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A YANG Data Model for SD-WAN Service Delivery
draft-sun-opsawg-sdwan-service-model-04

Abstract

This document provides a YANG data model for an SD-WAN service. An SD-WAN service is a connectivity service offered by a service provider network to provide connectivity across different locations of a customer network or between a customer network and an external network, such as the Internet or a private/public cloud network. This connectivity is provided as an overlay constructed using one of more underlay networks. The model can be used by a service orchestrator of a service provider to request, configure, and manage the components of an SD-WAN service.

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[1.](#) Introduction

An SD-WAN service is a connectivity service offered by a service provider network to provide connectivity across different locations of a customer network or between a customer network and an external network. Compared to a conventional PE-based connectivity service as defined in Layer 3 VPN Service Model [[RFC8299](#)] and Layer 2 VPN

Service Model [[RFC8466](#)], an SD-WAN service is a CE-based connectivity service that uses the Internet or PE-based connectivity services as underlay connectivity services. More specially, an SD-WAN service is an overlay connectivity service that provides the flexibility of

adding, removing, or moving services without needing to change the underlay networks.

Besides being an overlay service, an SD-WAN Service has the following characteristics:

- o Hybrid WAN access: The CE could connect to a variety of Internet access technologies, including fiber, cable, DSL-based, WiFi, or 4G/Long Term Evolution (LTE), which implies wider reachability and shorter provisioning cycles. It can also use private VPN connectivity services defined in [[RFC4364](#)] and [[RFC4664](#)], or Operator Ethernet Services, as defined in [[MEF51.1](#)], to take advantage of better performance.
- o Application based traffic forwarding: There are diverse applications used in enterprises, such as VoIP calling, video conferencing, streaming media, etc. Application traffic across the WAN will be forwarded based on business priorities, SLA requirements, or other enterprise requirements.
- o Centralized service management: Subscribers of the service need to be provided a singlepoint (such as a web portal) from which to dynamically add or modify services, such as configuring application policies, adding new sites, or adding new underlay connectivity services.

This draft specifies the SD-WAN service YANG model which is modelled from a customer perspective. The model parameters can be used as an input to automated control and configuration applications to manage SD-WAN services.

[1.1](#). Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119](#) [[RFC2119](#)].

1.2. Definitions

CE Device: Customer Edge Device , as per Provider Provisioned VPN Terminology [[RFC4026](#)] .

CE-based VPN: Refers to Provider Provisioned VPN Terminology [[RFC4026](#)]

PE Device: Provider Edge Device, as per Provider Provisioned VPN Terminology [[RFC4026](#)]

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SD-WAN Service YANG Model

July 2019

PE-Based VPNs: Refers to Provider Provisioned VPN Terminology [[RFC4026](#)]

SD-WAN: An automated, programmatic approach to managing enterprise network connectivity and circuit usage. It extends software-defined networking (SDN) into an application that businesses can use to quickly create a hybrid WAN, which comprises business-grade IP VPN, broadband Internet, and wireless services or multiple WANs of the same or different types. SD-WAN is also deemed as extended CE-based VPN.

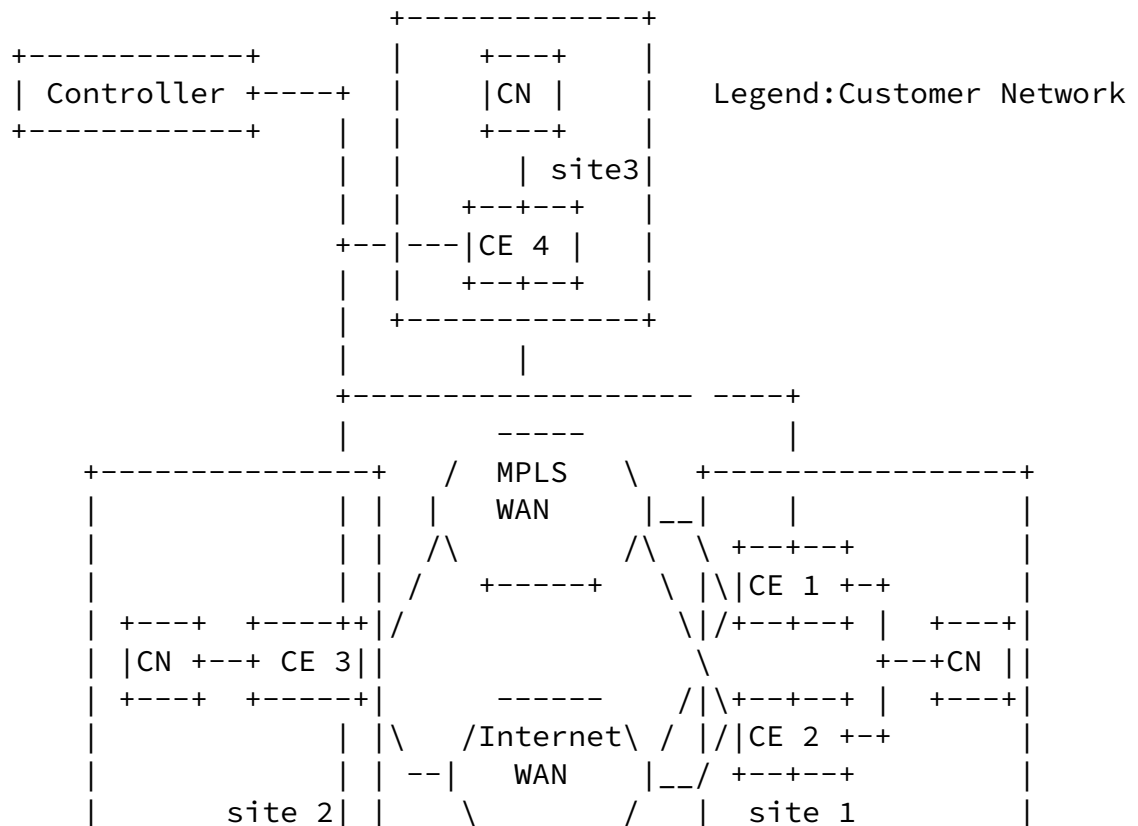
SD-WAN Controller: Refers to the abstract entity that combines Control Plane (CP) and Management Plane (MP) defined in SDN: Layers and Architecture Terminology [[RFC7426](#)], to configure, manage and control the CEs and other corresponding SD-WAN components.

