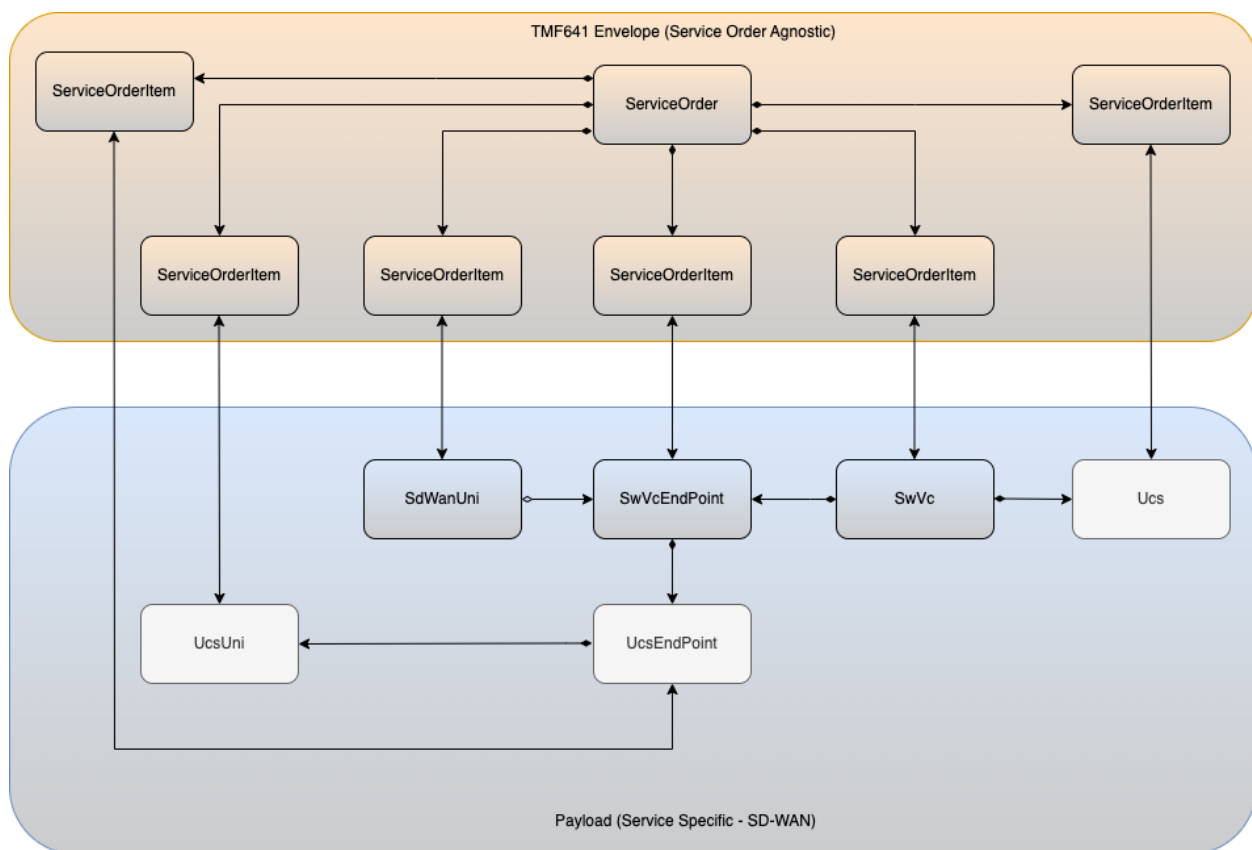


Figure 5-SD-WAN and UCS Service Order API Associations

The relationship between separately managed service is captured in the service-agnostic part of the Order API. The values in the Relationship Type column in the table below are used in the *relationshipType* field of the *ServiceRelationship*, and *OrderItemRelationship* types.

Source Service Resource	Relationship Role	Cardinality	Target Service Resource
SwVcEndPoint	ENDPOINT_OF_SWVC	1..*	SwVc
SwVc	SECURITY_POLICY_OF_SWVC	0..*	SecurityPolicyMap
SwVc	POLICY_OF_SWVC	0..*	PolicyMap
SwVc	APPLICATION_FLOW_OF_SWVC	0..*	ApplicationFlow
SwVcEndPoint	CONNECTS_TO_SDWAN_UNI	0..*	SdWanUni
SwVc	UCS_OF_SWVC	0..*	Ucs
UcsEndPoint	ENDPOINT_OF_UCS	0..*	Ucs
UcsEndPoint	CONNECTS_TO_UCS_UNI	0..*	UcsUni

Table 3-SD-WAN Service and UCS Relationship Roles

- [R18]** For an SD-WAN Service, the Relationship Type field of the Service Relationship Order Item Relationship types **MUST** contain the value shown in the Relationship Type column in Table 4-Place Relationship Role.
- [R19]** For Order, the relationship to a UNI **MUST** be specified for every INSTALL of, or CHANGE to, an IP IPVC services.
- [R20]** For an IP Access UNI Access Link services, the relationship to a UNI **MUST** reference an IP UNI service or an equivalent Order Item.
- [R21]** For a CHANGE to UNI Access Link service the relationship to the UNI **MUST NOT** be changed from the value present in the Service Inventory.

Service	Place Relationship Role	INSTALL	CHANGE
SdWanUni	INSTALL_LOCATION	Mandatory	Mandatory

Table 4-Place Relationship Role

- [R22] For IP UNI products, the Role field (*role*) of the Related Place (*RelatedPlaceRefOrValue*) type **MUST** contain the INSTALL_LOCATION value shown in the Place Relationship Role column in **Błąd! Nie można odnaleźć źródła odwołania..**
- [R23] For Order, the Related Place (*RelatedPlaceRefOrValue*) **MUST** be specified for every INSTALL of, or CHANGE to, an IP UNI.
- [R24] For a CHANGE to a UNI product the Related Place **MUST NOT** be changed from the value present in the Service Inventory.

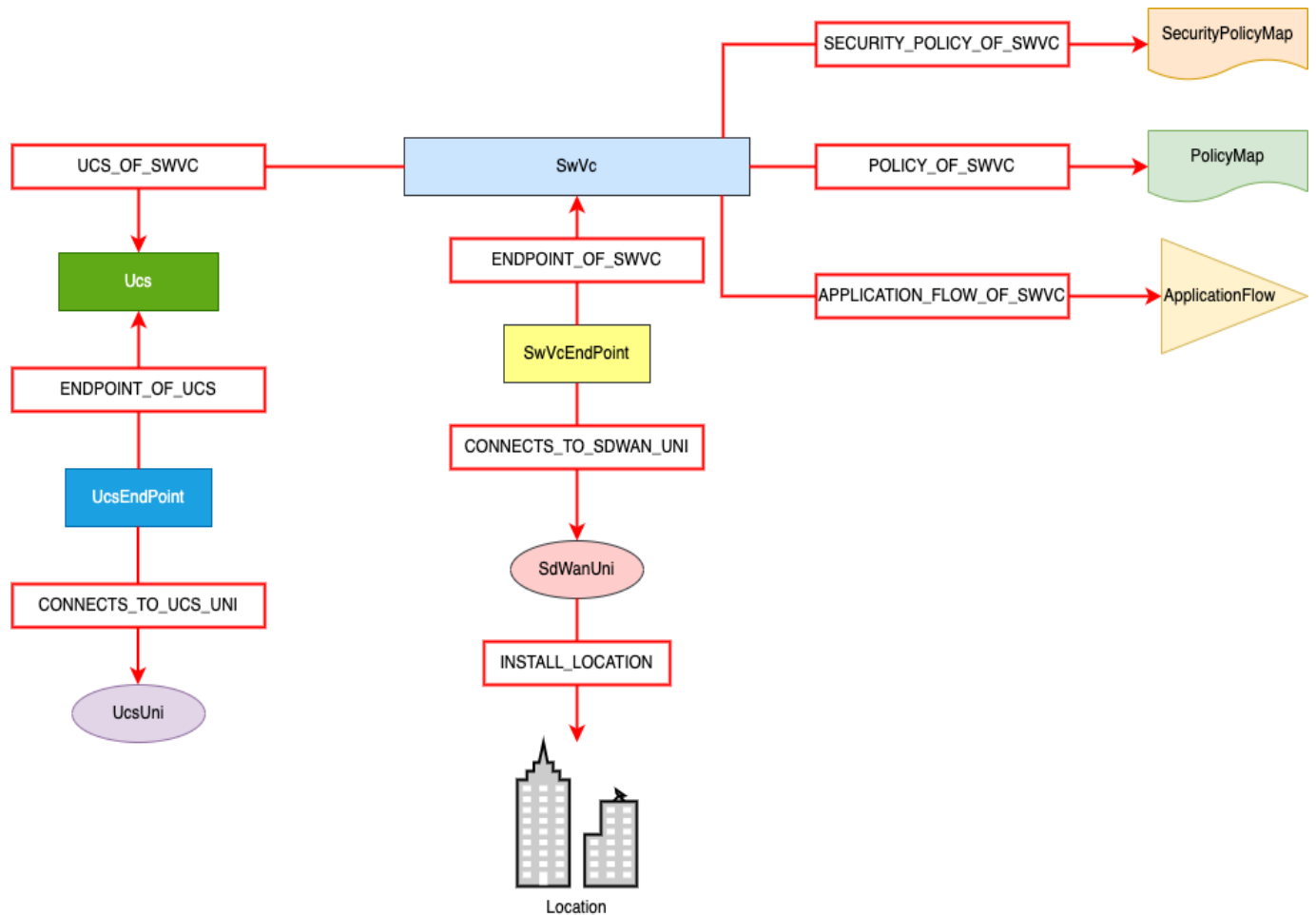


Figure 6-SD-WAN and UCS Service Relationships

12 SD-WAN Services Data Model

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

The Service Attributes are listed in groups:

- SD-WAN Services:
 - SwVc
 - SwvcEndPoint
 - SdwanUni

12.1 SwVc

An association of SD-WAN Virtual Connection End Points in an SD-WAN Service that provides the logical construct of a L3 Virtual Private Routed Network for a Subscriber. SwVc is a resource that represents a SD-WAN Virtual Connection. Reference MEF 70.2 Section 9 SD-WAN Virtual Connection (SWVC) Service Attribute.

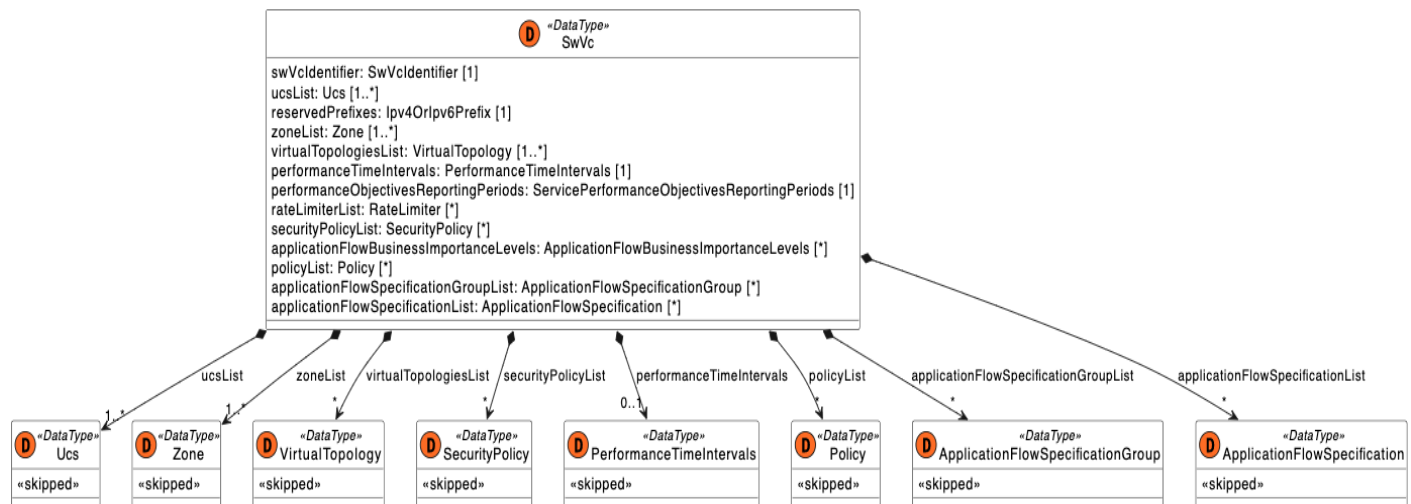


Figure 7-SwVc Service Model

Schema File Name: sdWan/swVc.yaml

Specified Service: SD-WAN VC			
\$id: urn:mef:iso:spec:legato:swVc:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
swVcIdentifier	SwVcIdentifier	1	Identification of the SWVC for management purposes. Reference MEF 70.2, Section 9.1 SWVC Identifier Service Attribute.
ucsList	Ucs	1..*	A list of the Underlay Connectivity Services that are used by SWVC. A non-empty list of UCS Identifiers. Reference MEF 70.2 Section 9.3 SWVC List of UCSs Service Attribute.
reservedPrefixes	Ipv4OrIpv6Prefix	0..*	Specifies a list of IPv6 Prefixes that the Service Provider reserves for use for the SWVC within their own network or for distribution to the Subscriber via DHCP or SLAAC. Reference MEF 70.2 Section 9.4 SWVC Reserved Prefixes Service Attribute.
zoneList	Zone	1..*	A list of the Zones supported at one or more UNIs in the SD-WAN Service and Zone-wide Policies associated with the Zones. Reference MEF 70.2 Section 9.5 SWVC List of Zones Service Attribute.
virtualTopologiesList	VirtualTopology	1..*	A list of named Virtual Topologies of the form of a 3-tuple <vtName,vtType,vtEP>. Reference MEF 70.2 Section 9.6 SWVC List of Virtual Topologies Service Attribute.
performanceTimeIntervals	PerformanceTimeInterval	0..1	Time intervals used in the evaluation of the PERFORMANCE Policy Criterion and the Performance Metrics. Reference MEF 70.2 Section 9.7 SWVC

			Performance Time Intervals Service Attribute.
performanceObjectivesReportingPeriods	ServicePerformancePerformanceObjectivesReportingPeriod	0..1	Definition of reporting periods for evaluating Service Performance Objectives. Reference MEF 70.2 Section 9.8 SWVC Service Performance Objectives Reporting Periods Service Attribute.
rateLimiterList	RateLimiter	0..*	<p>A 3-tuple, <name,commit,limit> where:</p> <ul style="list-style-type: none"> * name is an Identifier String that is name of Rate Limiter. * commit is the threshold rate (bits per second) at or below which the SD-WAN Service Provider commits to deliver packets in the Bandwidth Flow with high probability under all traffic conditions. * limit is the threshold information rate (bits per second) above which the Service Provider does not deliver IP Packet in the Bandwidth Flow under any conditions. Reference MEF 70.2 Section 9.9 SWVC List of Rate Limiters Service Attribute.
securityPolicyList	SecurityPolicy	0..*	A list of the Security Policies (defined in MEF 88) that are available for use in this SWVC. Reference MEF 70.2 Section 9.10 SWVC List of Security Policies Service Attribute.
applicationFlowSpecificationGroupList	ApplicationFlowBusinessImportanceLevels	0..*	Specifies and ordered list of labels that can be assigned to Application Flows to indicate the relative importance of each Application Flow. Reference MEF 70.2 Section 9.11 SWVC List of Application

			Flow Business Importance Levels Service Attribute.
policyList	Policy	1..*	A list of the Policies that can be applied to Application Flows carried by the SWVC. Reference MEF 70.1 Section 9.10 SWVC List of Policies Service Attribute.
applicationFlowSpecificationGroupList	ApplicationFlowGroup	0..*	A list (possibly empty) of Application Flow Group names. Reference MEF 70.2 Section 9.13 SWVC List of Application Flow Groups Service Attribute.
applicationFlowSpecificationList	ApplicationFlowSpecification	1..*	Specifies the Application Flows that can be recognized by the SD-WAN Service. Reference MEF 70.2 Section 9.14 SWVC List of Application Flow Specifications Service Attribute.

Table 5-SwVc Service Attributes

12.2 SwVcEndPoint

The SwVcEndPoint is the construct that represents the attachment of an SWVC to a UNI. The SwVcEndPoint provides a container for attributes of the SWVC that can differ at each UNI. Reference MEF 70.2 Section 10 SD-WAN Virtual Connection (SWVC) End Point.

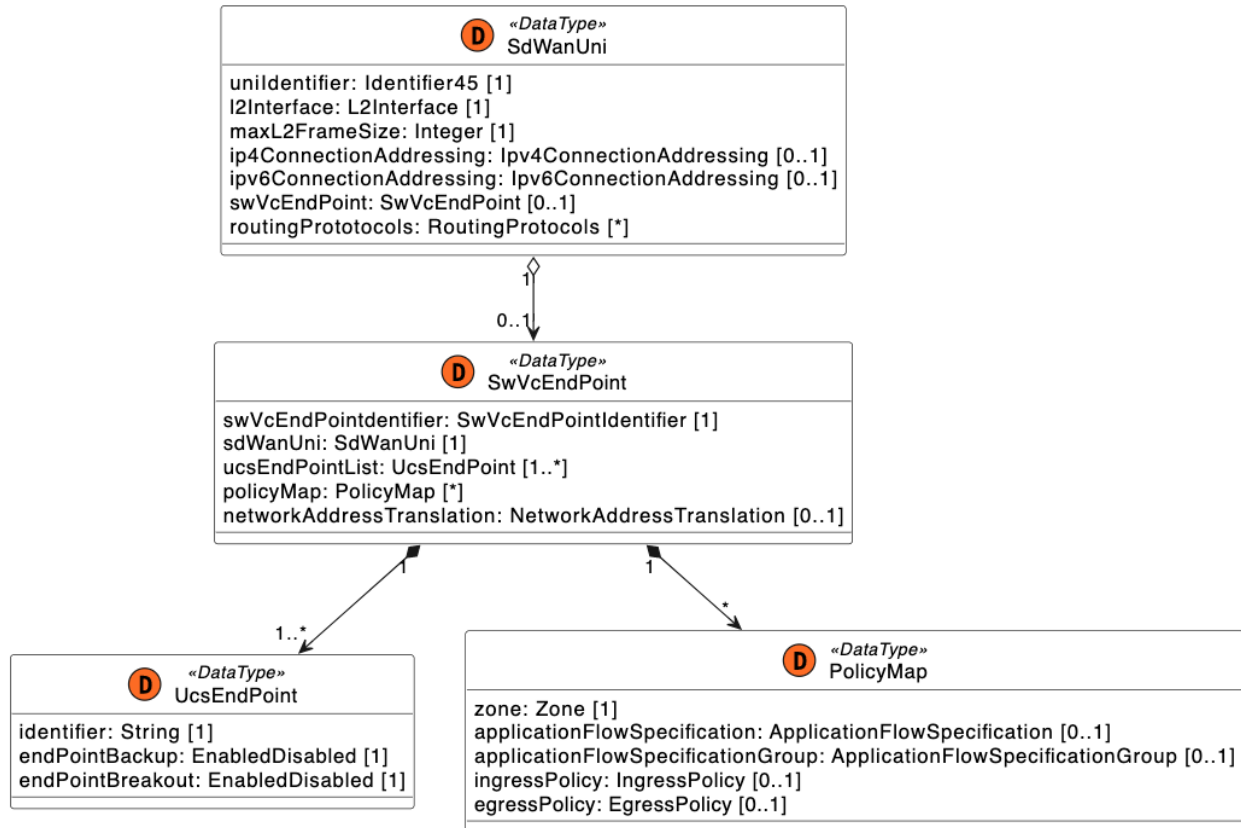


Figure 8-SwVcEndPoint Service Model

Schema File Name: sdWan/swVcEndPoint.yaml			
Specified Service: SD-WAN VC End Point			
\$id: urn:mef:iso:spec:legato:swVcEndPoint:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
swVcEndPointIdentifier	SwVcEndPointIdentifier	1	The value of the SWVC End Point Identifier Service Attribute is a string that is used to allow the Subscriber and Service Provider to uniquely identify the association of the SWVC with a UNI. Reference MEF 70.2 Section 10.1 SWVC End Point Identifier Service Attribute.
policyMap	PolicyMap	0..*	Maps Policies to Application Flows and Application Flow Groups. Reference MEF 70 Section 9.3 SWVC End Point Policy Map.

ucsEndPoint	UcsEndPoint	1..*	Each SWVC End Point has a list of one or more UCS End Points to which it can forward Ingress IP Packets (from the UNI) and from which it can forward Egress IP Packets (towards the UNI). Reference MEF 70 Section 10.3 SWVC End Point List of UCS End Points Service Attribute.
networkAddressTranslation	NetworkAddressTranslation	0..1	When Ingress IP Packets are destined to the Internet via Internet Breakout, the Subscriber might require the SD-WAN Service Provider to perform Network Address Translation (NAT), translating the Subscriber's IP addresses into public IP addresses and vice versa. Reference MEF 70.2 Section 10.5 SWVC End Point Network Address Translation Service Attribute.

Table 6-SwVcEndPoint Service Attributes

12.3 SdWanUni

An SD-WAN User Network Interface, or SD-WAN UNI, is the demarcation point between the responsibility of the Service Provider and the responsibility of the Subscriber. The SD-WAN UNI is on the boundary between the Subscriber Network and the Service Provider Network. The basic unit of transport at the SD-WAN UNI is an IP Packet. Reference MEF 70.2 Section 7.4 SD-WAN UNI.

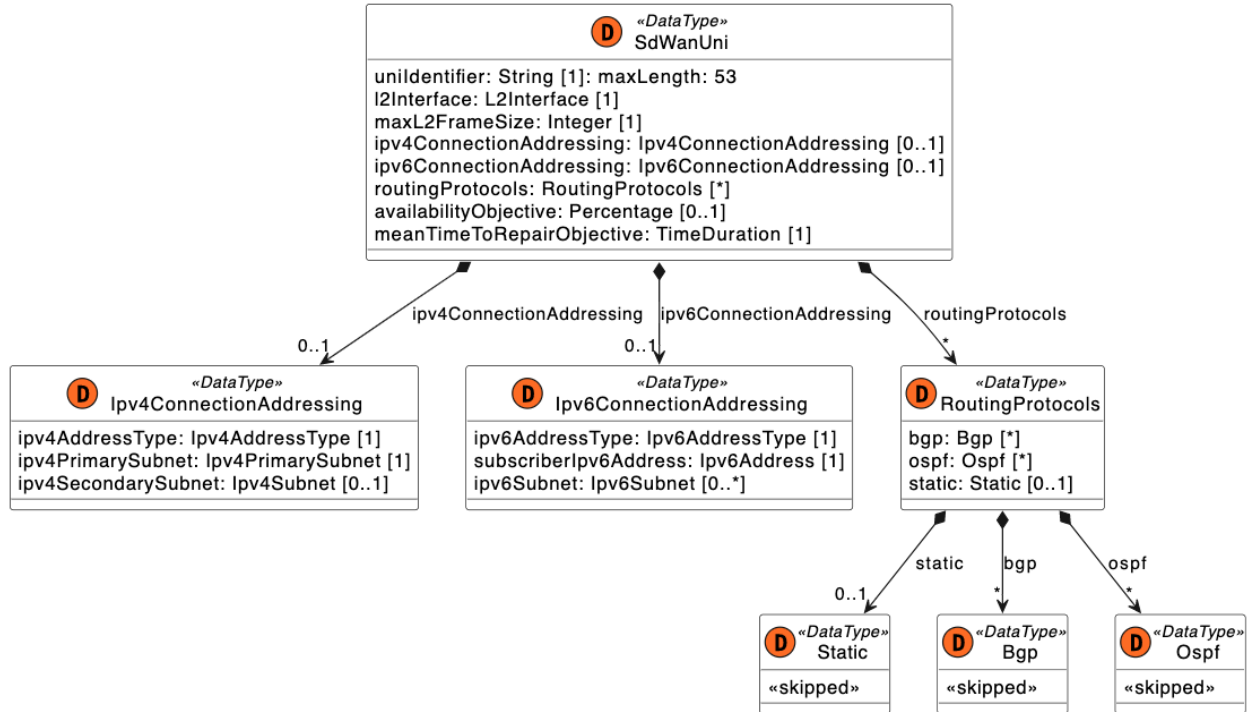


Figure 9-SdWanUni Model

Schema File Name: sdWan/sdWanUni.yaml			
Specified Service: SD-WAN UNI			
\$id: urn:mef:iso:spec:legato:sdWanUni:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
unIdentifier	String maxLength:53 pattern: "[\x20-\x7F]+"	1	Identification of the UNI for management purposes. Reference MEF 70.2, Section 11.1 SD-WAN UNI Identifier Service Attribute.
l2Interface	L2Interface	1	Describes the underlying L2 technology for the UNI. Reference MEF 70.2, Section 11.2 SD-WAN UNI L2 Interface Service Attribute.
maxL2FrameSize	Integer	1	Specifies the maximum length L2 frame that is

			accepted by the Service Provider. Reference MEF 70.2, Section 11.3 SD-WAN UNI Maximum L2 Frame Size Service Attribute.
ipv4ConnectionAddressing	Ipv4ConnectionAddressing	0..1	Specifies how IPv4 addresses are allocated to the devices on the Subscriber side for the UNI. This attribute is omitted if there is no IPv4 address (i.e., if the Service Attribute value is None). Reference MEF 70.2, Section 11.4 SD-WAN UNI IPv4 Connection Addressing Service Attribute.
ipv6ConnectionAddressing	Ipv6ConnectionAddressing	0..1	Specifies how IPv6 addresses are allocated to the devices connected to the UNI. This attribute is omitted if there is no IPv6 address (i.e., if the Service Attribute value is None). Reference MEF 70.2 Section 11.5 SD-WAN UNI IPv6 Connection Addressing Service Attribute.
routingProtocols	RoutingProtocols	0..*	List of Routing Protocols used across the UNI. Reference MEF 70.2 Section 11.6 SD-WAN UNI Routing Protocols Service Attribute.
availabilityObjective	Percentage	0..1	UNI Availability. Reference MEF 70.2 Section 11.7 SD-WAN UNI Availability

			Objective Service Attribute.
meanTimeToRepairObjective	TimeDuration	0..1	Mean Time to Repair Objective. Reference MEF 70.2 Section 11.8 SD-WAN UNI Mean Time To Repair Objective Service Attribute.

Table 7-SdWanUni Service Attributes

12.4 SD-WAN Policy, Security Policy, Application Flows and Application Flow Groups

This section describes a more detailed model for the supporting classes for Policy, Application Flow and Application Flow Group.

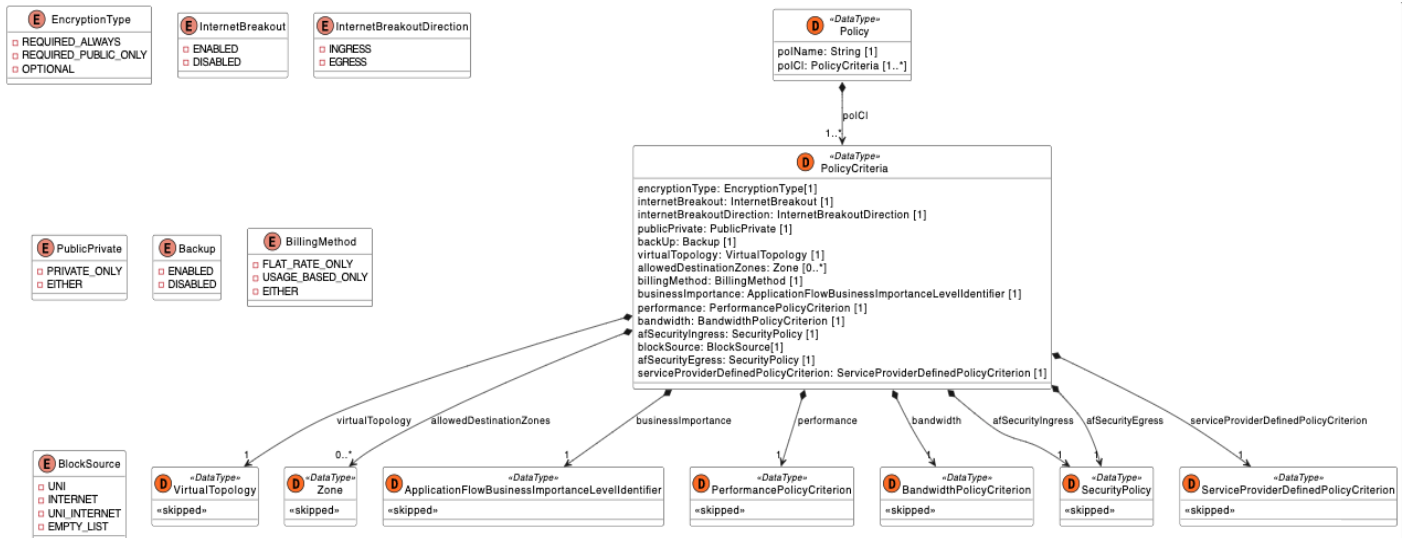


Figure 10-Policy Model

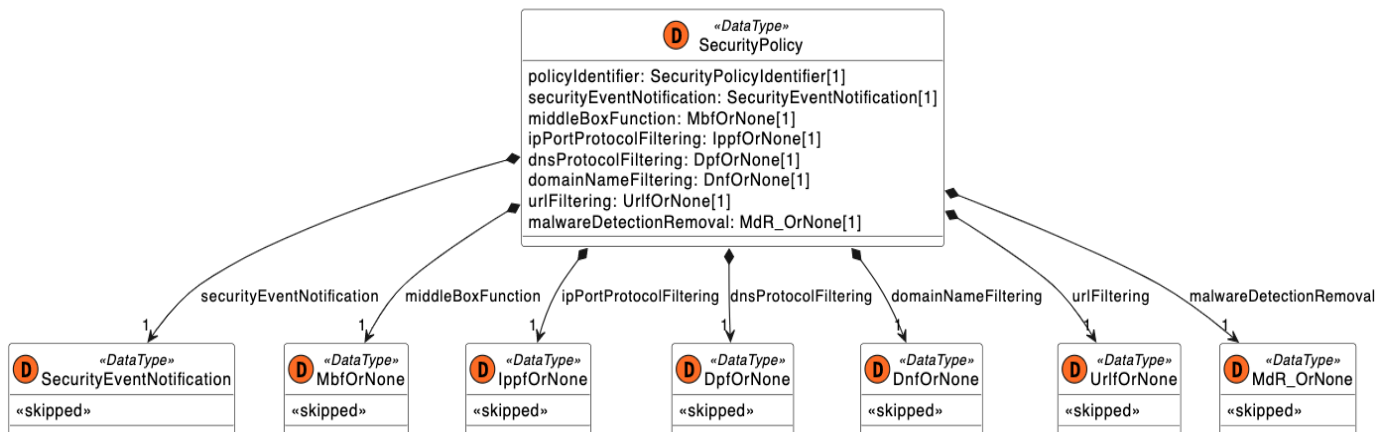


Figure 11- Security Policy Model

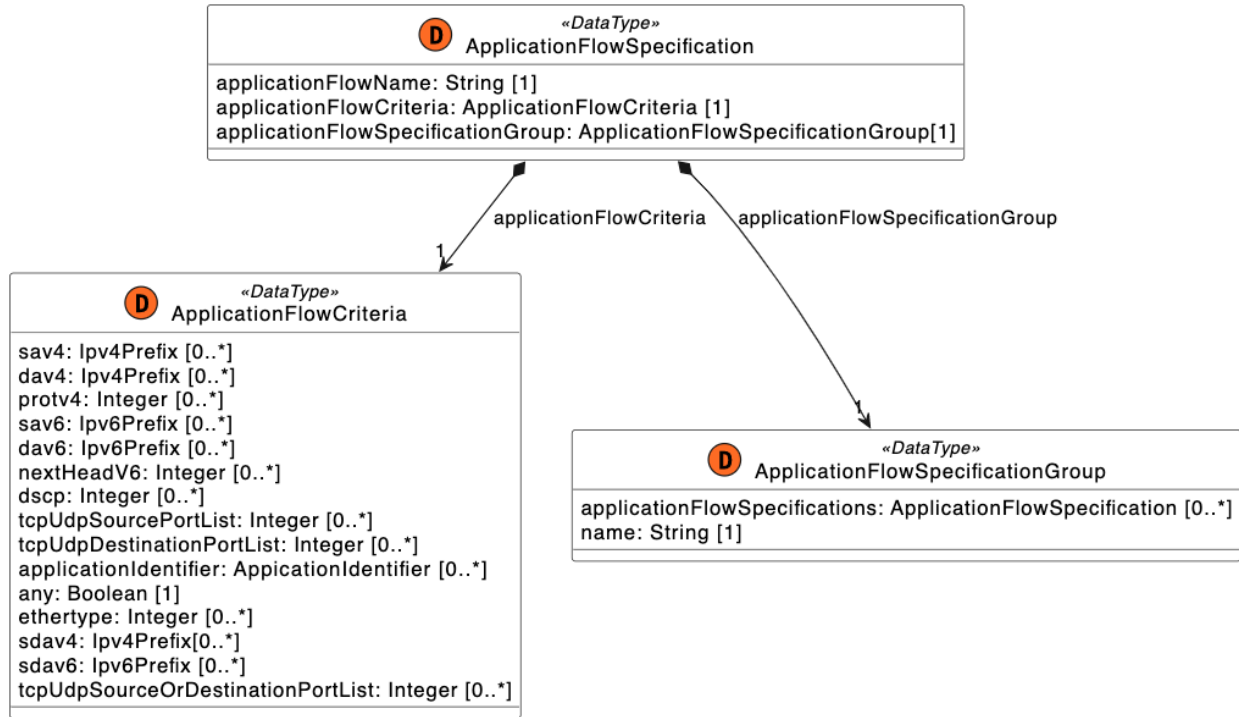


Figure 12- Application Flows and Application Flow Groups Model

12.4.1 ApplicationFlowBusinessImportanceLevels

Specifies an ordered list of labels that can be assigned to Application Flows to indicate importance of each Application Flow. Reference MEF 70.2 Section 9.11 SWVC List of Application Flow Business Importance Levels Service Attribute.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
implist	ApplicationFlowBusinessImportanceLevelIdentifier	1..*	A non-empty list of Identifier Strings that are the business importance labels ordering from highest importance to lowest.

afbilDefault	ApplicationFlowBusinessImportanceLevelIdentifier	1	Default ApplicationFlowBusinessImportanceLevelIdentifier.
--------------	--	---	---

Table 8-ApplicationFlowBusinessImportanceLevels Attributes

12.4.2 ApplicationFlowBusinessImportanceLevelIdentifier

File: /sdWan/sdWanCommon.yaml

The Identifier string of business importance labels.