Underlay network: A network that provides connectivity across SD-WAN sites and over which customer network packets are tunnelled. An underlay network does not need to be aware that it is carrying overlay customer network packets. Addresses on an underlay network appear as "outer addresses" in encapsulated overlay packets. In general, an underlay network can use a completely different protocol (and address family) from that of the overlay network.

Overlay network: A virtual network in which the separation of customer networks is hidden from the underlying physical infrastructure. That is, the underlying transport networks do not need to know about customer separation to correctly forward traffic. IPsec tunnels [[RFC6071](#)] are an example of an L3 overlay network.

2. High Level Overview of SD-WAN Service

From a customer perspective, an example of SD-WAN service network is shown in figure 1.



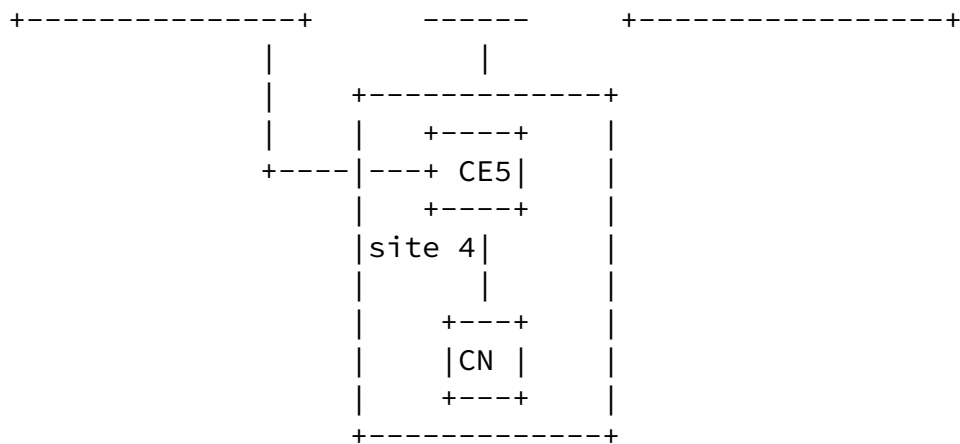


figure 1 SD-WAN network example

As shown in figure 1, the SD-WAN network consists of a number of sites, which are connected through Internet or MPLS VPN.

Within each site, a CE is connected with customer's network on one side, and is also connected to Internet, or to private WAN, or to both on the other side. The customer network could be an L2 or L3 network. For the WAN side, Internet provides ubiquitous IP connectivity via access network like Broadband access or LTE access, while MPLS WAN, like conventional VPN, provides secure and committed connectivity. The boundary between the customer and the service provider is between customer node and the CE device.

Additionally, a site could deploy one or more CEs to improve availability.

The controller is a centralized entity that manages all the CEs involved in the SD-WAN. The controller could provide bootstrapping of the CEs, ongoing CE configuration, and establishment of secured tunnels between CEs to support the SD-WAN service and application policy enforcement. Various IP tunnelling options (e.g., GRE [\[RFC2784\]](#) and IPsec [\[RFC6071\]](#)), could be used depending on whether traffic from the site is across underlying private VPN or public Internet, and the specific definition is out of scope of this document.

Besides basic connectivity between the sites, the SD-WAN service could be extended by providing direct Internet connectivity, cloud

network connectivity, or conventional MPLS VPN interoperability.

3. Service Data Model Usage

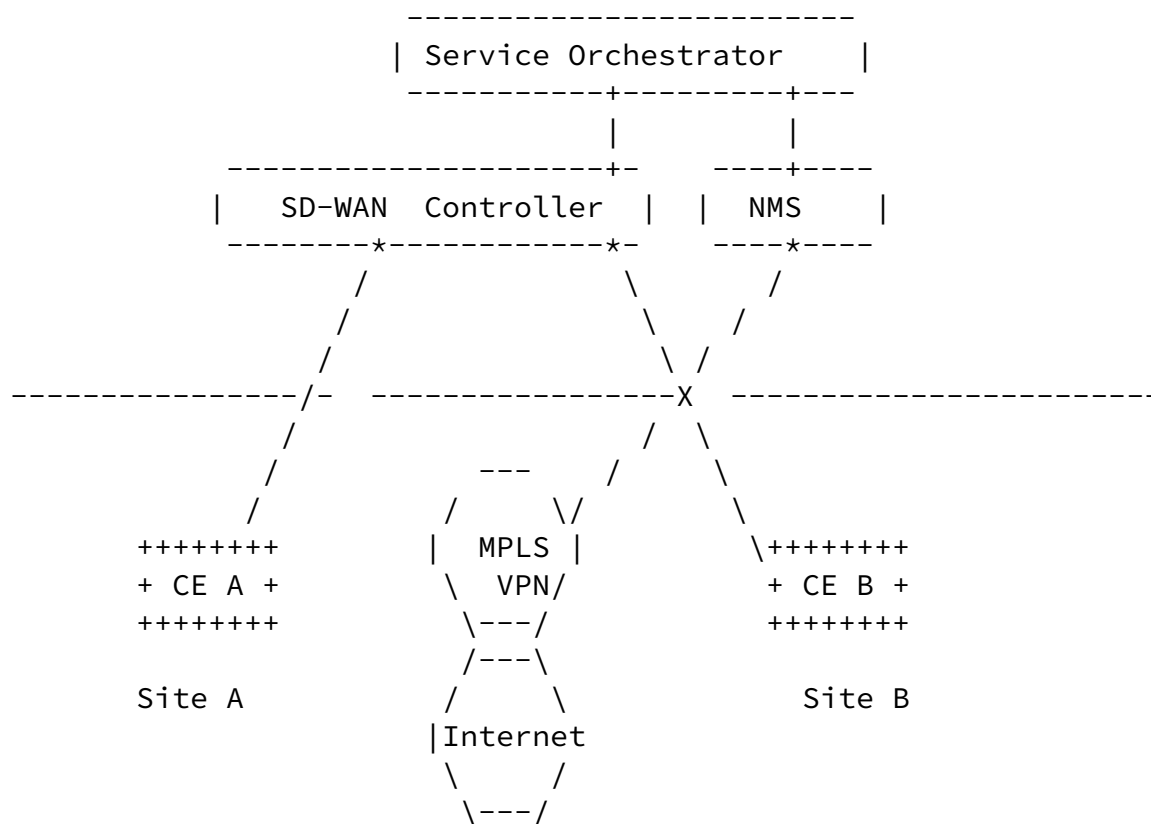
The SD-WAN service model provides an abstracted interface to request, configure, and manage the components of an SD-WAN service.