- type: string
- maxLength: 53
- pattern: "[/x20-\x7F]+"

12.4.3 ApplicationFlowSpecification

Specifies the Application Flows that can be recognized by the SD-WAN service and information about how to identify IP Packets in each Application Flow. A non-empty ordered list of 3-tuples <AFname, AFCritList, AFGroup>.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
applicationFlowName	String	1	Identifier String that is used to refer to Application Flow Specification. Reference MEF W70.2 Section 9.14 SWVC List of Application Flow Specifications Service Attribute.
applicationFlowCriteria	ApplicationFlowCriteria	1	Pointer to associated ApplicationFlowCriteria. Reference MEF W70.2 Section 9.14 SWVC List of Application Flow Specifications Service Attribute.
applicationFlowSpecificationGroup	ApplicationFlowSpecificationGroup	1	Pointer to associated ApplicationFlowSpecificationGroup. Reference MEF W70.2 Section 9.14 SWVC List of Application Flow

			Specifications Service Attribute.
--	--	--	-----------------------------------

Table 9-ApplicationFlowAttributes

12.4.4 ApplicationFlowCriteria

The ApplicationFlowCriteria describes the standard criteria that can be used to describe an Application Flow, as defined in MEF W70.2 Table 7 – Application Flow Criteria – Support Required and Table 9 Application Flow Criteria – Support Recommended.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
sav4	Ipv4Prefix	0..*	IPv4 Source Address. List of IPv4 Prefixes. Reference MEF W70.2 Section 9.14 Table-7.
dav4	Ipv4Prefix	0..*	IPv4 Destination Address. List of IPv4 Prefixes. Reference MEF W70.2 Section 9.14 Table-7.
protv4	ProtocolV4	0..*	IPv4 Protocol List. List of integers in the range 0 to 255 or a list of keywords for IANA Protocol Numbers Registry. Reference MEF W70.2 Section 9.14 Table-7.
sav6	Ipv6Prefix	0..1	IPv6 Source Address. List of IPv6 Prefixes. Reference MEF W70.2 Section 9.14 Table-7.
dav6	Ipv6Prefix	0..1	IPv6 Destination Address. List of IPv6 Prefixes. Reference MEF W70.2 Section 9.14 Table-7.
nextHeadV6	PositiveInteger	0..*	IPv6 Next Header List. Reference MEF W70.2 Section 9.14 Table-7.
dscp	Dscp	0..*	List of Integers in the range 0 to 63.

			Reference MEF W70.2 Section 9.14 Table-7.
sport	PositiveInteger	0..*	Transport Source Port. List of integers in the range 0 to 65535 or a list of service names from IANA Service Name and Port Number Registry. Reference MEF W70.2 Section 9.14 Table-7/8.
dport	PositiveInteger	0..*	List of integers in the range 0 to 65535 or a list of service names from IANA Service Name and Port Number Registry. Reference MEF W70.2 Section 9.14 Table-7.
appld	ApplicationIdentifier	0..*	Custom match including heuristic/algorithmic matching. MEF W70.2 Section 9.14 Table-7.
any	Boolean	1	Match any IP Packet. Reference MEF W70.2 Section 9.14 Table-7.
ethertype	Ethertype	0..1	Ethertype. Integer in the range 0x600 to 0xffff. Reference MEF W70.2 Section 9.14 Table-8.
sdav4	Ipv4Prefix	0..*	Match a list of values for either the source or designation address. Reference MEF W70.2 Section 9.14 Table-8.
sdav6	Ipv6Prefix	0..*	Same as previous.
sdport	PositiveInteger	0..*	Match a list of values for either the source or destination port.

Table 10-ApplicationFlowCriteria Attributes

731

12.4.5 ApplicationFlowSpecificationGroup

Provides a mechanism for associating a Policy with multiple Application Flows. Reference MEF W70.2 Section 9.13 SWVC List of Application Flow Specification Groups Service Attribute.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
applicationFlowSpecifications	ApplicationFlowSpecification	0..*	Associated Application Flows.
name	String	1	Application Flow Group name.

Table 11-ApplicationFlowGroup Attributes

12.4.6 ApplicationIdentifier

A method for referring to named packet matching definitions (both simple and complex) defined by a Service Provider.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
applicationIdentifier	String	1	
additionalArguments	String	0..*	
applicationMatch	String	0..*	

Table 12-ApplicationIdentifier Attributes

12.4.7 BandwidthPolicyCriterion

Provides a method to express the intended bandwidth requirements for an Application Flow, and the probability of packet delay or discard in the face of varying bandwidth contention for Underlay Connectivity Service resources. Reference MEF W70.2 Section 9.12.2.10 BANDWIDTH Ingress Policy Criterion.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description

unnamedRateLimiter	UnnamedRateLimiter	0..1	An unnamed Rate Limiter.
rateLimiter	RateLimiter	0..1	A named Rate Limiter specified in the SWVC List of Rate Limiters.

Table 13-BandwidthPolicyCriterion Attributes

one of:

- required: [unnamedRateLimiter]
- required: [rateLimiter]

12.4.8 CipherSuite

A Cipher suite includes the protocol name (i.e., TLS), the Key Exchange algorithm (e.g., DHE_RSA), with the encryption algorithm (e.g., AES_128_GCM) and the Message Authentication algorithm (e.g., SHA256). Reference IANA, TLSCipher Suites Registry, <https://www.iana.org/assignments/tls-parameters/tls-parameters.xhtml>.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
value	String	1	Cipher value.
name	String	1	Enumeration (in future) representing Cipher Suite Name.

Table 14-CipherSuite Attributes

12.4.9 DnfOrNone

Data type to allow the selection of lppf or *None*. Note that the value *None* indicates that the IPPF Security Function is *Disabled* for all Application Flows to which this Security Policy is applied. Reference MEF 88 Section 6.5 DNS Protocol Filtering Parameter.

File: /sdWan/sdCommon.yaml			
one of:			
-required: [dnfNone]			
-required: [dnfSelect]			
Attribute Name	Type	Multiplicity	Description

dnfNone	String Enum: • NONE	1	Select NONE for no DNF.
dnfSelect	DomainNameFilter	1	Select DNF.

Table 15-DnfOrNone Attributes

12.4.10 Dpf

Service Provider maintained list of 5-tuple for IP filtering. Reference MEF 88 Section 9.2 DNS Protocol Filtering.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
sav4	Ipv4AddressOrAny	1..*	A list of IPv4 source addresses or a value of ANY meaning any IPv4 address.
dav4	Ipv4AddressOrAny	1..*	A list of IPv4 destination addresses or a value of ANY meaning any IPv4 address.
sav6	Ipv6AddressOrAny	1..*	A list of IPv6 source addresses or a value of ANY meaning any IPv6 address.
dav6	Ipv6AddressOrAny	1..*	A list of IPv6 destination addresses or a value of ANY meaning any IPv6 address.
dnsMessageType	String	1	One of the DNS messages, as specified in RFC 6895.

Table 16-Dpf Attributes

12.4.11 DpfOrNone

Data type to allow the selection of Ippf or *None*. Note that the value *None* indicates that the IPPF Security Function is *Disabled* for all Application Flows to which this Security Policy is applied. Reference MEF 88 Section 6.5 DNS Protocol Filtering Parameter.

File: /sdWan/sdCommon.yaml
one of:

-required: [dpfNone]			
-required: [dpfSelect]			
Attribute Name	Type	Multiplicity	Description
dpfNone	String Enum: <ul style="list-style-type: none">NONE	1	Select NONE for no DPF.
dpfSelect	DnsProtocolFilter	1	Select DPF.

Table 17-DpfOrNone Attributes

12.4.12 Dnf

Domain Name Filtering is defined as the Security Function that determines whether an Application Flow, or subset of an Application Flow, contains domain names. This data type represents a Domain Name for filtering.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
domainName	String	1	Domain name.

Table 18-Dnf Attributes

12.4.13 DnsProtocolFilter

Provides for the filtering of Application Flows with respect to IP addresses of DNS servers and DNS message types. Reference MEF 88 Section 6.5 DNS Protocol Filtering Parameter.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
dpfBlockList	Dpf	1..*	List of match criteria in DPF Block List or None.
dpfAllowList	Dpf	1..*	List of match criteria in DPF Allow List or None.
dpfQuarantineList	Dpf	1..*	List of match criteria in DPF Quarantine List or None.
nm	String	1	Parameter that determines the behavior when a subset of the Application Flow does not match

			criteria entry on any of the DPF List. The possible values are ALLOW or BLOCK.
duration	TimeDuration	1	Duration of the time between updates of the IPPF security threat database.

Table 19-DnsProtocolFilter Attributes

12.4.14 DomainNameFilter

Provides for the filtering of Application Flows with respect to domain names. Reference MEF 88 Section 6.6 Domain Name Filtering Parameter.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
dnfBlockList	Dnf	1..*	List of match criteria in DNF Block List or None.
dnfAllowList	DnfOrNone	1..*	List of match criteria in DPF Allow List or None.
dnfQuarantineList	DnfOrNone	1..*	List of match criteria in DPF Quarantine List or None.
nm	String	1	Parameter that determines the behavior when a subset of the Application Flow does not match criteria entry on any of the DPF List. The possible values are ALLOW or BLOCK.
duration	TimeDuration	1	Duration of the time between updates of the IPPF security threat database.

Table 20-DomanProtocolFilter Attributes

12.4.15 IanaProtocols

Protocol Numbers values. Reference IANA Protocol Numbers.

File: /sdWan/common/ipCommon.yaml

- HOPOPT
- ICMP
- IGMP

- 799 • GGP
- 800 • IPV4
- 801 • ST
- 802 • TCP
- 803 • CBT
- 804 • EGP
- 805 • IGP
- 806 • BBN_RCC_MON
- 807 • NVP_II
- 808 • PUP
- 809 • ARGUS
- 810 • EMCON
- 811 • XNET
- 812 • CHAOS
- 813 • UDP
- 814 • MUX
- 815 • DCN_MEAS
- 816 • HMP
- 817 • PRM
- 818 • XNS_IDP
- 819 • TRUNK_1
- 820 • TRUNK_2
- 821 • LEAF_1
- 822 • LEAF_2
- 823 • RDP
- 824 • IRTP
- 825 • ISO_TP4
- 826 • NETBLT
- 827 • MFE_NSP
- 828 • DCCP
- 829 • 3PC
- 830 • IDPR
- 831 • XTP
- 832 • DDP
- 833 • IDRP_CMTTP
- 834 • TP_PLUS_PLUS
- 835 • IL
- 836 • IPV6
- 837 • SDRP
- 838 • IPV6_ROUTE
- 839 • IPV6_FRAG

- 840 • IDRP
- 841 • RSVP
- 842 • GRE
- 843 • DSR
- 844 • BNA
- 845 • ESP
- 846 • AH
- 847 • I_NLSP
- 848 • SWIPE
- 849 • NARP
- 850 • MOBILE
- 851 • TLSP
- 852 • SKIP
- 853 • IPV6_ICMP
- 854 • IPV6_NO_NXT
- 855 • IPV6_OPTS
- 856 • CFTP
- 857 • SAT_EXPAK
- 858 • KRYPTOLAN
- 859 • RVD
- 860 • IPPC
- 861 • SAT_MON
- 862 • VISA
- 863 • IPCV
- 864 • CPNX
- 865 • CPHB
- 866 • WSN
- 867 • PVP
- 868 • BR_SAT_MON
- 869 • SUN_ND
- 870 • WB_MON
- 871 • WB_EXPAK
- 872 • ISO_IP
- 873 • VMTP
- 874 • SECURE_VMTP
- 875 • VINES
- 876 • IPTM
- 877 • NSFNET-IGP
- 878 • DGP
- 879 • TCF
- 880 • EIGRP

- 881 • OSPFIGP
- 882 • SPRITE_RPC
- 883 • LARP
- 884 • MTP
- 885 • AX_25
- 886 • IPIP
- 887 • MICP
- 888 • SCC_SP
- 889 • ETHERIP
- 890 • ENCAP
- 891 • GMTP
- 892 • IFMP
- 893 • PNNI
- 894 • PIM
- 895 • ARIS
- 896 • SCPS
- 897 • QNX
- 898 • A_N
- 899 • IP_COMP
- 900 • SNP
- 901 • COMPAQ_PEER
- 902 • IPX_IN_IP
- 903 • VRRP
- 904 • PGM
- 905 • L2TP
- 906 • DDX
- 907 • IATP
- 908 • STP
- 909 • SRP
- 910 • UTI
- 911 • SMP
- 912 • SM
- 913 • PTP
- 914 • ISIS_OVER_IPV4
- 915 • FIRE
- 916 • CRTP
- 917 • CRUDP
- 918 • SSCOPMCE
- 919 • IPLT
- 920 • SPS
- 921 • PIPE

- SCTP
- FC
- RSVP_E2E_IGNORE
- MOBILITY_HEADER
- UDP_LITE
- MPLS_IN_IP
- MANET
- HIP
- SHIM6
- WESP
- ROHC
- ETHERNET
- AGGFRAG
- UNASSIGNED
- EXPERIMENTATION
- RESERVED

12.4.16 IanaProtocolsIntegers

File: /sdWan/common/ipCommon.yaml

type: integer

maximum: 255

minimum: 0

12.4.17 IanaProtocolsIntegerOrKeyword

File: /sdWan/common/ipCommon.yaml

Data type which allows IANA Protocols integer values or keywords.

one of:

- required: [IanaProtocols]
- required: [IanaProtocolsIntegers]

12.4.18 Ippf

Service Provider maintained list of 8-tuples for IP filtering. Reference MEF 88 Section 9.1 IP, Port and Protocol Filtering.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
sav4	Ipv4AddressOrAny	1..*	A list of IPv4 source addresses or a value of ANY meaning any IPv4 address.
dav4	Ipv4AddressOrAny	1..*	A list of IPv4 destination addresses or a value of ANY meaning any IPv4 address.
protov4	IanaProtocolsIntegerOrKeyword	1..*	The IPv4 protocol list, is a list of integers in range 0 to 255 or a list of keywords from IANA Protocol Numbers, or a mix of integers and keywords.
sav6	Ipv6AddressOrAny	1..*	A list of IPv6 source addresses or a value of ANY meaning any IPv6 address.
dav6	Ipv6AddressOrAny	1..*	A list of IPv6 destination addresses or a value of ANY meaning any IPv6 address.
nexttheadv6	IanaProtocolsIntegerOrKeyword	1..*	The IPv6 protocol list, is a list of integers in the range 0 to 255 or a list of keywords from IANA, Protocol Numbers or a mix of integers and keywords.
sport	ServiceNameAndTransportProtocolsOrAny	1..*	Transport Source Port is a list of integers in the range 0 to 65535 or a list of keywords from IANA, Protocol Numbers, or a mix of integers and keywords. Any could be used to indicate that any source port number is on the list.
dport	ServiceNameAndTransportProtocolsOrAny	1..*	Transport Destination Port is a list of integers in the range 0 to 65535 or a list of keywords from IANA, Protocol Numbers, or a mix of integers and keywords. Any could be used to indicate that any source port number is on the list.

Table 21-Ippf Attributes

953

12.4.19 IppfOrNone

Data type to allow the selection of Ippf or *None*. Note that the value *None* indicates that the IPPF Security Function is *Disabled* for all Application Flows to which this Security Policy is applied. Reference MEF 88 Section 6.4 IP, Port and Protocol Filtering Parameter.

File: /sdWan/sdCommon.yaml			
one of:			
-required: [ippfNone]			
-required: [ippfSelect]			
Attribute Name	Type	Multiplicity	Description
ippfNone	String Enum: <ul style="list-style-type: none">NONE	1	Select NONE for no IPPF.
ippfSelect	IpPortProtocolFilter	1	Select IPPF.

Table 22-IppfOrNone Attributes

12.4.20 IpPortProtocolFilter

Provides for the filtering of Application Flows with respect to IP addresses, port numbers and IP protocols. Reference MEF 88 Section 6.4 IP, Port and Protocol Filtering Parameter.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ippfBlockList	Ippf	1..*	List of match criteria in IPPF Block List or None.
ippfAllowList	Ippf	1..*	List of match criteria in IPPF Allow List or None.
ippfQuarantineList	Ippf	1..*	List of match criteria in IPPF Quarantine List or None.
nm	String	1	Parameter that determines the behavior when a subset of the Application Flow does not match criteria entry on any of the IPPF List. The possible values are ALLOW or BLOCK.

duration	TimeDuration	1	Duration of the time between updates of the IPPF security threat database.
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Table 23-IpPortProtocolFilter Attributes

12.4.21 MalwareDetectionRemoval

Provides for the identification of Malware in an Application Flow and removal of the Malware or blocking of the subset of the Application Flow containing the malware. Reference MEF 88 Section 6.8 Malware Detection and Removal Parameter.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
mdR_BlockList	Md_R	1..*	Supported Md_R list.
mdR_AllowList	Md_R	1..*	Unsupported Md_R list.
mdR_QuarantineList	Md_R	1..*	Block Md_R list.
allowList	Mbf	1..*	Allow MBF list.
nm	String String Enum: <ul style="list-style-type: none"> ALLOW BLOCK 	1	Determines behavior when a subset of the Application Flow does not match a match criteria entry on any of the MD+R Lists.
duration	TimeDuration	1	Duration of time between updates of MD+R security thread database.
detection	String	1	Detection type.
removalBehavior	String String Enum: <ul style="list-style-type: none"> BLOCK_OBJECT_BLOCK_SUBSET_AF BLOCK_OBJECT_ALLOW_SUBSET_AF 	1	Malware removal behavior.

	<ul style="list-style-type: none"> QUARAN TINE_OBJ ECT_BLO CK_SUBS ET_AF QUARAN TINE_OBJ ECT_ALL OW_SUB SET_AF REMOVE AL_MAL WARE_A LLOW_S UBSET_A F 		
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Table 24-MalwareDetectionRemoval Attributes

12.4.22 Mb

Maintained by the Service Provider for each Application Flow, which each match criteria entry on a list using a 2-tuple of the form <P, CS>, where P is a specific TLS protocol version and CS is the list of cipher suites for that TLS protocol version. Any can be used to indicate that any cipher suite for a given TLS protocol version is on the list.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
tlsProtocolVersion	String	1	TLS Protocol version.
cipherList	CipherSuite	1	Cipher suite.

Table 25-MbList Attributes

12.4.23 MbOrNone

Data type to allow the selection of MBF or None. Note that the value of None indicates that the MBF Security Function is Disabled for all Application Flows to which this Security Policy is applied.

<p>Schema File Name: sdWan/sdWanCommon.yaml</p> <p>one of:</p> <p>-required: [mbfNone]</p>
--

-required: [mbfSelect]			
Attribute Name	Type	Multiplicity	Description
mbfNone	String Enum: • NONE	1	Select NONE for no MBF.
mbfSelect	MiddleBoxFunction	1	Select MiddleBoxFunction.

Table 26-MbfOrNone Attributes

12.4.24 Md_R

Under development.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
	String	1	

Table 27-MdR Attributes

12.4.25 MdR_OrNone

Data type to allow the selection of Md_R or *None*. Note that the value *None* indicates that the MD+R Security Function is *Disabled* for all Application Flows to which this Security Policy is applied. Reference MEF 88 Section 6.8 Malware Detection and Removal Parameter.

File: /sdWan/sdCommon.yaml			
one of:			
-required: [mdR_None]			
-required: [mdR_Select]			
Attribute Name	Type	Multiplicity	Description
mdRNone	String Enum: • NONE	1	Select NONE for no MD+R.
mdRSelect	MalwareDetectionRemoval	1	Select MD+R.

Table 28-MdR_OrNone Attributes

12.4.26 MiddleBoxFunction

The MBF Security Function provides for the decryption and re-encryption of Application Flows that use Transport Layer Security (TLS). Reference MEF 88 Section 6.3 MBF Parameter.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
supportedList	Mbf	1..*	Supported MBF list.
unsupportedList	Mbf	1..*	Unsupported MBF list.
blockList	Mbf	1..*	Block MBF list.
allowList	Mbf	1..*	Allow MBF list.
nm	String String Enum: <ul style="list-style-type: none"> ALLOW BLOCK 	1	Determines behavior when a subset of the Application Flow does not match a match criteria entry on either the MBF Block List or MBF Allow List.
certificateAuthority	String	1..*	The method for notifying the client in the Subscriber's network is beyond the scope of MEF 88 (at this timeO.
caBehaviorIfInvalid	String Enum: <ul style="list-style-type: none"> ALLOW BLOCK 	1	Determines behavior of the MBF when the target server certificate is invalid.

Table 29-MiddleBoxFunction Attributes

12.4.27 OneWayMeanPacketDelayPrimary

Specifies the primary One Way Mean Packet Delay parameters.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description

threshold	TimeDuration	1	Threshold value. See MEF W70.2 Figure 16.
ceiling	TimeDuration	1	Ceiling value. See MEF W70.2 Figure 16.
remediation	TimeDuration	1	Remediation value. See MEF W70.2 Figure 16.

Table 30-OneWayMeanPacketDelayPrimary Attributes

12.4.28 OneWayMeanPacketDelayVariationPrimary

Specifies the primary One Way Mean Packet Delay Variation parameters.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
threshold	TimeDuration	1	Threshold value. See MEF W70.2 Figure 16.
ceiling	TimeDuration	1	Ceiling value. See MEF W70.2 Figure 16.
remediation	TimeDuration	1	Remediation value. See MEF W70.2 Figure 16.

Table 31-OneWayMeanPacketDelayVariationPrimary Attributes

12.4.29 OneWayMeanPacketLossRatioPrimary

Specifies the primary One Way Mean Packet Delay Variation parameters.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
threshold	Percentage	1	Threshold value. See MEF W70.2 Figure 16.
ceiling	Percentage	1	Ceiling value. See MEF W70.2 Figure 16.
remediation	Percentage	1	Remediation value. See MEF W70.2 Figure 16.

Table 32-OneWayMeanPacketDelayVariationPrimary Attributes

12.4.30 OneWayMeanPacketDelaySecondary

Specifies the secondary One Way Mean Packet Delay parameters.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
threshold	TimeDuration	1	Threshold value. See MEF W70.2 Figure 16.

Table 33-OneWayMeanPacketDelaySecondary Attributes

12.4.31 OneWayMeanPacketDelayVariationSecondary

Specifies the secondary One Way Mean Packet Delay Variation parameters.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
threshold	TimeDuration	1	Threshold value. See MEF W70.2 Figure 16.

Table 34-OneWayMeanPacketDelayVariationSecondary Attributes

12.4.32 OneWayMeanPacketLossRatioSecondary

Specifies the secondary One Way Mean Packet Delay Variation parameters.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
threshold	Percentage	1	Threshold value. See MEF W70.2 Figure 16.

Table 35-OneWayMeanPacketDelayVariationSecondary Attributes

12.4.33 PerformanceMetricsPrimary

Describes the most important Performance Metrics for this Application Flow for Primary.

File: /sdWan/sdWanCommon.yaml

Attribute Name	Type	Multiplicity	Description
oneWayMeanPacketDelay	OneWayMeanPacketDelayPrimary	1	Primary One Way Mean Packet Delay definition.
oneWayMeanPacketDelayVariation	OneWayMeanPacketDelayVariationPrimary	1	Primary One Way Mean Packet Delay Variation definition.
oneWayMeanPacketLossRatio	OneWayMeanPacketLossRatioPrimary	1	Primary One Way Mean Packet Loss Ratio definition.

Table 36-PerformanceMetricsPrimary Attributes

12.4.34 PerformanceMetricsSecondary

Describes the most important Performance Metrics for this Application Flow for Secondary.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
oneWayMeanPacketDelay	OneWayMeanPacketDelaySecondary	1	Secondary One Way Mean Packet Delay definition.
oneWayMeanPacketDelayVariation	OneWayMeanPacketDelayVariationSecondary	1	Secondary One Way Mean Packet Delay Variation definition.
oneWayMeanPacketLossRatio	OneWayMeanPacketLossRatioSecondary	1	Secondary One Way Mean Packet Loss Ratio definition.

Table 37-PerformanceMetricsSecondary Attributes

12.4.35 PerformancePolicyCriterion

Allows the Subscriber to indicate the importance Performance Metrics for each Ingress Application Flow.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
primary	PerformanceMetricsPrimary	1	Primary performance metrics.
secondary	PerformanceMetricsSecondary	1	Secondary performance metrics.

Table 38-PerformancePolicyCriterion Attributes

12.4.36 Policy

Associated with each SWVC is a list of Policies that be assigned to each Application Flow. A Policy is composed of Policy Criteria. Reference MEF 70.2 Section 9.12 SWVC List of Policies Service Attribute.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
polName	String Enum: Not: <ul style="list-style-type: none">NONEBLOCK	1	An identifier String that specifies the Policy.
polCl	PolicyCriteria	1..*	A non-empty list of Policy Criteria 2-tuples of form <pcName, pcParam>

Table 39-Policy Attributes

12.4.37 PolicyCriteria

Data type representing a Policy Criteria 2-tuples, of the form <pcName,pcParam>. Reference MEF W70.2 Section 9.12 SWVC List of Policies Service Attribute, Tables 4 and 5.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
encryptionType	String Enum: <ul style="list-style-type: none">REQUIRED_ALWAYSREQUIRED_PUBLIC_ONLYOPTIONAL	0..1	Indicates whether the Application Flow requires encryption.
internetBreakout	String Enum:	0..1	Indicates whether the Application Flow can be forwarded to an Internet destination.

	<ul style="list-style-type: none"> ENABLED DISABLED 		
publicPrivate	String Enum: <ul style="list-style-type: none"> PRIVATE_ONLY EITHER 	0..1	Indicates whether the Application Flow can traverse Internet Access Underlay Connectivity Service or not.
backup	String Enum: <ul style="list-style-type: none"> ENABLED DISABLED 	0..1	Indicates whether this Application Flow can use a UCS designated as “backup”.
virtualTopology	VirtualTopology	0..1	Indicates the Virtual Topology that the Application Flow should be forwarded over.
allowedDestinationZones	Zone	0..*	Specifies which Zones the IP Packets in the Application Flow can be delivered to.
billingMethod	String Enum: <ul style="list-style-type: none"> FLAT_RATE_ONLY USAGE_BASED_ONLY EITHER 	0..1	Indicates whether the Application Flow can be sent over an Underlay Connectivity Service that has usage-based or flat-rate billing.
businessImportance	ApplicationFlowBusinessImportanceLevelIdentifier	0..1	Indicates the relative business importance of the Application Flow.
performance	PerformancePolicyCriterion	0..1	Specifies a list of performance requirements for the Application Flow.
bandwidth	BandwidthPolicyCriterion	0..1	Specifies a bandwidth commitment and bandwidth limit on the Application Flow.
afSecurityIngress	SecurityPolicy	0..1	Specifies the Security Functions to apply to the Application Flow at Ingress UNI.

blockSource	String Enum: <ul style="list-style-type: none">UNIINTERNETUNI_INTE RNETEMPTY_LI ST	0..1	Indicates specific source to disallow for egress. <ul style="list-style-type: none">UNI – Discard all IP Packets in the Application Flow if the Application Flow is not in Zone INTERNET.INTERNET – Discard all IP Packets in the Application Flow if the Application Flow is in Zone INTERNET.UNI_INTERNET – Discard all IP Packets in the Application Flow.EMPTY_LIST – No effect on IP Packets in the Application Flow.
afSecurityEgress	SecurityPolicy	0..1	Specifies the Security Functions to apply to the Application Flow at the Egress UNI.
serviceProviderDefinedPolicyCriterion	ServiceProviderDefinedPolicyCriterion	0..*	Service Provider defined own Policy Criteria.

Table 40-PolicyCriteria Attributes

12.4.38 PolicyMap

Specifies the Policies that are assigned to Application Flows and Application Flow Groups at the SWVC End Point. Reference MEF 70 Section 9.3 SWVC End Point Policy Map.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
applicationFlow	ApplicationFlowSpecification	0..1	Pointer to Application Flow. Reference MEF 70 Section 9.3 SWVC End Point UNI Service Attribute. NOTE: One of applicationFlow and applicationFlowGroup must be specified.
applicationFlowSpecificationGroup	ApplicationFlowSpecificationGroup	0..1	Pointer to Application Flow Group.

policy	Policy	1	Pointer to Policy.
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Table 41-PolicyMap Attributes

12.4.39 SecurityEventNotification

Data type to allow the selection of SecurityEventNotification. A SEN is a notification to the Subscriber of a security event. The value of SEN is either *None* or a two-tuple of the form (R, T) where R is a list of recipients authorized to receive the SEN, and T is the format of the timestamp of the SEN, e.g., data and time in UTC or local time. Reference MEF 88 Section 6.2 Security Event Notification Parameter.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
receipients	Receipient	1	Receipients of security event notifications.
timestamp	TimeAndDate	1	Timestamp.

Table 42-SecurityEventNotification Attributes

12.4.40 SecurityEventNotificationOrNone

Data type to allow the selection of SecurityEventNotification or *None*. Note that the value *None* indicates that the SEN if not need for this Security Policy. Reference MEF 88 Section 6.2 Security Event Notification Parameter.

File: /sdWan/sdCommon.yaml			
one of:			
-required: [ippfNone]			
-required: [ippfSelect]			
Attribute Name	Type	Multiplicity	Description
senNone	String Enum: • NONE	1	Select NONE for no SEN.
senSelect	SecurityEventNotific ation	1	Select SEN.

Table 43-SecurityEventNotificationOrNone Attributes

12.4.41 SecurityPolicy

A set of parameters that are agreed between the Subscriber and Service Provider (as part of the SWVC List of Policies Service Attribute) and that specify which Security Functions are to be applied to an Application Flow. A Security Policy could be referenced in zero or more Ingress (SD-WAN) Policies and zero or more Egress (SD-WAN) Policies. Reference MEF 88 Section 6 Security Policy.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
policyIdentifier	SecurityPolicyIdentifier	1	Parameter of a Security Policy that provides a unique identifier. Reference MEF 88 Section 6.1 Security Policy Identifier Parameter.
securityEventNotification	SecurityEventNotification	1	Notification to the Subscriber of a security event. Reference MEF 88 Section 6.2 Security Event Notification Parameter.
middleBoxFunction	MbfOrNone	1	Provides for the decryption and re-encryption of Application Flows that use Transport Layer Security (TLS). Reference MEF 88 Section 6.3 MBF Parameter.
ipPortProtocolFiltering	IppfOrNone	1	Provides for the filtering of Application Flows with respect to IP addresses, port numbers and IP protocols. Reference MEF 88 Section 6.4 IP, Port and Protocol Filtering Parameter.
dnsProtocolFiltering	DpfOrNone	1	Provides for the filtering of Application Flows with respect to IP addresses of DNS servers and DNS message types. Reference MEF 88 Section 6.5 DNS Protocol Filtering Parameter.
domainNameFiltering	DnfOrNone	1	Provides for the filtering of Application Flows with respect to domain names. Reference MEF 88 Section 6.6 Domain Name Filtering Parameter.
urlFiltering	UrlfOrNone	1	Provides for the filtering of Application Flows with respect to URLs. Reference MEF 88

			Section 6.7 URL Filtering Parameter.
malwareDetectionRemoval	MdR_OrNone	1	Provides for the identification of Malware in an Application Flow and removal of the Malware or blocking of the subset of the Application Flow containing the malware. Reference MEF 88 Section 6.8 Malware Detection and Removal Parameter.

Table 44-SecurityPolicy Attributes

12.4.42 SecurityPolicyIdentifier

File: /sdWan/sdWanCommon.yaml

Parameter of a Security Policy that provides a unique identifier. Reference MEF 88 Section 6.1 Security Policy Identifier Parameter.

- Type: string
- maxLength: 53
- pattern: "[/x20-\x7F]+"

12.4.43 ServiceProviderDefinedPolicyCriterion

Service Provider defined Policy Criterion. Reference MEF W70.2 Section 9.12 SWVC List of Policies Service Attribute.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
polName	string	1	Policy name.
criterionValue	string	1	Criterion value.
behavior	string	1	Behavior.
policyDirection	Enum: INGRESS EGRESS	1	Direction of the policy.

Table 45-ServiceProviderDefinedPolicyCriterion Attributes

12.4.44 Urlf

Data type representing URL.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
url	String Format: uri	1	URL name.

Table 46-Urlf Attributes

12.4.45 UrlFilter

Provides for the filtering of Application Flows with respect to URLs. Reference MEF 88 Section 6.7 URL Filtering Parameter.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
urlfBlockList	lppf	1..*	List of match criteria in URLF Block List or None.
urlfAllowList	lppf	1..*	List of match criteria in URLF Allow List or None.
urlfQuarantineList	lppf	1..*	List of match criteria in URLF Quarantine List or None.
nm	String	1	Parameter that determines the behavior when a subset of the Application Flow does not match criteria entry on any of the URLF List. The possible values are ALLOW or BLOCK.
duration	TimeDuration	1	Duration of the time between updates of the IPPF security threat database.

Table 47-UrlFilter Attributes

12.4.46 UrlfOrNone

Data type to allow the selection of URL Filter or None. Note that the value None indicates that the DNF Security Function is Disabled for all Application Flows to which this Security Policy is applied. Reference MEF 88 Section 6.7 URL Filtering Parameter.

Schema File Name: sdWan/sdWanCommon.yaml one of: -required: [urlfNone] -required: [urlfSelect]			
Attribute Name	Type	Multiplicity	Description
urlfNone	String Enum: • NONE	1	Select NONE for no URL Filtering.
urlfSelect	UrlFilter	1	Select URL Filtering.

Table 48-UrlfOrNone Attributes

12.5 Underlay Connectivity Service

This section details the associated set of objects and data types that define the Underlay Connectivity Service model. Underlay Connectivity Services are network services independent of the SD-WAN Service and can have many “characteristics” or “attributes” that define their configuration and behavior.

The UCS and UCS End Point Service Attributes defined in this model are in addition to those attributes and include only those attributes necessary to define UCS external interfaces and behavior to the extent necessary to implement SD-WAN Policies.

Attributes that are internal to the UCS itself, such as those defining the associations between the UCS and UCS End Points or between the UCS End Point and UCS UNI are part of the UCS Service Agreement described earlier in this paragraph and are not included as Service Attributes for the SD-WAN Service.

12.5.1 Ucs

Underlay Connectivity Services are network services independent of the SD-WAN Service and can have many 'characteristics' or 'attributes' that define their configuration and behavior. Reference MEF 70.1 Section 12 UCS Service Attributes.