A typical usage for this model is as an input to a service orchestrator that is responsible for service management. Based on the user's service request, the service orchestrator can instruct the SD-WAN controller to add a new site, VPN or application policy in real-time. The orchestrator could orchestrator the other network, such as legacy MPLS VPN network to interconnect with SD-WAN network where Layer 2 VPN Service Mode [[RFC8466](#)] or Layer 3 VPN Service Model [[RFC8299](#)] could be used.

Customer Service Requester

SD-WAN
Service
Model

|
|
|
|
|



Reference Architecture for the Use of SD-WAN Service Model Usage

For an SD-WAN to be established under the SP's control, the customer informs the Service Provider of which sites should become part of the requested service and what types of policy will provide. And then the SP configures and updates the service base on the service model and the available resources derived from the SD-WAN controller, and then provisions and manages the customer's service through the SD-WAN controller. How the SD-WAN controller to control and manage the CEs is out of scope of the document.

4. Design of the Data Model

An SD-WAN service consist of two service components:

1. SD-WAN connectivity service

2. SD-WAN application policy service

[4.1.](#) SD-WAN connectivity service

SD-WAN connectivity service is the basic component of the SD-WAN service that represents a virtual connection between two or more customer sites. In this model, each virtual connection is defined as a VPN. Each customer can have one or more VPNs, and each VPN can be established between a subset of sites. The association of sites and VPNs is modelled by VPN endpoints.

[4.1.1.](#) VPNs

The "sdwan-vpn" list item contains service parameters that apply to an SD-WAN VPN. These parameters are specified as follows:

- o The "vpn-id" leaf is under the vpn-service list, and provides a unique ID for a VPN.
- o The "endpoints" list is under the vpn-service list. Each "endpoint" is a logical point associated with a site. The two main functions of the endpoint are the association of a VPN with a site and per site application based policy enforcement.
- o The "topology" leaf is under the vpn-service list, which refers to a specific topology of the VPN service. Different VPN connection topology can be used. For a VPN with a few sites, simple topologies such as hub-and-spoke or full-mesh can be used. For a large VPN, a hierarchical topology may be taken.
- o The "performance-objectives" container specifies the performance-related properties of an SD-WAN VPN that can be measured. System uptime is the only performance objective defined currently. It indicates the proportion of time, during a given time period that the service is working from the customer perspective. Three parameters are defined, including the start time of the evaluation, the time interval of the evaluation, and the service uptime defined by a percentage.
- o The "reserved-prefixes" container specifies the IP Prefixes that need to be reserved for Service Provider management purposes, such as diagnostics, so as to ensure they are not overlapping with IP Prefixes used by the customer network.

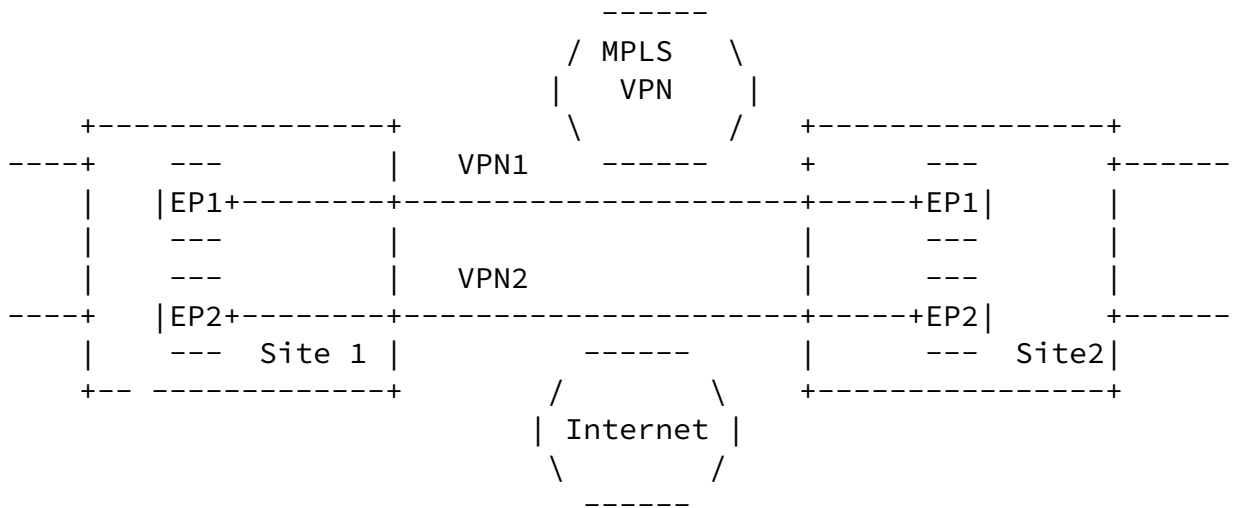


figure 3 SD-WAN VPN example

4.1.2. Sites

A site represents a customer office located at a specific geographic location. The "sites" container specifies the following parameters:

- o "site-id: uniquely identifies the site within the overall network infrastructure.
- o "device" specifies the device type (physical or virtual device) and the number of the devices.
- o "lan-accesses": Specifies the customer network access link parameters. A "site" is composed of at least one "lan-access" where one or more subnets can reside. The "lan-access" consists of the following categories of parameters:
 - * "bearer": defines requirements of the attachment (below Layer 3), bearer type including Ethernet, etc.
 - * IP Connection: defines Layer 3 parameters of the attachment, including IPv4 connection parameters and IPv6 connection parameters.
- o "wan-accesses": Specifies the WAN access link parameters. A "site" is composed of at least one "wan-access". The WAN access can be further specified by access type, service provider name, and bandwidth of the WAN connectivity. The "wan-access" consists of the following categories of parameters:

- * "access-type": specifies whether the access is Broadband Internet, Wireless Internet or private circuit.

- * "access-provider": specifies the service provider name.
- * bandwidth: specifies the WAN link bandwidth including input and output bandwidth.
- * "bearer": defines requirements of the attachment (below Layer 3), bearer type including Ethernet, etc.
- * IP Connection: defines Layer 3 parameters of the attachment, including IPv4 connection parameters and IPv6 connection parameters.

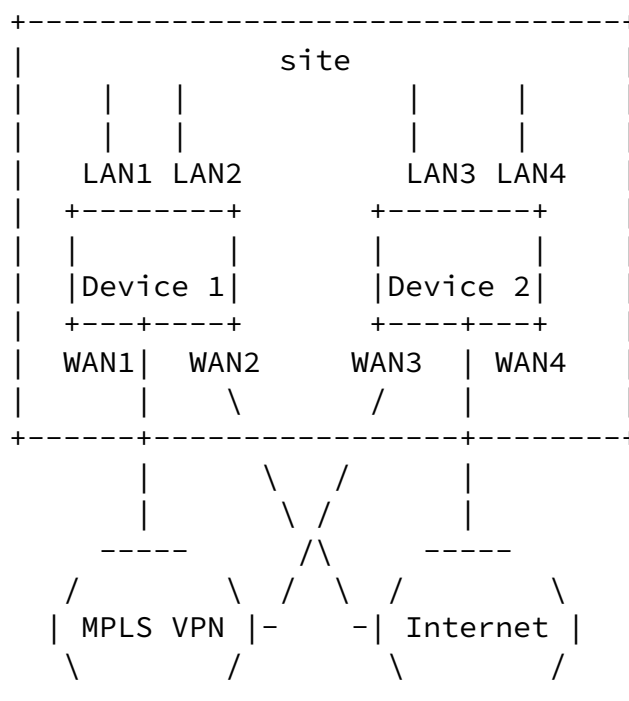


figure 4 Site example

[4.2.](#) Application based Policy Service

The connectivity service establishes a virtual connection for the enterprise network, and the Application based Policy Service is designed to ensure business-critical and real-time application

experience while also ensuring the security and corporate policies.

Typically, application policies common to each VPN can be defined and then enforced when traffic from a customer's network at a particular site is sent over the WAN.

The application policy assignment is defined under the VPN endpoint container to specify the mapping of application flow name or application group name and their associated policy list names. If an

application flow and the application flow group in which the Application Flow is a member are both assigned a policy at an VPN End Point, the policy assigned to the application flow will supersede the group policy.

The application policy per VPN consists of three lists under the VPN container:

- o application flow list: Describes the characteristics of an enterprise application and is used to identify applications, e.g., based on layer 3 source and destination addresses, layer 4 ports, layer 4 protocol, etc.
- o application group list: Describes application flow aggregation, which is used to deliver aggregation policies, such as bandwidth restrictions for a group of applications.
- o policy list: Defines the application's policy set. Since SD-WAN has more than one WAN connectivity and various encrypted or unencrypted overlay tunnels, there could be multiple tunnel or link selection combination. In this model, different path selection policies are combined to meet different needs based on application SLA, security, cost, and so on. For example, when different applications in a branch need to pass over the WAN, according to the application-aware policy requirements and the IP forwarding table, the Internet application or the SaaS application can be accessed through the Internet, and the data center FTP application can use the Internet encrypted tunnel as the primary path, and the tunnel could only be over broadband Internet instead of wireless internet. This policy combination is not an exhaustive list and could be augmented according to business needs.

An example of a classification of application flows is as follows:

The HTTP traffic from the 192.0.2.0/24 LAN destined for port 80 will be classified in app-id 1.

The FTP traffic from the 192.0.2.0/24 LAN destined for 203.0.113.1/32 will be classified in app-id 2.

An example of a policy list is as follows:

```
"policy": [  
  {  
    "policy-id": "pol-a",  
    "policy-package":  
      {  
        "encryption": "false",  
        "internet-breakout": "true"  
        "public-private": "public",  
        "billing-method": "flat-only"  
        "backup": "false",  
        "bandwidth": "20","50"  
      }  
  },  
  {  
    "policy-id": "pol-b",  
    "policy-package":  
      {  
        "encryption": "true",  
        "internet-breakout": "false"  
        "public-private": "public",  
        "billing-method": "flat-only"  
        "backup": "false",  
        "bandwidth": "50","none"  
      }  
  }  
]
```

```
]
```

An example of an application policy list is as follows:

```
"app-policy": [  
  {  
    "app-id": "1"  
    "policy-id": "pol-a",  
  },  
  {  
    "app-id": "1"  
    "policy-id": "pol-b",  
  }  
]
```