Schema File Name: sdWan/ucs.yaml

Specified Service: UCS			
\$id: urn:mef:iso:spec:legato:ucs:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
ucsIdentifier	String	1	The value of the UCS Identifier Service Attribute is a string that is used to allow the Subscriber and Service Provider to uniquely identify an Underlay Connectivity Service. Reference MEF 70.1 Section 12.1 UCS Identifier Service Attribute.
ucsType	UcsType	1	The value of the UCS Type Service Attribute indicates whether the UCS is a Public UCS (i.e., an Internet Access Service) or a Private UCS. The possible values are Public or Private. Reference MEF 70.1 Section 12.2 UCS Type Service Attribute.
ucsBillingMethod	UcsBillingMethod	1	Indicates how access to the Underlay Connectivity Service is billed. The allow values are FLAT_RATE, USAGE_BASED and OTHER. Reference MEF 70.1 Section 12.3 UCS Billing Method Service Attribute.

Table 49-Ucs Attributes

12.5.2 UcsUni

Access to an Underlay Connectivity Service is provided at the SD-WAN Edge via the UCS UNI. Reference MEF 70.1 Section 13 UCS UNI Service Attribute.

Schema File Name: sdWan/ucsUni.yaml			
Specified Service: UCS UNI			
\$id: urn:mef:iso:spec:legato:ucsUni:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
identifier	String	1	The value of the UCS UNI Identifier Service Attribute is a string that is used to allow the Subscriber and Service

			Provider to uniquely identify an Underlay Connectivity Service UNI. Reference MEF 70.1 Section 13 UCS UNI Service Attributes.
--	--	--	---

Table 50-UcsUni Attributes

12.5.3 UcsEndPoint

A UCS is connected to a UCS UNI by a UCS End Point. Some service architectures support multiple UCSs at the same UCS UNI. The UCS End Point captures Service Attributes at the UCS UNI whose value can differ between UCSs. Reference MEF 70.1 Section 14 UCS End Point Service Attributes.

Schema File Name: sdWan/ucsUniEndPoint.yaml Specified Service: UCS UNI End Point \$id: urn:mef:iso:spec:legato:ucsUniEndPoint:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
identifier	String	1	Identification of the Underlay Connectivity Service End Point. Reference MEF 70.1 Section 14.1 UCS End Point Identifier Service Attribute.
endPointBackup	EnabledDisabled	1	Indicates whether the UCS should be treated as a Primary underlay or a Backup underlay at this UCS End Point. Reference MEF 70 Section 14.2 UCS End Point Backup Service Attribute.
endPointBreakout	EnabledDisabled	1	Indicates whether the SD-WAN Service can "break out" to the underlying UCS Service from this End Point. Reference MEF 70.1 Section 14.3 UCS End Point Breakout Service Attribute.

Table 51-UcsEndPoint Attributes

13 Common Classes and Types

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

13.1 Bgp Model

When an entry in the (SD-WAN) UNI Routing Protocol is for BGP, BGP as specified in RFC 4271 is used across the UNI to exchange routing information. Reference MEF 61.1 Section 12.7.3 BGP and MEF W70.2 Section 11.6.2 BGP. Figure 13 depicts the model of BGP routing protocol configuration model.

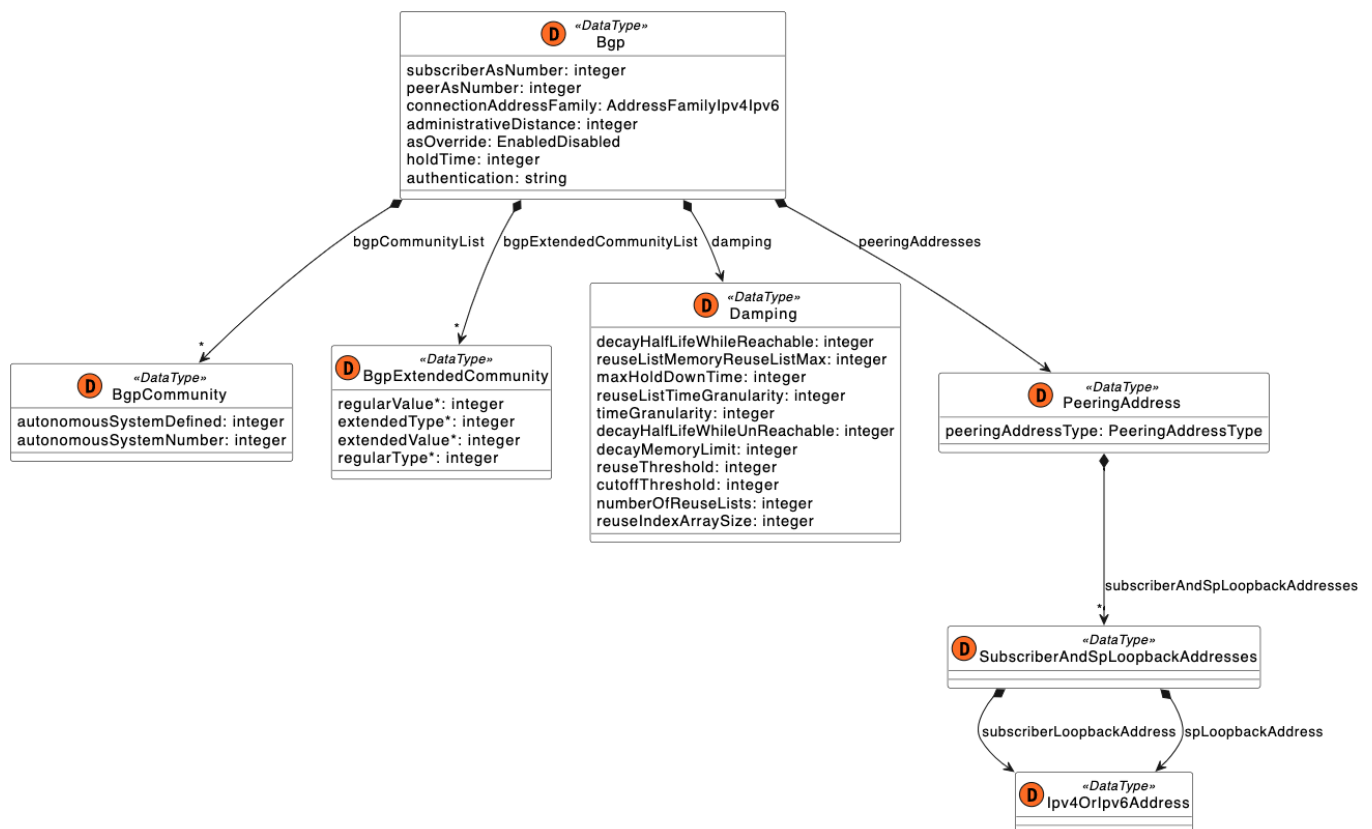


Figure 13-Bgp Model

13.1.1 Bgp

When an entry in the (SD-WAN) UNI Routing Protocol is for BGP, BGP as specified in RFC 4271 is used across the UNI to exchange information. Reference MEF 61.1 Section 12.7.3 BGP and MEF W70.2 Section 11.6.2 BGP.

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
subscriberAsNumer	Integer	0..1	BGP Subscriber Autonomous System number.
peerAsNumber	Integer	0..1	BGP Peer Autonomous System Number.
bgpExtendedCommunityList	BgpExtendedCommunity[]	0..*	Mechanism for labeling information carried in BGP-4. Provide enhancement over existing BGP Community Attribute: An extended range, the addition of type field.
connectionAddressFamily	AddressFamilyIpv4I pv6	0..1	Connection Address Family (IPv4 or IPv6).
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.
administrativeDistance	Integer	0..1	BGP Administrative Distance.
asOverride	EnabledDisabled	0..1	Autonomous System Override. The SP (or Operator) can overwrite instances of the Subscriber's AS Number in the AS Path with their own AS Number, when advertising routes to the Subscriber. This needs to be explicitly agreed between the SP and the Subscriber, and/or between an SP/SO and an Operator.
peeringAddresses	PeeringAddress	0..1	Peering Addresses.
holdTime	Integer	0..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.
authentication	String	0..1	BGP Authentication. It is either None or if present is a value of MD5 Password. It is assumed that an encrypted channel is

			used for API session so that the password is protected.
bgpCommunityList	BgpCommunity[]	0..*	Used to control which routers are accepted, preferred, distributed, or advertised.

Table 52-Bgp Attributes

13.1.2 BgpCommunity

A community is a group of destinations which share some common property. Each autonomous system administrator may define which communities a destination belongs to.

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
autonomousSystemDefined	Integer	1	The remaining octets.
autonomousSystemNumber	Integer	1	The first two octets encoding the Autonomous System value.

Table 53-BgpCommunity Attributes

13.1.3 BgpExtendedCommunity

This attribute provides a mechanism for labeling information carried in BGP-4. These labels can be used to control the distribution of this information, or for other applications.

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
regularValue	Integer	0..1	Octets 2-8 of the value part of the address. Used in case only Regular Type is provided.
extendedType	Integer	0..1	Extended Type Field, 2 octets length.
extendedValue	Integer	0..1	Octets 3-8 of the value part of the address. Used in case only Extended Type is provided.

regularType	Integer	0..1	Regular Type Field, 1 octet length.
-------------	---------	------	-------------------------------------

Table 54-BgpExtendedCommunity Attributes

one of:

- required: [regularType, regularValue]
- required: [extendedType, extendedValue]

13.1.4 Damping

Damping parameters as defined in RFC 2439 BGP Route Flap Damping, Section 4.2

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
cutoffThreshold	Integer	1	This value is expressed as a number of route withdrawals. It is the value above which a route advertisement will be suppressed.
decayHalfLifeWhileReachable	Integer	1	This value is the time duration in seconds during which the accumulated stability figure of merit will be reduced by half if the route is considered reachable (whether suppressed or not).
decayHalfLifeWhileUnreachable	Integer	1	This value is the time duration in seconds during which the accumulated stability figure of merit will be reduced by half if the route is considered unreachable. If not specified or set to zero, no decay will occur while a route remains unreachable.
decayMemoryLimit	Integer	1	This is the maximum time (in seconds) that any memory of previous instability will be retained given that the route's state remains unchanged, whether reachable or

			unreachable. This parameter is generally used to determine array sizes.
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.
numberOfReuseLists	Integer	1	This is the number of reuse lists. It may be determined from reuse-list-max or set explicitly.
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.
reuseListTimeGranularity	Integer	1	This is the time (in seconds) interval between evaluations of the reuse lists. Each reuse lists corresponds to an additional time increment.
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.
timeGranularity	Integer	1	This is the time granularity in seconds used to perform all decay computations.
reuseIndexArraySize	Integer	1	This is the size of reuse index arrays. This size determines the accuracy with which suppressed routes can be placed within the set of reuse lists when suppressed for a long time.

Table 55-Damping Attributes

13.1.5 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). *NOTE: UNI Access Link is applicable only to IP services.*

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
nextHopIpAddress	Ipv4OrIpv6Address	0..1	Next hop IP address.

Table 56-ForwardingInformation Attributes

13.1.6 PeeringAddress

Peering Addresses. Connection Addresses, or Loopbacks plus a list of pairs of IP addresses. Reference MEF 61.1 Section 12.7.3 BGP and MEF W70.2 Section 11.6.2 BGP.

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
subscriberAndSpLoopbackAddresses	SubscriberAndSpLoopbackAddresses	0..*	A list of pairs of IP addresses, 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. <i>NOTE: SD-WAN will have a single pair of IP addresses.</i> <i>Review.</i>
peeringAddressType	PeeringAddressType	0..1	SD-WAN unlike IP (MEF 61.1) will only use LOOPBACKS address with a single BGP Session. <i>NOTE: Review</i>

Table 57-PeeringAddress Attributes

13.1.7 PeeringAddressType

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. 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.

File: /sdWan/common/ipCommon.yaml

- CONNECTION_ADDRESSES
- LOOPBACKS

13.2 IP Addressing Model

The following section provides schemas specific to support for IPv4 and IPv6 specific to support for SD-WAN services. Note that the API schema leverages the OAS embedded *ipv4* and *ipv6* formats and uses them to specify the *Ipv4Address* and *Ipv6Address* data types that are used when an address value is provided.



Figure 14-Ipv4Address Model

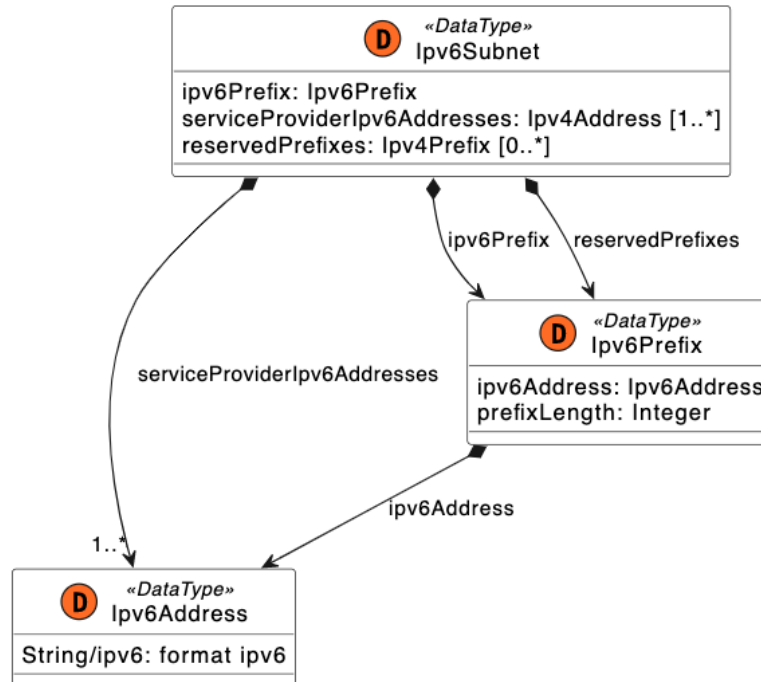


Figure 15-IPv6Address Model

13.2.1 AddressFamilyIpv4Ipv6

File: /sdWan/common/ipCommon.yaml

Specifies whether the session is established over IPv4 or IPv6.

- IPV4
- IPV6

13.2.2 Any

File: /sdWan/common/ipCommon.yaml

Used to specify ANY for IPv4 or IPv6 address.

- ANY

13.2.3 Dscp

File: /sdWan/common/ipCommon.yaml

Differentiated Services Code Point.

1205 type: integer

1206 maximum: 63

1207 minimum: 0

1208 **13.2.4 EnabledDisabled**

1209 File: /sdWan/common/ipCommon.yaml

1210 Enumeration to indicated Enabled or Disabled state of an attribute.

1211 • "ENABLED"

1212 • "DISABLED"

1213

1214 **13.2.5 IanaProtocolNumbers**

1215 File: /sdWan/common/ipCommon.yaml

1216

1217 Specifies whether the session is established over IPv4 or IPv6.

1218

1219 type: string

1220 enum:

1221 • HOPOPT

1222 • ICMP

1223 • IGMP

1224 • GGP

1225 • IPV4

1226 • ST

1227 • TCP

1228 • CBT

1229 • EGP

1230 • IGP

1231 • BBN_RCC_MON

1232 • NVP_II

1233 • PUP

1234 • ARGUS

1235 • EMCON

1236 • XNET

- 1237 • CHAOS
- 1238 • UDP
- 1239 • MUX
- 1240 • DCN_MEAS
- 1241 • HMP
- 1242 • PRM
- 1243 • XNS_IDP
- 1244 • TRUNK_1
- 1245 • TRUNK_2
- 1246 • LEAF_1
- 1247 • LEAF_2
- 1248 • RDP
- 1249 • IRTP
- 1250 • ISO_TP4
- 1251 • NETBLT
- 1252 • MFE_NSP
- 1253 • DCCP
- 1254 • 3PC
- 1255 • IDPR
- 1256 • XTP
- 1257 • DDP
- 1258 • IDRP_CMTTP
- 1259 • TP++
- 1260 • IL
- 1261 • IPV6
- 1262 • SDRP
- 1263 • IPV6_ROUTE
- 1264 • IPV6_FRAG
- 1265 • IDRP
- 1266 • RSVP
- 1267 • GRE
- 1268 • DSR
- 1269 • BNA
- 1270 • ESP
- 1271 • AH
- 1272 • I_NLSP
- 1273 • SWIPE
- 1274 • NARP
- 1275 • MOBILE
- 1276 • TLSP
- 1277 • SKIP

- 1278 • IPV6_ICMP
- 1279 • IPV6_NO_NXT
- 1280 • IPV6_OPTS
- 1281 • CFTP
- 1282 • SAT_EXPAK
- 1283 • KRYPTOLAN
- 1284 • RVD
- 1285 • IPPC
- 1286 • SAT_MON
- 1287 • VISA
- 1288 • IPCV
- 1289 • CPNX
- 1290 • CPHB
- 1291 • WSN
- 1292 • PVP
- 1293 • BR_SAT_MON
- 1294 • SUN_ND
- 1295 • WB_MON
- 1296 • WB_EXPAK
- 1297 • ISO_IP
- 1298 • VMTP
- 1299 • SECURE_VMTP
- 1300 • VINES
- 1301 • IPTM
- 1302 • NSFNET-IGP
- 1303 • DGP
- 1304 • TCF
- 1305 • EIGRP
- 1306 • OSPFIGP
- 1307 • SPRITE_RPC
- 1308 • LARP
- 1309 • MTP
- 1310 • AX_25
- 1311 • IPIP
- 1312 • MICP
- 1313 • SCC_SP
- 1314 • ETHERIP
- 1315 • ENCAP
- 1316 • GMTP
- 1317 • IFMP
- 1318 • PNNI

- 1319 • PIM
- 1320 • ARIS
- 1321 • SCPS
- 1322 • QNX
- 1323 • A_N
- 1324 • IP_COMP
- 1325 • SNP
- 1326 • COMPAQ_PEER
- 1327 • IPX_IN_IP
- 1328 • VRRP
- 1329 • PGM
- 1330 • L2TP
- 1331 • DDX
- 1332 • IATP
- 1333 • STP
- 1334 • SRP
- 1335 • UTI
- 1336 • SMP
- 1337 • SM
- 1338 • PTP
- 1339 • ISIS_OVER_IPV4
- 1340 • FIRE
- 1341 • CRTP
- 1342 • CRUDP
- 1343 • SSCOPMCE
- 1344 • IPLT
- 1345 • SPS
- 1346 • PIPE
- 1347 • SCTP
- 1348 • FC
- 1349 • RSVP_E2E_IGNORE
- 1350 • MOBILITY_HEADER
- 1351 • UDP_LITE
- 1352 • MPLS_IN_IP
- 1353 • MANET
- 1354 • HIP
- 1355 • SHIM6
- 1356 • WESP
- 1357 • ROHC
- 1358 • ETHERNET
- 1359 • AGGFRAG

- UNASSIGNED
- EXPERIMENTATION
- RESERVED

13.2.6 Ipv4Address

File: /sdWan/common/ipCommon.yaml

Data type representing IPv4 address.