5. Modules Tree Structure

This document defines an SD-WAN service YANG data model.

```
module: ietf-sdwan-svc  
  +--rw sdwan-svc  
    +--rw vpn-services  
      | +--rw vpn-service* [vpn-id]
```

```
| +--rw vpn-id          svc-id  
| +--rw topology?      identityref  
| +--rw performance-objective  
|   | +--rw start-time?  yang:date-and-time  
|   | +--rw duration?    string  
|   | +--rw uptime-objective  
|   |   +--rw duration?  decimal64  
| +--rw reserved-prefixes  
|   | +--rw prefix*      inet:ip-prefix  
| +--rw application* [app-id]  
|   | +--rw app-id       svc-id  
|   | +--rw ac* [name]  
|   |   +--rw name              string  
|   |   +--rw (match-type)?  
|   |     +--:(match-flow)  
|   |       | +--rw match-flow  
|   |       |   +--rw ethertype?  uint16  
|   |       |   +--rw cvlan?      uint8
```



```

+--rw lan-access* [name]
|   +--rw name          string
|   +--rw l2-technology
|   |   +--rw l2-type?          identityref
|   |   +--rw untagged-interface
|   |   |   +--rw speed?    uint32
|   |   |   +--rw mode?     neg-mode
|   |   +--rw tagged-interface
|   |   |   +--rw type?          identityref
|   |   |   +--rw dot1q-vlan-tagged
|   |   |   |   +--rw tg-type?    identityref
|   |   |   |   +--rw cvlan-id    uint16
|   |   |   +--rw priority-tagged
|   |   |   |   +--rw tag-type?    identityref
|   |   +--rw l2-mtu?          uint32
|   +--rw ip-connection
|   |   +--rw ipv4
|   |   |   +--rw address-allocation-type?    identityref
|   |   |   +--rw dhcp
|   |   |   |   +--rw primary-subnet
|   |   |   |   |   +--rw ip-prefix?
|   |   |   |   |   |   inet:ipv4-prefix
|   |   |   |   |   +--rw default-router?    inet:ip-address
|   |   |   |   |   +--rw provider-addresses*
|   |   |   |   |   |   inet:ipv4-address
|   |   |   |   |   +--rw subscriber-address?    inet:ip-address
|   |   |   |   |   +--rw reserved-ip-prefix*    inet:ip-prefix
|   |   |   |   +--rw secondary-subnet* [ip-prefix]
|   |   |   |   |   +--rw ip-prefix
|   |   |   |   |   |   inet:ipv4-prefix
|   |   |   |   |   +--rw provider-addresses*
|   |   |   |   |   |   inet:ipv4-address
|   |   |   |   |   +--rw reserved-ip-prefix*
|   |   |   |   |   |   inet:ipv4-prefix
|   |   |   +--rw static
|   |   |   |   +--rw primary-subnet
|   |   |   |   |   +--rw ip-prefix?

```

```

|   |   |   |   |   +--rw default-router?    inet:ip-address
|   |   |   |   |   +--rw provider-addresses*
|   |   |   |   |   |   inet:ipv4-address

```



```

| | | +--rw subscriber-address?   inet:ip-address
| | | +--rw reserved-ip-prefix*   inet:ip-prefix
| | +--rw secondary-subnet* [ip-prefix]
| | | +--rw ip-prefix
| | | |   inet:ipv4-prefix
| | | +--rw provider-addresses*
| | | |   inet:ipv4-address
| | | +--rw reserved-ip-prefix*
| | | |   inet:ipv4-prefix
+--rw ipv6
| +--rw address-allocation-type?   identityref
| +--rw dhcp
| | +--rw subnet* [ip-prefix]
| | | +--rw ip-prefix
| | | |   inet:ipv6-prefix
| | | +--rw provider-addresses*
| | | |   inet:ipv6-address
| | | +--rw reserved-ip-prefix*
| | | |   inet:ipv6-prefix
+--rw slaac
| +--rw subnet* [ip-prefix]
| | +--rw ip-prefix
| | |   inet:ipv6-prefix
| | +--rw provider-addresses*
| | |   inet:ipv6-address
| | +--rw reserved-ip-prefix*
| | |   inet:ipv6-prefix
+--rw static
| +--rw subnet* [ip-prefix]
| | +--rw ip-prefix
| | |   inet:ipv6-prefix
| | +--rw provider-addresses*
| | |   inet:ipv6-address
| | +--rw reserved-ip-prefix*
| | |   inet:ipv6-prefix
+--rw subscriber-address?   inet:ipv6-address
+--rw wan-access* [name]
| +--rw name                 string
| +--rw access-type?         identityref
| +--rw access-provider?     string
| +--rw bandwidth
| | +--rw input-bandwidth?   uint64
| | +--rw output-bandwidth?  uint64
+--rw l2-technology

```

```

|   +--rw l2-type?                identityref
|   +--rw untagged-interface
|   |   +--rw speed?    uint32
|   |   +--rw mode?     neg-mode
|   +--rw tagged-interface
|   |   +--rw type?                identityref
|   |   +--rw dot1q-vlan-tagged
|   |   |   +--rw tg-type?    identityref
|   |   |   +--rw cvlan-id    uint16
|   |   +--rw priority-tagged
|   |   |   +--rw tag-type?    identityref
|   +--rw l2-mtu?                uint32
+--rw ip-connection
|   +--rw ipv4
|   |   +--rw address-allocation-type?    identityref
|   |   +--rw dhcp
|   |   |   +--rw primary-subnet
|   |   |   |   +--rw ip-prefix?
|   |   |   |   |   inet:ipv4-prefix
|   |   |   |   +--rw default-router?      inet:ip-address
|   |   |   |   +--rw provider-addresses*
|   |   |   |   |   inet:ipv4-address
|   |   |   |   +--rw subscriber-address?  inet:ip-address
|   |   |   |   +--rw reserved-ip-prefix*  inet:ip-prefix
|   |   |   +--rw secondary-subnet* [ip-prefix]
|   |   |   |   +--rw ip-prefix
|   |   |   |   |   inet:ipv4-prefix
|   |   |   |   +--rw provider-addresses*
|   |   |   |   |   inet:ipv4-address
|   |   |   |   +--rw reserved-ip-prefix*
|   |   |   |   |   inet:ipv4-prefix
|   |   +--rw static
|   |   |   +--rw primary-subnet
|   |   |   |   +--rw ip-prefix?
|   |   |   |   |   inet:ipv4-prefix
|   |   |   |   +--rw default-router?      inet:ip-address
|   |   |   |   +--rw provider-addresses*
|   |   |   |   |   inet:ipv4-address
|   |   |   |   +--rw subscriber-address?  inet:ip-address
|   |   |   |   +--rw reserved-ip-prefix*  inet:ip-prefix
|   |   |   +--rw secondary-subnet* [ip-prefix]
|   |   |   |   +--rw ip-prefix
|   |   |   |   |   inet:ipv4-prefix
|   |   |   |   +--rw provider-addresses*
|   |   |   |   |   inet:ipv4-address
|   |   |   |   +--rw reserved-ip-prefix*
|   |   |   |   |   inet:ipv4-prefix

```

+++rw ipv6

```
+++rw address-allocation-type?  identityref
+++rw dhcp
|   +++rw subnet* [ip-prefix]
|       +++rw ip-prefix
|           inet:ipv6-prefix
|       +++rw provider-addresses*
|           inet:ipv6-address
|       +++rw reserved-ip-prefix*
|           inet:ipv6-prefix
+++rw slaac
|   +++rw subnet* [ip-prefix]
|       +++rw ip-prefix
|           inet:ipv6-prefix
|       +++rw provider-addresses*
|           inet:ipv6-address
|       +++rw reserved-ip-prefix*
|           inet:ipv6-prefix
+++rw static
|   +++rw subnet* [ip-prefix]
|       +++rw ip-prefix
|           inet:ipv6-prefix
|       +++rw provider-addresses*
|           inet:ipv6-address
|       +++rw reserved-ip-prefix*
|           inet:ipv6-prefix
+++rw subscriber-address?  inet:ipv6-address
```

[6.](#) YANG Modules

<CODE BEGINS> file "ietf-sdwan-svc@2019-06-06.yang"

```
module ietf-sdwan-svc {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-sdwan-svc";
  prefix sdwan-svc;

  import ietf-inet-types {
    prefix inet;
  }
  import ietf-yang-types {
```

```
    prefix yang;
}

organization
  "IETF foo Working Group.";
contact
  "WG List: foo@ietf.org
  Editor:  ";
```

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```
description
  "The YANG module defines a generic service configuration
  model for Managed SD-WAN.";

revision 2019-06-06 {
  description
    "Initial revision";
  reference "A YANG Data Model for SD-WAN service.";
}

typedef svc-id {
  type string;
  description
    "Type definition for service identifier";
}

typedef address-family {
  type enumeration {
    enum ipv4 {
      description
        "IPv4 address family.";
    }
    enum ipv6 {
      description
        "IPv6 address family.";
    }
  }
  description
    "Defines a type for the address family.";
}

typedef neg-mode {
  type enumeration {
```

```

    enum full-duplex {
        description
            "Defining Full duplex mode";
    }
    enum auto-neg {
        description
            "Defining Auto negotiation mode";
    }
}
description
    "Defining a type of the negotiation mode";
}

typedef device-type {
    type enumeration {

```

```

    enum physical {
        description
            "Physical device";
    }
    enum virtual {
        description
            "Virtual device";
    }
}
description
    "Defines device types.";
}

identity device-type {
    description
        "Base identity for device type.";
}

identity virtual-ce {
    base device-type;
    description
        "Identity for virtual-ce.";
}

identity physical-ce {
    base device-type;

```

```

        description
            "Identity for physical-ce.";
    }

    identity customer-application {
        description
            "Base identity for customer application.";
    }

    identity web {
        base customer-application;
        description
            "Identity for Web application (e.g., HTTP, HTTPS).";
    }

    identity mail {
        base customer-application;
        description
            "Identity for mail application.";
    }

    identity file-transfer {

```

```

        base customer-application;
        description
            "Identity for file transfer application (e.g., FTP, SFTP).";
    }

    identity database {
        base customer-application;
        description
            "Identity for database application.";
    }

    identity social {
        base customer-application;
        description
            "Identity for social-network application.";
    }

    identity games {
        base customer-application;

```

```

    description
        "Identity for gaming application.";
}

identity p2p {
    base customer-application;
    description
        "Identity for peer-to-peer application.";
}

identity network-management {
    base customer-application;
    description
        "Identity for management application
        (e.g., Telnet, syslog, SNMP).";
}

identity voice {
    base customer-application;
    description
        "Identity for voice application.";
}

identity video {
    base customer-application;
    description
        "Identity for video conference application.";
}

```

```

identity eth-inf-type {
    description
        "Identity of the Ethernet interface type.";
}

identity tagged {
    base eth-inf-type;
    description
        "Identity of the tagged interface type.";
}

identity untagged {

```

```

    base eth-inf-type;
    description
        "Identity of the untagged interface type.";
}

identity lag {
    base eth-inf-type;
    description
        "Identity of the LAG interface type.";
}

identity tag-type {
    description
        "Base identity from which all tag types
        are derived from";
}

identity c-vlan {
    base tag-type;
    description
        "A Customer-VLAN tag, normally using the 0x8100
        Ethertype";
}

identity tagged-inf-type {
    description
        "Identity for the tagged
        interface type.";
}

identity dot1q {
    base tagged-inf-type;
    description
        "Identity for dot1q vlan tagged interface.";
}

```

```

identity priority-tagged {
    base tagged-inf-type;
    description
        "This identity the priority-tagged interface.";
}

```