Format: ipv4

13.2.7 Ipv4AddressOrAny

Data type which allows an IPv4 address or any IPv4 address to be specified.

File: /sdWan/common/ipCommon.yaml			
oneOf:			
required: Ipv4Address			
required: Any			
Attribute Name	Type	Multiplicity	Description

Table 58-Ipv4AddressOrAny Attributes

13.2.8 Ipv4ConnectionAddressing

A data type representing how IPv4 addresses are allocated to the devices on the Subscriber side.

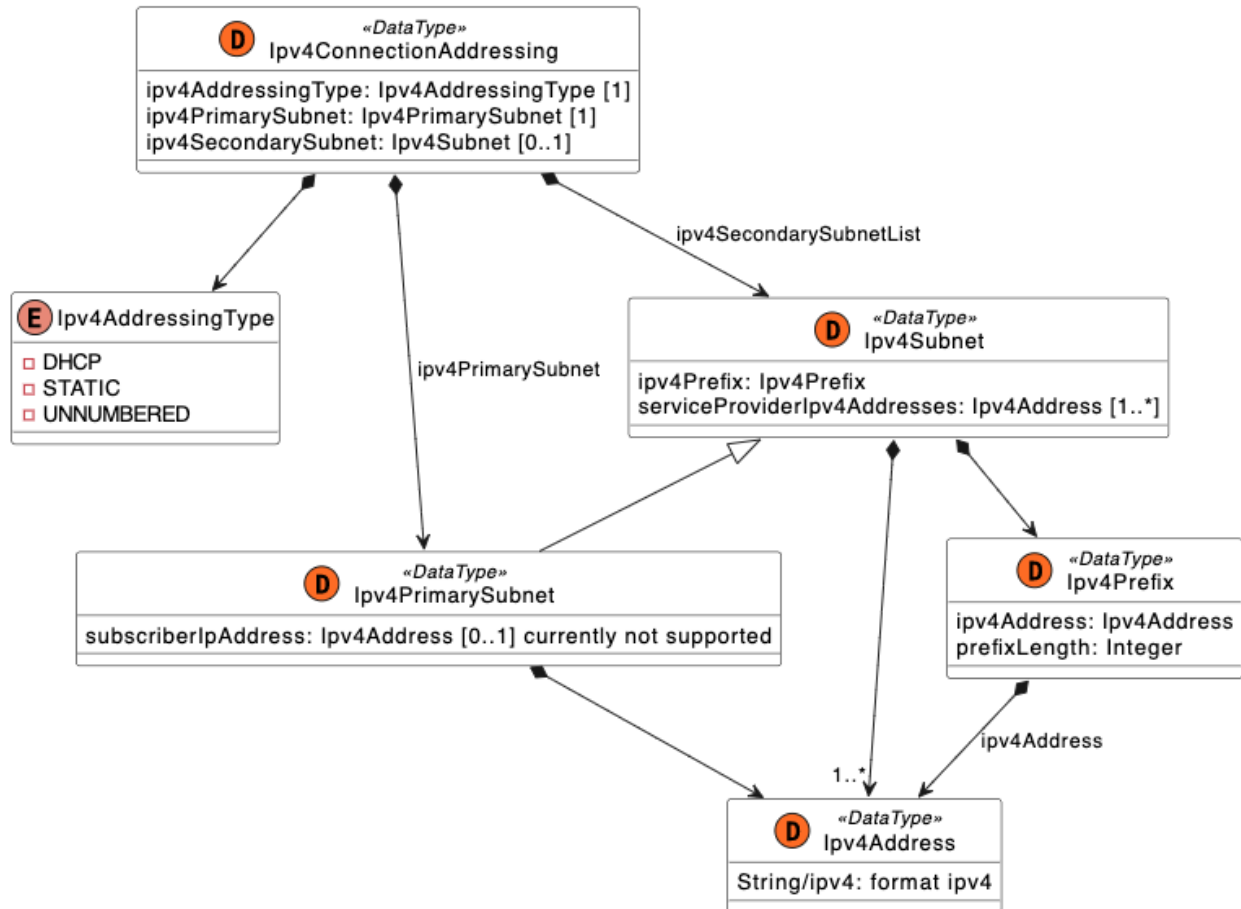


Figure 16-IPv4ConnectionAddressing Model

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4AddressingType	IPv4AddressingType	1	IPv4 address type.
ipv4PrimarySubnet	IPv4PrimarySubnet	1	Primary IPv4 Subnet.
ipv4SecondarySubnet	IPv4Subnet	0..*	Secondary IPv4 subnet list.

Table 59-IPv4ConnectionAddressing Attributes

13.2.9 IPv4AddressingType

Enumeration representing IPv4 Address Types.

File: /sdWan/common/ipCommon.yaml

- DHCP:
 - Dynamic Host Configuration Protocol (DHCP) is used the Subscriber devices to request IPv4 addresses in each subnet from the SP or Operator.
- STATIC:
 - IPv4 addresses in each IPv4 subnet are statically assigned to the SP or Operator and to the Subscriber.
- UNNUMBERED:
 - The SP or Operator and the Subscriber each assigned 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.

13.2.10 Ipv4Prefix

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

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
prefixLength	Integer	1	IPv4 address prefix. Length 0-31.
ipv4Address	Ipv4Address	1	IPv4 address.

Table 60-Ipv4Prefix Attributes

13.2.11 Ipv4Subnet

Data type representing an IPv4 subnet logical partition of an IP network. Included is list of Service Provider IPv4 addresses.

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4Prefix	Ipv4Prefix	1	IPv4 address prefix (IPv4 address prefix and mask length between 0 and 31 in bits).
serviceProviderIpv4Addresses	Ipv4Address	1..*	List of Service Provider IPv4 addresses. [R25] If 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 69.1[1] Section 9.4 Subscriber

			Internet Access Service: UNI Access Link Requirements
reservedPrefixes	Ipv4Prefix	0..*	List of IPv4Prefixes, possibly empty.

Table 61-Ipv4Subnet Attributes

13.2.12 Ipv4PrimarySubnet

Used in context of Primary subnet. It adds the subscriberIpv4Address attribute to the Ipv4Subnet.

File: /sdWan/common/ipCommon.yaml			
Inherits from: Ipv4Subnet			
Attribute Name	Type	Multiplicity	Description
subscriberIpv4Address	Ipv4Address	0..1	Subscriber IPv4 Address.

Table 62-Ipv4PrimarySubnet Attributes

13.2.13 Ipv6Address

Data type representing IPv6 address.

File: /sdWan/common/ipCommon.yaml

Format: ipv6

13.2.14 Ipv6AddressOrAny

Data type which allows an IPv6 address or any IPv6 address to be specified.

File: /sdWan/common/ipCommon.yaml			
oneOf:			
required: Ipv6Address			
required: Any			
Attribute Name	Type	Multiplicity	Description

Table 63-Ipv6AddressOrAny Attributes

13.2.15 Ipv6AddressingType

Enumeration representing IPv6 Address Types.

File: /sdWan/common/ipCommon.yaml

- DHCP:
 - Dynamic Host Configuration Protocol (DHCP) is used the Subscriber devices to request IPv4 addresses in each subnet from the SP.
- SLAAC:
 - Stateless Address Autoconfiguration is used by the Subscriber devices to create unique IPv6 global addresses within an IP prefix advertised by the SP or Operator as described in RFC 4826.
- STATIC:
 - IPv4 addresses in a given IPv4 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 addressed used on the UNI.

13.2.16 Ipv6ConnectionAddressing

A data type representing how IPv6 addresses are allocated to the devices on the Subscriber side.

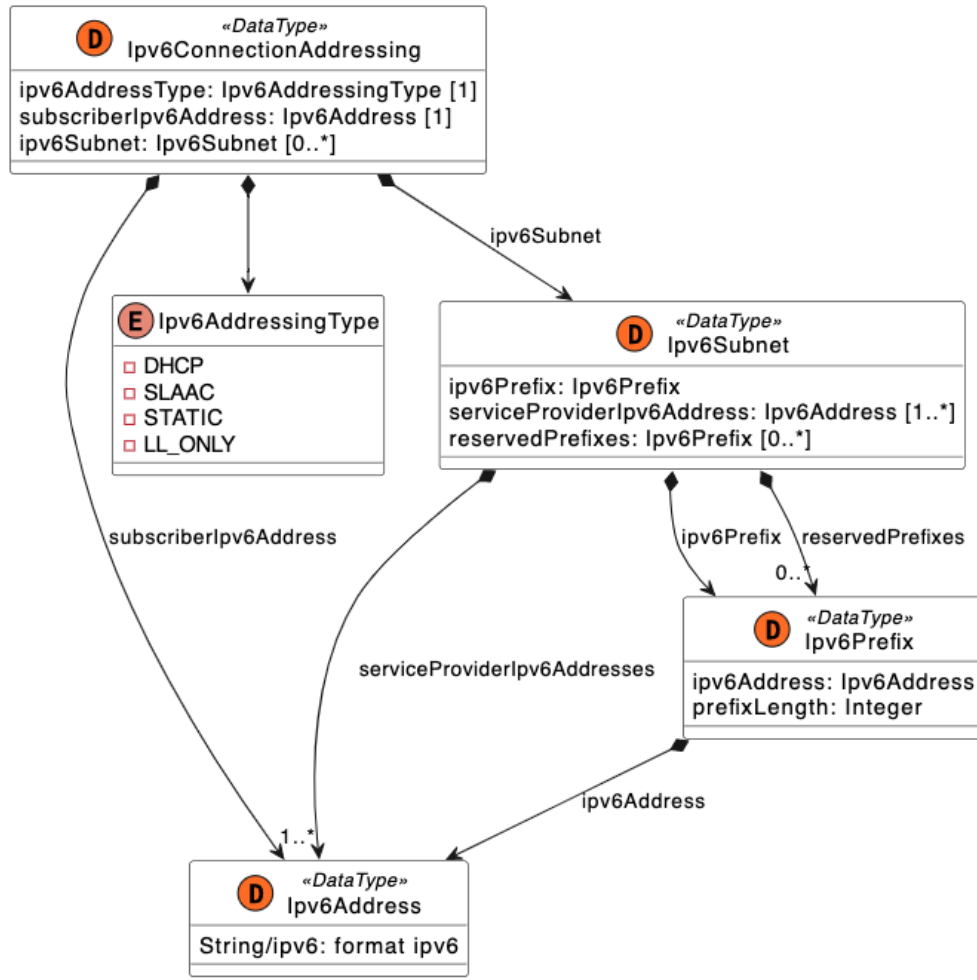


Figure 17-Ipv6ConnectionAddressing Model

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv6AddressingType	Ipv6AddressingType	1	IPv6 address type.
subscriberIpv6Address	Ipv6Address	1	Subscriber IPv6 address.
ipv6Subnet	Ipv6Subnet	0..*	IPv6 subnet list.

Table 64-Ipv6ConnectionAddressing Attributes

13.2.17 Ipv6AddressingType

Enumeration representing IPv6 Address Types.

File: /sdWan/common/ipCommon.yaml

- DHCP:
 - Dynamic Host Configuration Protocol (DHCP) is used the Subscriber devices to request IPv4 addresses in each subnet from the SP or Operator.
- SLAAC:
 - Stateless Address Autoconfiguration (SLAAC) is used by the Subscriber devices to create unique IPv6 global addresses in a given IP Prefix advertised by SP as described in RFC 4862.
- STATIC:
 - IPv6 addresses in a given IPv6 subnet are statically assigned to the SP and to the Subscriber.
- LL_ONLY:
 - If the value if LL-only, these are only IPv6 addresses used.

13.2.18 Ipv6Prefix

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

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
prefixLength	Integer	0..1	IPv6 address prefix. Length 0-127.
ipv6Address	Ipv6Address	1	IPv6 address.

Table 65-Ipv6Prefix Attributes

13.2.19 Ipv6Subnet

Data type representing an IPv6 subnet logical partition of an IP network. Included is list of Service Provider IPv6 addresses.

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv6Prefix	Ipv6Prefix	1	IPv6 address prefix (IPv6 address prefix and mask length between 0 and 127 in bits).
serviceProviderIpv6Addresses	Ipv6Address	1..*	List of Service Provider IPv6 addresses.
reservedPrefixes	Ipv6Prefix	0..*	List of IPv6Prefixes, possibly empty.

Table 66-Ipv6Subnet Attributes

13.2.20 Ipv4OrIpv6Prefix

Data type representing an IPv4 or IPv6 prefix. Includes subnet address and prefix length.

File: /sdWan/common/ipCommon.yaml			
one of:			
-required: [ipv4Prefix]			
-required: [ipv6Prefix]			
Attribute Name	Type	Multiplicity	Description
ipv6Prefix	Ipv6Prefix	0..1	IPv6 prefix.
ipv4Prefix	Ipv4Prefix	0..1	IPv4 prefix.

Table 67-Ipv4OrIpv6Prefix Attributes

13.2.21 Ipv4OrIpv6Address

Data type representing IPv4 or IPv6 address.

File: /sdWan/common/ipCommon.yaml

type: string

oneOf:

- format: ipv4
- format: ipv6

13.3 NetworkAddressTranslation

When Ingress IP Packets are destined to the Internet via Internet Breakout, the Subscriber might require the SD-WAN Service Provider to perform Network Address Translation (NAT), translating the Subscriber's IP addresses into public IP addresses and vice versa.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description

ipversion	Enum: - IPV4 - IPv6 - BOTH	1	An enumeration that indicates the type(s) of Subscriber addresses that are translated.
publicPrefix	Ipv4Prefix	1..*	Public-assigned IPv4 Prefix representing the public address or addresses that the Subscriber's IP addresses are translated to (and from).
exceptions	Ipv4Prefix	0..*	A list (possibly empty) of IP prefixes that are not subject to translation.

Table 68-NetworkAddressTranslation Attributes

13.4 Ospf Model

When an entry in the UNI Routing Protocols is for OSPF, OSPF as specified in RFC 2328 (for IPv4) and/or RFC 5340 (for IPv6) is used across each UNI Access Link (IP) and UNI (for SD-WAN) to exchange routing information. Reference MEF 61.1 Section 12.7.2 OSPF and MEF W70.2 Section 11.6.3 OSPF.

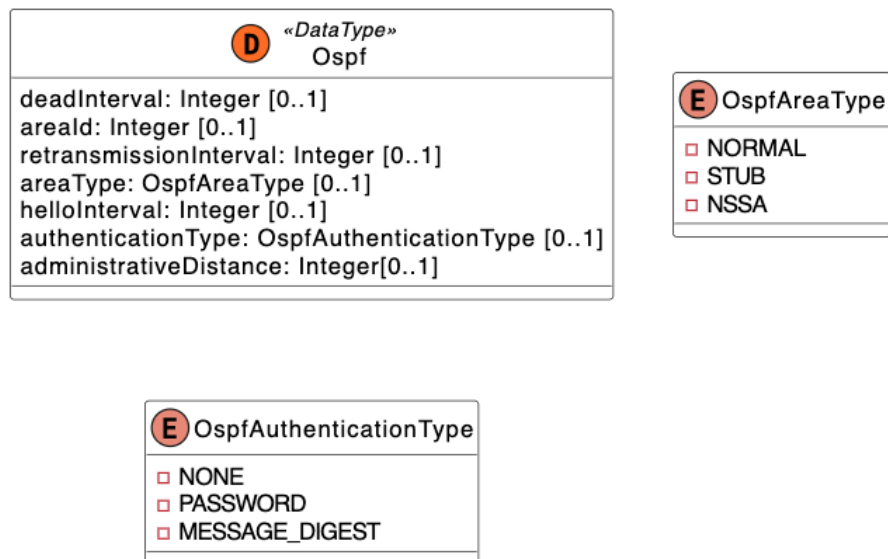


Figure 18-OSPF Model

13.4.1 Ospf

File: /sdWan/common/ipCommon.yaml

Attribute Name	Type	Multiplicity	Description
areaid	Integer	0..1	Area ID (0-429967295), normally expressed as an IPv4 address.
areaType	OspfAreaType	0..1	OSPF Area Type enumeration.
authenticationType	OspfAuthentication Type	0..1	OSPF Authentication Type.
helloInterval	Integer	0..1	Hello interval (0-429967295, in seconds).
deadInterval	Integer	0..1	Dead interval (0-429967295, in seconds).
retransmissionInterval	Integer	0..1	Retransmit interval (integer greater than 0, in seconds).
administrativeDistance	Integer	0..1	Administrative distance (integer greater than 0).

Table 69-Ospf Attributes

13.4.2 OspfAreaType

OSPF Area Type enumeration. Reference MEF 61.1 Section 12.7.2 OSPF and MEF W70.2 Section 11.6.3 OSPF.

File: /sdWan/common/ipCommon.yaml

- NORMAL
- STUB
- NSSA

13.4.3 OspfAuthenticationType

OSPF Authentication Type enumeration.

File: /sdWan/common/ipCommon.yaml

- NONE
- PASSWORD
- MESSAGE_DIGEST

13.5 PerformanceTimeIntervals

Specifies a set of time intervals used in the determination of the performance of all Paths in the SWVC. The value of the Service Attribute is a 3-tuple <evalInterval,arrivalInterval,irDuration>. Reference MEF 70.2 Section 9.7 SWVC Performance Time Intervals Service Attribute.

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File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
evalInterval	Integer	1	The interval in milliseconds over which the Performance Metrics specified in the performance Policy Criterion are evaluated.
arrivalIntervals	Integer	1	The difference in arrival times (specified in milliseconds) at the Ingress UNI between two packets used to compute the Mean One-Way Packet Delay Variation.
irDuration	Integer Maximum = 1000	1	The time interval in milliseconds over which the information rate is determined in the evaluation of the BANDWIDTH Policy Criterion. The information rate is determined over any time interval of duration. Should not exceed 1000 milliseconds.

Table 70-PerformanceTimeIntervals Attributes

1500

13.6 RateLimiter

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A 3-tuple, <name, commit, limit> where:

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- name is an Identifier String that is name of Rate Limiter.
- commit is the threshold rate (bits per second) at or below which the SD-WAN Service Provider commits to deliver packets in the Bandwidth Flow with high probability under all traffic conditions.
- limit is the threshold information rate (bits per second) above which the Service Provider does not deliver IP Packet in the Bandwidth Flow under any conditions.

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Reference MEF 70.2 Section 9.9 SWVC List of Rate Limiters Service Attribute.

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File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
name	String	1	Identifier of Rate Limiter.
commit	InformationRate	1	Threshold rate at or below which the SD-WAN Service Provider

			commits to deliver packets in the Bandwidth Flow with high probability under all traffic conditions.
limit	InformationRate	1	Threshold information rate above which the Service Provider does not deliver IP Packet in the Bandwidth Flow under any conditions.

Table 71-RateLimiter Attributes

13.7 Routing Protocols Model

The UNI Routing Protocol Service Attribute specifies the specifies the 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, BGP, or OSPF), the type of routes that will be exchanged (one of IPv4, IPv6 or Both), and a set of additional parameters as specified in the subsections below. According to [R109] in MEF 61.1 and [R139] in MEF W70.2 the value of the UNI Routing Protocols Service Attribute **MUST NOT** contain more than one entry for the same protocol name, except when there are exactly two entries with a given protocol name, one with route type IPv4 and one with route type IPv6. This means per given type of routing protocols one out of four possible sets of configurations can be provided: IPv4, IPv6, IPv4 and IPv6, Both. To model that in the API resource model additional types have been added *RoutingProtocolsXXXOptions* that has four mutually exclusive attributes: *ipv4*, *ipv6*, *ipv4Andipv6*, *both*, respectively to handle this requirement.

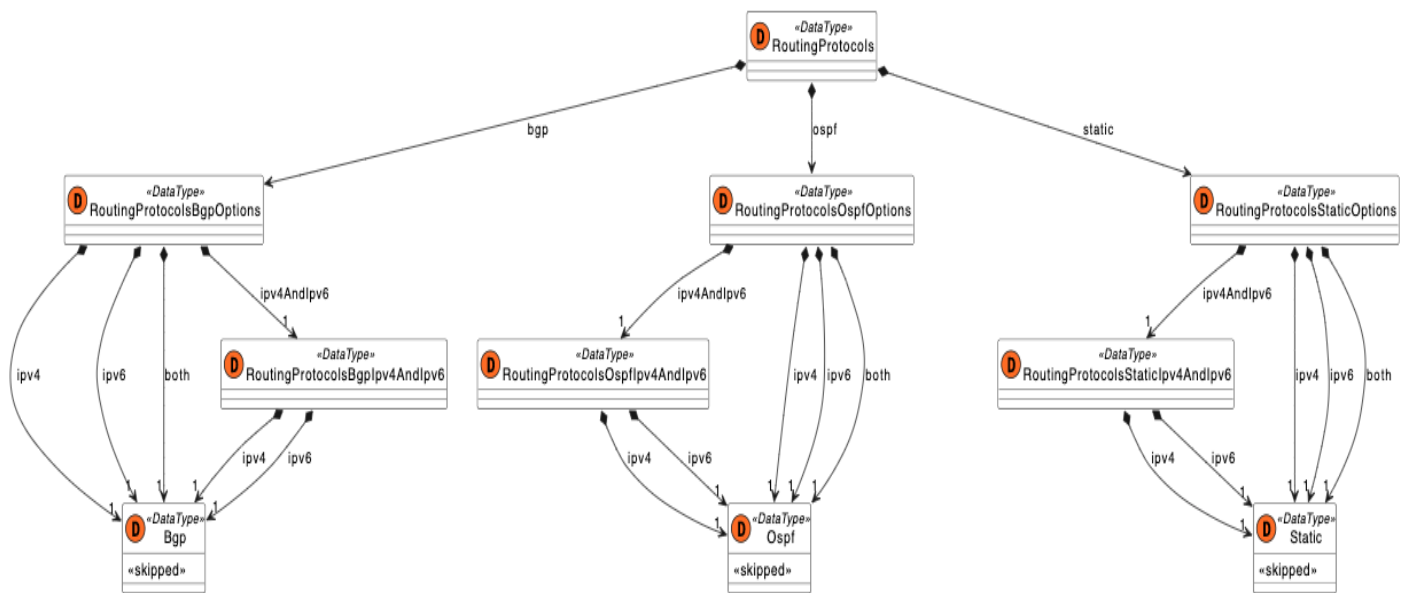


Figure 19-RoutingProtocols Model

13.7.1 RoutingProtocols

Data type to support routing protocols and associated parameters that are used to exchange IP routes across a UNI. The value is a list of protocols (possibly empty), where each entry consists of the protocol name (one of Static, BGP, or OSPF) the type of routes that will be exchanged (one of IPv4 or IPv6 or Both) and a set of additional parameters as specified. Reference MEF 61.1 Section 12.7 UNI Routing Protocols Service Attribute or MEF W70.2 Section 11.6 SD-WAN UNI Routing Protocols Service Attribute.

File: /common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
static	RoutingProtocolStaticOptions	0..1	Static routing configuration options.
bgp	RoutingProtocolBgpOptions	0..1	BGP routing protocol configuration options.
ospf	RoutingProtocolOspfOptions	0..1	OSPF routing protocol configuration options.

Table 72-RoutingProtocol Attributes

13.7.2 RoutingProtocolsBgpIpv4AndIpv6

Configuration for exchanging IPv4 and IPv6 types of routes.

File: /common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4	Bgp	1	Configuration for exchanging IPv4 types of routes.
ipv6	Bgp	1	Configuration for exchanging IPv6 types of routes.

Table 73-RoutingProtocolsBgpIpv4AndIpv6 Attributes

13.7.3 RoutingProtocolsBgpOptions

BGP routing protocol configuration options. The configuration of the BGP can be provided for the following type of routes that will be exchanged:

- ipv4, or
- ipv6, or
- both, or

- ipv4 and ipv6

File: /common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4	Bgp	0..1	Configuration for exchanging IPv4 types of routes.
ipv6	Bgp	0..1	Configuration for exchanging IPv6 types of routes.
ipv4Andipv6	RoutingProtocolsBgp plpv4Andipv6	0..1	Configuration for exchanging IPv4 and IPv6 types of routes.
both	Bgp	0..1	Configuration for exchanging both IPv4 and IPv6 types of routes.

Table 74-RoutingProtocolsBgpOptions Attributes

oneOf:

- required: [ipv4]
- required: [ipv6]
- required: [both]
- required: [ipv4AndIpv6]

13.7.4 RoutingProtocolsOspfIpv4AndIpv6

Configuration for exchanging IPv4 and IPv6 types of routes.

File: /common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4	Ospf	1	Configuration for exchanging IPv4 types of routes.
Ipv6	Ospf	1	Configuration for exchanging IPv6 types of routes.

Table 75-RoutingProtocolsOspfIpv4AndIpv6 Attributes

13.7.5 RoutingProtocolsOspfOptions

OSPF routing protocol configuration options. The configuration of the OSPF can be provided for the following types of routes that will be exchanged:

- ipv4, or
- ipv6, or
- both, or
- ipv4 and ipv6

File: /common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4	Bgp	0..1	Configuration for exchanging IPv4 types of routes.
ipv6	Bgp	0..1	Configuration for exchanging IPv6 types of routes.
ipv4Andipv6	RoutingProtocolsOs pflpv4AndIpv6	0..1	Configuration for exchanging IPv4 and IPv6 types of routes.
both	Ospf	0..1	Configuration for exchanging both IPv4 and IPv6 types of routes.

Table 76-RoutingProtocolsOspfOptions Attributes

oneOf:

- required: [ipv4]
- required: [ipv6]
- required: [both]
- required: [ipv4AndIpv6]

13.7.6 RoutingProtocolsStaticIpv4AndIpv6

Configuration for exchanging IPv4 and IPv6 types of routes.

File: /common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4	Static	1	Configuration for exchanging IPv4 types of routes.
Ipv6	Static	1	Configuration for exchanging IPv6 types of routes.

Table 77-RoutingProtocolsStaticIpv4AndIpv6 Attributes

13.7.7 RoutingProtocolsStaticOptions

Static routing protocol configuration options. The configuration of the Static can be provided for the following types of routes that will be exchanged:

- ipv4, or
- ipv6, or
- both, or
- ipv4 and ipv6

File: sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
ipv4	Static	0..1	Configuration for exchanging IPv4 types of routes.
ipv6	Static	0..1	Configuration for exchanging IPv6 types of routes.
ipv4Andipv6	RoutingProtocolsStaticIpv4AndIpv6	0..1	Configuration for exchanging IPv4 and IPv6 types of routes.
both	Static	0..1	Configuration for exchanging both IPv4 and IPv6 types of routes.

Table 78-RoutingProtocolsStaticOptions Attributes

oneOf:

- required: [ipv4]
- required: [ipv6]
- required: [both]
- required: [ipv4AndIpv6]

13.7.8 ServiceNameAndTransportProtocols

Service names and port numbers are used to distinguish between different services that run over transport protocols such as TCP, UDP, DCCP, and SCTP.

File: sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
serviceName	string	1	Service name.

portNumber	Integer Min: 0 Max: 65535	1	Port number.
transportProtocol	String Enum: • TCP • UDP	1	Transport protocol.

Table 79-ServiceNameAndTransportProtocols Attributes

13.7.9 ServiceNameAndTransportProtocolsOrAny

Data type which allows an ServiceNameAndTransportProtocols or Any.

File: /sdWan/common/ipCommon.yaml oneOf: required: ServiceNameAndTransportProtocols required: Any			
Attribute Name	Type	Multiplicity	Description
subscriberIpv4Address	Ipv4Address	0..1	Subscriber IPv4 Address.

Table 80-ServiceNameAndTransportProtocolsAndAny Attributes

13.8 ServicePerformanceObjectivesReportingPeriods

Service Performance Objectives are evaluated over a series of consecutive time periods. The value of this Service Attribute is a 2-tuple <s,T> where:

- s (startTime) is a time that represents the date and time that the evaluation of Service Performance Objectives starts for the SWVC and its components.
- T (duration) is a time duration.

Reference MEF 70.2 Section 9.8 SWVC Service Performance Objectives Reporting Periods Service Attribute.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description

startTime	TimeAndDate	1	Time that represents the date and time that the evaluation of Service Performance Objectives starts for the SWVC and its components.
duration	TimeDuration	1	Time duration.

Table 81-ServicePerformanceObjectivesReportingPeriods Attributes

13.9 Static Model

When an entry in the (SD-WAN) UNI Routing Protocols list is for Static, the IP Prefixes used in the Subscriber Network that are reachable via this UNI are specified as additional parameters in the entry. These are known as Static IP Prefixes. Reference MEF 61.1 Section 12.7.1 Static and MEF W70.2 Section 11.6.1.

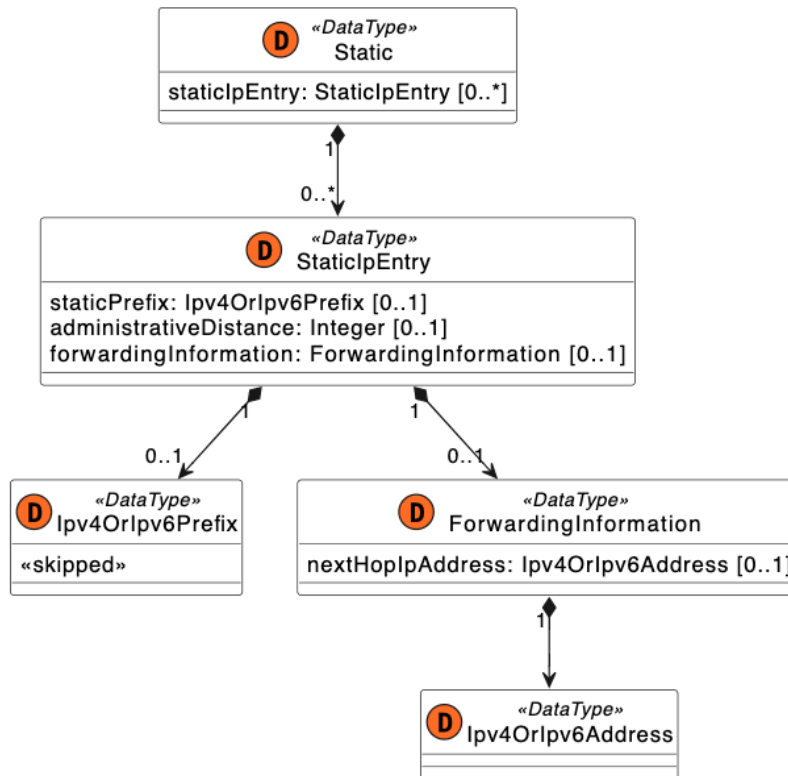


Figure 20-Static Model

13.9.1 Static

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description

staticIpEntry	StaticIpEntry	1..*	Static IP address entry.
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Table 82-Static Attributes

13.9.2 StaticIpEntry

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

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
staticIpEntry	StaticIpEntry	1..*	Static IP address entry.

Table 83-Static Attributes

13.10 SubscriberAndSpLoopbackAddresses

A list of pairs of IP addresses, 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.

File: /sdWan/common/ipCommon.yaml			
Attribute Name	Type	Multiplicity	Description
subscriberLoopbackAddress	Ipv4OrIpv6Address	0..1	Subscriber's loopback address for BGP establishing a session.
spLoopbackAddress	Ipv4OrIpv6Address	0..1	Service Provider's loopback address for BGP establishing a session.

Table 84-SubscriberAndSpLoopbackAddresses Attributes

13.11 SwVcIdentifier

File: /sdWan/sdWanCommon.yaml

The value of SWVC Identifier Service Attribute is a string that is used by the Subscriber and the Service Provider to uniquely identify an SWVC. Reference MEF 70.2 Section 9.1 SWVC Identifier Service Attribute.

- type: string
- maxLength: 53
- pattern: "[/x20-\x7F]+"

13.12 SwVcEndPointIdentifier

File: /sdWan/sdWanCommon.yaml

SWVC End Point Identifier as described in MEF 70.2 Section 10.1 SWVC End Point Identifier Service Attribute. A string that is used to allow the Subscriber and Service Provider to uniquely identify the association of the SWVC with a UNI.

- type: string
- maxLength: 53
- pattern: "[/x20-\x7F]+"

13.13 TimeAndDate

Date type for Time and Date in UTC.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
day	Integer	1	This denotes the day.
hour	Integer	1	This denotes the hour.
minute	Integer	1	This denotes the minute.
month	Integer	1	This denotes the month.
second	Integer	1	This denotes the second.
year	Integer	1	This denotes the year.

Table 85-TimeAndDate Attributes

13.14 TimeDuration

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

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
timeDurationValue	integer	1	The value of the duration. For example, if the duration is 20 ms, this element is 20.

timeDurationUnits	TimeDurationUnits	1	The unit of measure in duration. For example, if an interval is 2 ms, this element is NS.
-------------------	-------------------	---	---

Table 86-TimeDuration Attributes

13.15 TimeDurationUnits

File: /sdWan/sdWanCommon.yaml

The unit of measure in the duration. For example, if an interval is 2ms, this element is MS.

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

13.16 Ucs

Underlay Connectivity Services are network services independent of the SD-WAN Service and can have many "characteristics" or "attributes" that define their configuration and behavior. Reference MEF 70.2, Section 12.1 UCS Service Attributes.

Schema File Name: sdWan/ucs.yaml			
\$id: urn:mef:iso:spec:legato:ucs:v0.0.1:all			
Attribute Name	Type	Multiplicity	Description
ucsIdentifier	UcsIdentifier	1	The value is a string that is to allow the Subscriber and Service Provider to uniquely identify an Underlay Connectivity Service.