```

identity vpn-topology {
    description
        "Base identity for vpn topology.";
}

identity any-to-any {
    base vpn-topology;
    description
        "Identity for any-to-any VPN topology.";
}

identity hub-spoke {
    base vpn-topology;
    description
        "Identity for Hub-and-Spoke VPN topology.";
}

identity site-role {
    description
        "Site Role in a VPN topology ";
}

identity any-to-any-role {
    base site-role;
    description
        "Site in an any-to-any IP VPN.";
}

identity hub {
    base site-role;
    description
        "Hub Role in Hub-and-Spoke IP VPN.";
}

identity spoke {
    base site-role;
    description
        "Spoke Role in Hub-and-Spoke IP VPN.";
}

identity access-type {
    description

```

```

    "Access type of a site in a connection to different WAN";
}

identity commodity {
    base access-type;
    description
        "Internet access";
}

identity cellular {
    base access-type;
    description
        "Refers to a subset of 3G/4G/LTE and 5G";
}

identity private {
    base access-type;
    description
        "Refers to private circuits such as Ethernet, T1, etc";
}

identity routing-protocol-type {
    description
        "Base identity for routing protocol type.";
}

identity ospf {
    base routing-protocol-type;
    description
        "Identity for OSPF protocol type.";
}

identity bgp {
    base routing-protocol-type;
    description
        "Identity for BGP protocol type.";
}

identity static {
    base routing-protocol-type;
    description
        "Identity for static routing protocol type.";
}

identity address-allocation-type {
    description
        "Base identity for address-allocation-type for PE-CE link.";
}

```

```
identity dhcp {
  base address-allocation-type;
  description
    "Provider network provides DHCP service to customer.";
}

identity static-address {
  base address-allocation-type;
  description
    "Provider-to-customer addressing is static.";
}

identity slaac {
  base address-allocation-type;
  description
    "Use IPv6 SLAAC.";
}

identity ll-only {
  base address-allocation-type;
  description
    "Use IPv6 Link Local.";
}

identity traffic-direction {
  description
    "Base identity for traffic direction";
}

identity inbound {
  base traffic-direction;
  description
    "Identity for inbound";
}

identity outbound {
  base traffic-direction;
  description
    "Identity for outbound";
}

identity both {
```

```
    base traffic-direction;
    description
        "Identity for both";
}
```

```
identity traffic-action {
```

```
    description
        "Base identity for traffic action";
}
```

```
identity permit {
    base traffic-action;
    description
        "Identity for permit action";
}
```

```
identity deny {
    base traffic-action;
    description
        "Identity for deny action";
}
```

```
identity bd-limit-type {
    description
        "base identity for bd limit type";
}
```

```
identity percent {
    base bd-limit-type;
    description
        "Identity for percent";
}
```

```
identity value {
    base bd-limit-type;
    description
        "Identity for value";
}
```

```
identity protocol-type {
    description
```

```

    "Base identity for protocol field type.";
}

identity tcp {
    base protocol-type;
    description
        "TCP protocol type.";
}

identity udp {
    base protocol-type;
    description
        "UDP protocol type.";
}

```

```

}

identity icmp {
    base protocol-type;
    description
        "ICMP protocol type.";
}

identity icmp6 {
    base protocol-type;
    description
        "ICMPv6 protocol type.";
}

identity gre {
    base protocol-type;
    description
        "GRE protocol type.";
}

identity ipip {
    base protocol-type;
    description
        "IP-in-IP protocol type.";
}

identity hop-by-hop {
    base protocol-type;
}

```

```

    description
        "Hop-by-Hop IPv6 header type.";
}

```

```

identity routing {
    base protocol-type;
    description
        "Routing IPv6 header type.";
}

```

```

identity esp {
    base protocol-type;
    description
        "ESP header type.";
}

```

```

identity ah {
    base protocol-type;
    description
        "AH header type.";
}

```

```

}

grouping vpn-endpoint {
    leaf endpoint-id {
        type svc-id;
        description
            "Identity for the vpn endpoint";
    }
    leaf site-role {
        type identityref {
            base site-role;
        }
        default "any-to-any-role";
        description
            "Role of the site in the VPN.";
    }
    container site-attachment {
        leaf site-id {
            type leafref {
                path "/sdwan-svc/sites/site/site-id";
            }
        }
    }
}

```

```

        description
            "Defines site id attached.";
    }
    description
        "Defines site attachment to a vpn endpoint.";
}
container endpoint-policy-map {
    list app-group-policy {
        key "app-group-id";
        leaf app-group-id {
            type leafref {
                path "/sdwan-svc/vpn-services/vpn-service"+
                    "/application-group/app-group-id";
            }
            description
                "Identity for application";
        }
        leaf policy-id {
            type leafref {
                path "/sdwan-svc/vpn-services/vpn-service/policy/policy-id";
            }
            description
                "Identity for value";
        }
        description
            "list for application group policy";
    }
}

```

```

list app-policy {
    key "app-id";
    leaf app-id {
        type leafref {
            path "/sdwan-svc/vpn-services/vpn-service"+
                "/application/app-id";
        }
        description
            "Identity for application";
    }
    leaf policy-id {
        type leafref {
            path "/sdwan-svc/vpn-services/vpn-service/policy/policy-id";
        }
    }
}

```

```

        description
            "Identity for value";
    }
    description
        "list for application policy";
    }
    description
        "Identity for policy maps";
    }
    description
        "grouping for vpn endpoint";
}

grouping flow-definition {
    container match-flow {
        leaf ethertype {
            type uint16;
            description
                "Ethertype value, e.g. 0800 for IPv4.";
        }
        leaf cvlan {
            type uint8 {
                range "0..7";
            }
            description
                "802.1Q matching.";
        }
        leaf ipv4-src-prefix {
            type inet:ipv4-prefix;
            description
                "Match on IPv4 src address.";
        }
        leaf ipv4-dst-prefix {
            type inet:ipv4-prefix;

```

```

        description
            "Match on IPv4 dst address.";
    }
    leaf l4-src-port {
        type inet:port-number;
        description
            "Match on Layer 4 src port.";
    }

```



```

    }
    leaf l4-dst-port {
        type inet:port-number;
        description
            "Match on Layer 4 dst port.";
    }
    leaf ipv6-src-prefix {
        type inet:ipv6-prefix;
        description
            "Match on IPv6 src address.";
    }
    leaf ipv6-dst-prefix {
        type inet:ipv6-prefix;
        description
            "Match on IPv6 dst address.";
    }
    leaf protocol-field {
        type union {
            type uint8;
            type identityref {
                base protocol-type;
            }
        }
        description
            "Match on IPv4 protocol or IPv6 Next Header field.";
    }
    description
        "Describes flow-matching criteria.";
}
description
    "Grouping for flow definition.";
}

grouping application-criteria {
    list ac {
        key "name";
        ordered-by user;
        leaf name {
            type string;
            description
                "A description identifying application classification

```