			Reference MEF 70.2 Section 9.2 SWVC List of UCSs Service Attribute.
ucsType	UcsType	1	UcsType is an enumeration that represents the type of Underlay Connectivity Service types. Reference MEF 70.1 Section 12.1.2 UCS Type Service Attribute.
ucsBillingMethod	UcsBillingMethod	1	UcsBillingMethod is an enumeration that indicates how access to the Underlay Connectivity Service is billed. Reference MEF 70.2 Section 12.1.3 UCS Billing Method Service Attribute.

Table 87-Ucs Attributes

13.17 UcsBillingMethod

File: /sdWan/sdWanCommon.yaml

UcsBillingMethod is an enumeration that indicates how access to the Underlay Connectivity Service is billed. Reference MEF 70.2 Section 12.1.3 UCS Billing Method Service Attribute.

- FLAT_RATE
- USAGE_BASE
- OTHER

13.18 UcsIdentifier

File: /sdWan/sdWanCommon.yaml

UCS Identifier as described in MEF 70.2 Section 12.1 UCS Identifier Service Attribute. A string that is used to allow the Subscriber and Service Provider to uniquely identify an Underlay Connectivity Service.

- type: string
- maxLength: 53
- pattern: "[/x20-\x7F]+"

13.19 UcsType

UcsType is an enumeration that represents the type of Underlay Connectivity Service types. Reference MEF 70.2 Section 12.1.2 UCS Type Service Attribute.

- PUBLIC
- PRIVATE

13.20 UnnamedRateLimiter

A 2-tuple, <name, commit, limit> where:

- `commit` is the threshold rate (bits per second) at or below which the SD-WAN Service Provider commits to deliver packets in the Bandwidth Flow with high probability under all traffic conditions.
- `limit` is the threshold information rate (bits per second) above which the Service Provider does not deliver IP Packet in the Bandwidth Flow under any conditions.

Reference MEF 70.2 Section 9.9 SWVC List of Rate Limiters Service Attribute.

File: /sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
commit	InformationRate	1	Threshold rate at or below which the SD-WAN Service Provider commits to deliver packets in the Bandwidth Flow with high probability under all traffic conditions.
limit	InformationRate	1	Threshold information rate above which the Service Provider does not deliver IP Packet in the Bandwidth Flow under any conditions.

Table 88-UnnamedRateLimiter Attributes

13.21 VirtualTopology

Attribute representing differing forwarding topologies to different Application Flows. The value is a list of 3-tuples of the form <vtName, vtType, vtEP>. Reference MEF 70.2 Section 9.6 SWVC List of Virtual Topologies Service Attribute.

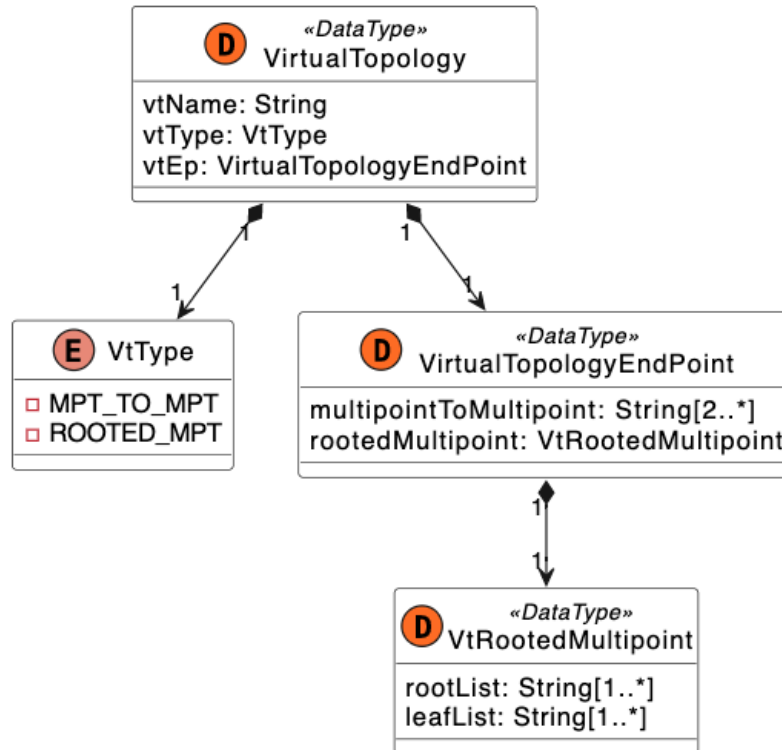


Figure 21-VirtualTopology Model

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
vtName	String	1	An identifier String that specifies the name of the Virtual Topology.
vtType	Enum: - MPT_TO_MPT - ROOTED_MPT	1	Provides a description of the type of connectivity provided by the Virtual Topology.
vtEp	VirtualTopologyEnd Point	1	Provides details of the SWVC End Points that are connected by the Virtual Topology.

Table 89-VirtualTopology Attributes

13.22 VirtualTopologyEndPoint

Virtual Topology End Point data type.

Schema File Name: sdWan/sdWanCommon.yaml	
one of:	

-required: [multipointToMultipoint]			
-required: [rootedMultipoint]			
Attribute Name	Type	Multiplicity	Description
multipointToMultipoint	SwVcEndPointIdentifier	2..*	Multipoint-to-Multipoint for a Virtual Topology requires specifying at least two SWVC End Point Identifiers,
rootedMultipoint	VtRootedMultipoint	1	Rooted-Multipoint Virtual Topology.

Table 90-VirtualTopologyEndPoint Attributes

13.23 VtRootedMultipoint

Rooted-multipoint data type for a Virtual Topology.

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
rootList	SwVcEndPointIdentifier	1..*	Root list.
leafList	SwVcEndPointIdentifier	1..*	Leaf list.

Table 91-VirtualTopologyEndPoint Attributes

13.24 Zone

Provides a mechanism to identify the Zones supported by SD-WAN Service and to enumerate a set of Zone-side Policies for each Zone. Reference MEF 70.2 Section 9.5 SWVC List of Zones Service Attribute.

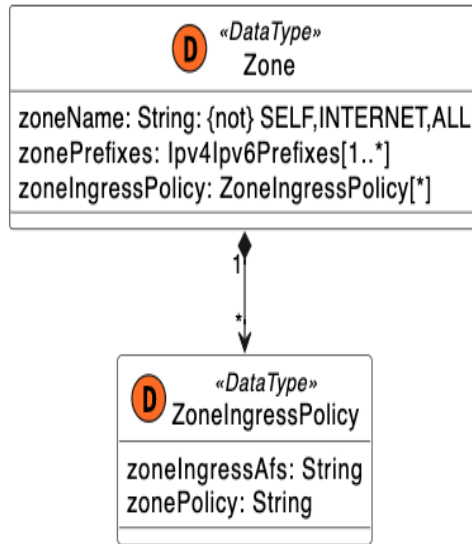


Figure 22-Zone Model

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
zoneName	String NOT(SELF, INTERNET, ALL)	1	An identifier String that specifies the name of the Zone.
zonePrefixes	Ipv4Ipv6Prefixes	1..*	Non-empty list of IP prefixes that identify the hosts in the Zone.
zoneIngressPolicy	ZoneIngressPolicy	0..*	A list (possibly empty) of 2-tuples <zoneIngressEFS, zoneIPol>.

Table 92-Zone Attributes

Schema File Name: sdWan/sdWanCommon.yaml			
Attribute Name	Type	Multiplicity	Description
zoneIngressAfs	String	1	Application Flow Specification Group Name.
zonePolicy	String	1	Name of ingress policy.

Table 93-ZoneIngressPolicy Attributes

14 References

- [1] IETF JSON Schema draft 7, *JSON Schema: A Media Type for Describing JSON Documents* and associated documents, by Austin Wright and Henry Andrews, March 2018. Copyright © 2018 IETF Trust and the persons identified as the document authors. All rights reserved.
- [2] IETF RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, by S. Bradner, March 1997.
- [3] IETF RFC 3444, *On the Difference between Information Models and Data Models*, January 2003
- [4] IETF RFC 4271, *A Border Gateway Protocol 4 (BGP-4)*, by Dr. Yakov Rekhter, January 2006. Copyright © The Internet Society (2006). All Rights Reserved.
- [5] IETF RFC 8174, *Ambiguity of Uppercase vs. Lowercase in RFC 2119 Key Words*, by B. Leiba, May 2017. Copyright © 2017 IETF Trust and the persons identified as the document authors. All rights reserved.
- [6] MEF 55.1, *Lifecycle Service Orchestration (LSO): Reference Architecture and Framework*, January 2021.
- [7] MEF W70.2 *SD-WAN Service Attributes and Service Framework*, January 2022.

Appendix A Usage examples (Informative)

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

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

The examples are delivered in two forms:

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

A.1 High-level Flow

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

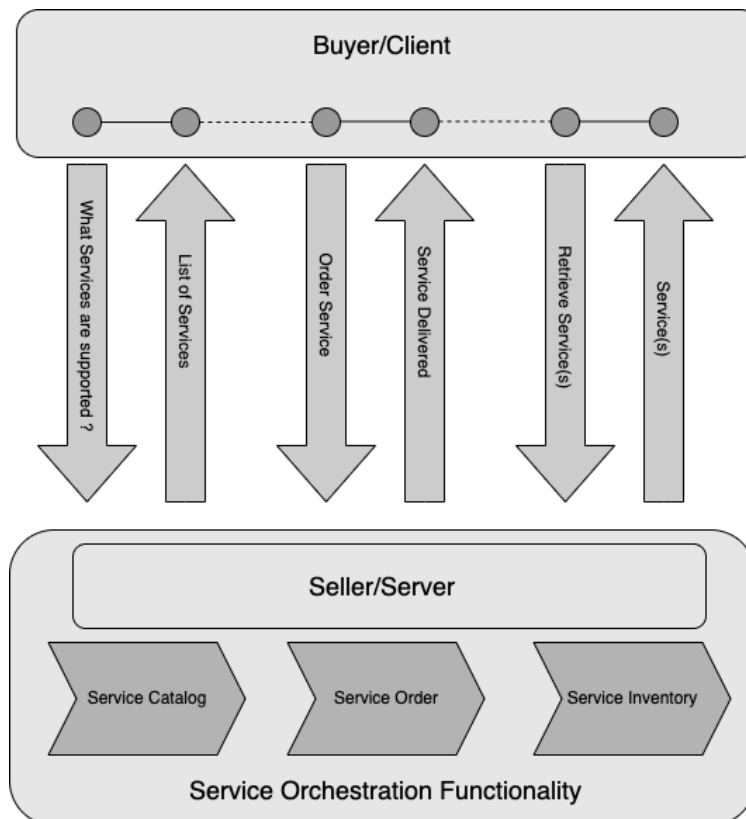


Figure 23-Legato End-to-End Flow

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

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

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

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

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

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

The extension hosting type in the API data model is `MefServiceConfiguration`. The `@type` attribute of that type must be set of a value that uniquely identifies the service specification. See Figure 24 and Figure 25. Figure 24-Extension Pattern: SD-WAN A unique identifier for MEF standard service specifications is in URN format and is assigned by MEF. This identifier is provided as root schema `$id` and in service specification documentation. In this case, this will be in format of examples below:

- `urn:mef:lso:spec:legato:sdWanUni:v0.0.1:all`
- `urn:mef:lso:spec:legato:sWvc:v.0.0.1:all`
- `urn:mef:lso:spec:legato:swVcEndPoint:v.0.0.1:all`
- `urn:mef:lso:spec:legato:ucs:v.0.0.1:all`
- `urn:mef:lso:spec:legato:ucsEndPoint:v.0.0.1:all`
- `urn:mef:lso:spec:legato:ucsUni:v.0.0.1:all`

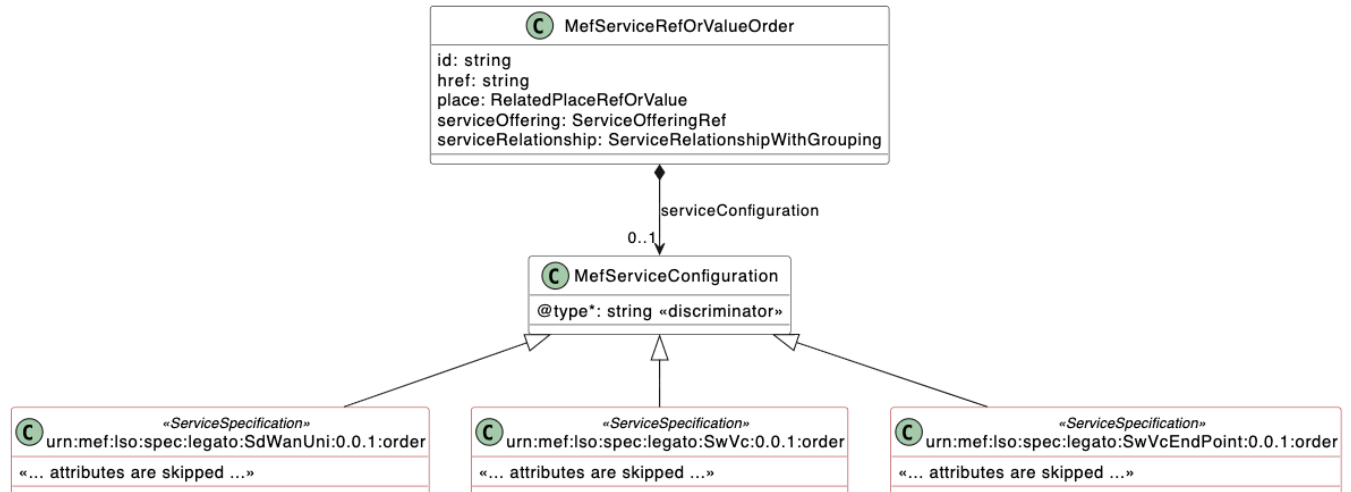


Figure 24-Extension Pattern: SD-WAN

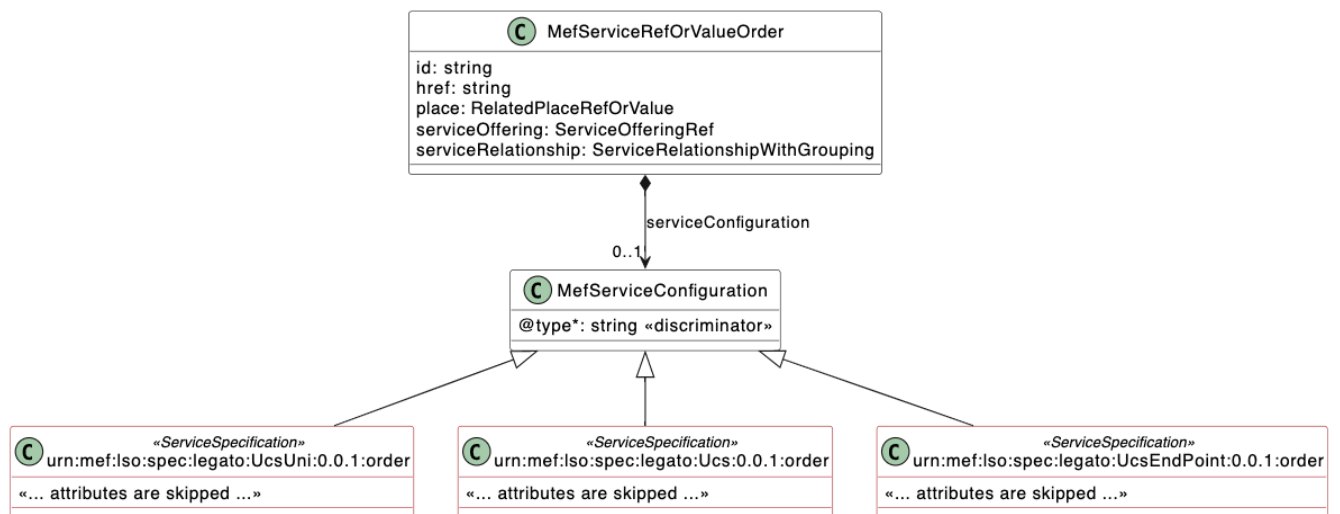


Figure 25-Extension Pattern: Underlay Connectivity Service

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

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

Figure 26-Service Order with SD-WAN Example

A.3 Action: Add

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

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

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

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

- `item.action` must be set to `add`
- `item.service.id` must not be provided
- `service.serviceConfiguration` must contain all desired configurations

A.3.1 Use Case 1: Service Order

Editor Note 2: Add Service Order Request

Figure 27-UC1: Service Order Request

Editor Note 3: Add Service Order Response

Figure 28-UC1: Service Order Response

Editor Note 4: Add Service Order Sequence Diagram

Figure 29-UC1: Service Order Sequence Diagram

Figure 30-UC1: Setup Diagram

This setup involves:

- Creation of the SD-WAN UNI(s):
 - `place: Minneapolis` (Location)
 - `place: St. Paul` (Location)
- Creation of the SD-WAN VC, including End Points and UCS components:
 - Configuration of a new SD-WAN UNI End Point with `id`

1819 **A.4 Action: Modify**

1820

1821 **A.4.1 Use Case 2: Service Order: Bandwidth change**

1822

1823 **A.4.2 Use Case 3: Service Order: IPv4 Static IP Address change at the SD-WAN UNI**

1824

1825 **A.5 Action: Delete**

1826

1827 **A.5.1 Use Case 4: Service Order: Delete SD-WAN UNI(s), SWVC and associated SWVC End**
1828 **Points**

1829

1830 **A.5.2 Use Case 5: Move SD-WAN UNI to a different Location**

1831