```

        criteria.";
    }
    choice match-type {
        default "match-flow";
        case match-flow {
            uses flow-definition;
        }
        case match-application {
            leaf match-application {
                type identityref {
                    base customer-application;
                }
                description
                    "Defines the application to match.";
            }
        }
    }
    description
        "Choice for classification.";
}
description
    "List of marking rules.";
}
description
    "This grouping defines QoS parameters for a site.";
}

grouping vpn-service {
    leaf vpn-id {
        type svc-id;
        description
            "Identity for VPN.";
    }
    leaf topology {
        type identityref {
            base vpn-topology;
        }
        description
            "vpn topology: hub-and-spoke or any-to-any";
    }
}
container performance-objective {
    leaf start-time {
        type yang:date-and-time;
        description
            "start-time indicates date and time.";
    }
    leaf duration {
        type string;
        description

```

```
        "Time duration.";
    }
    container uptime-objective {
        leaf duration {
            type decimal64 {
                fraction-digits 5;
                range "0..100";
            }
            units "percent";
            description
                "To be used to define the a percentage of the available
                service.";
        }
        description
            "Uptime objective.";
    }
    description
        "The performance objective.";
}
container reserved-prefixes {
    leaf-list prefix {
        type inet:ip-prefix;
        description
            "ip prefix reserved for SP management purpose.";
    }
    description
        "ip prefix list reserved for SP management purpose.";
}
list application {
    key "app-id";
    leaf app-id {
        type svc-id;
        description
            "application name";
    }
    uses application-criteria;
    description
        "list for application";
}
list application-group {
    key "app-group-id";
    leaf app-group-id {
        type svc-id;
```

```

    description
        "application name";
}
leaf-list app-id {
    type leafref {

```

```

    path "../..//application/app-id";
}
description
    "application member list in an application group";
}
description
    "list for application group";
}
list policy {
    key "policy-id";
    leaf policy-id {
        type svc-id;
        description
            "Policy names";
    }
    container policy-package {
        leaf encryption {
            type enumeration {
                enum yes {
                    description
                        "Indicates whether or not the application flow requires
                        to send over encrypted overlay tunnel.";
                }
                enum either {
                    description
                        " Either means this policy is not applied";
                }
            }
        }
        description
            "Indicates whether or not the application flow requires
            encryption.";
    }
    leaf public-private {
        type enumeration {
            enum private-only {
                description

```

```

        "The private WAN underlay is specified.";
    }
    enum either {
        description
            "Both public WAN or private WAN could be used";
    }
}
description
    "Indicates whether the Application Flow can traverse
    Public or Private Underlay Connectivity Services
    (or both).Either means this policy is not applied.";
}

```

```

leaf local-breakout {
    type boolean;
    description
        "indicates whether the Application Flow should be
        routed directly to the Internet using Local Internet
        Breakout.It can have values Yes and No.";
}
leaf billing-method {
    type enumeration {
        enum flat-only {
            description
                "Only flat-rate underlay could be used for the
                traffic.";
        }
        enum either {
            description
                "Either flat-rate or usage based underlay could
                be used for the traffic.";
        }
    }
    description
        "billing policy.";
}
leaf backup-path {
    type enumeration {
        enum yes {
            description
                "Only the primary tunnel overlay could be used for
                the traffic.";
        }
    }
}

```

```

    }
    enum no {
        description
            "Either the primary or backup overlay tunnel could be
            used for the traffic.";
    }
}
description
    "overlay connection as Primary or both Primary and
    Backup.";
}
container bandwidth {
    leaf commit {
        type uint32;
        description
            "CIR";
    }
    leaf max {
        type uint32;
    }
}

```

```

        description
            "max speed ";
    }
    description
        "Container for the bandwidth policy";
}
description
    "Container for policy package";
}
description
    "List for policy";
}
list endpoints {
    key "endpoint-id";
    uses vpn-endpoint;
    description
        "List of endpoints.";
}
description
    "Grouping of vpn service";
}

```

```

grouping site-l2-technology {
  container l2-technology {
    leaf l2-type {
      type identityref {
        base eth-inf-type;
      }
      default "untagged";
      description
        "Defines physical properties of an interface. By default, the
        Ethernet interface type is set to 'untagged'.";
    }
    container untagged-interface {
      leaf speed {
        type uint32;
        units "mbps";
        default "10";
        description
          "Port speed.";
      }
      leaf mode {
        type neg-mode;
        default "auto-neg";
        description
          "Negotiation mode.";
      }
      description

```

```

    "Container of Untagged Interface Attributes
    configurations.";
  }
  container tagged-interface {
    leaf type {
      type identityref {
        base tagged-inf-type;
      }
      default "dot1q";
      description
        "Tagged interface type. By default,
        the Tagged interface type is dot1q interface. ";
    }
    container dot1q-vlan-tagged {
      leaf tg-type {

```

```

        type identityref {
            base tag-type;
        }
        default "c-vlan";
        description
            "TAG type.By default, Tag type is Customer-VLAN tag.";
    }
    leaf cvlan-id {
        type uint16;
        mandatory true;
        description
            "VLAN identifier.";
    }
    description
        "Tagged interface.";
}
container priority-tagged {
    leaf tag-type {
        type identityref {
            base tag-type;
        }
        default "c-vlan";
        description
            "TAG type.By default, the TAG type is
            Customer-VLAN tag.";
    }
    description
        "Priority tagged.";
}
description
    "Container for tagged Interface.";
}
leaf l2-mtu {

```

```

        type uint32;
        units "bytes";
        description
            " L2 Maximum Frame Size MUST be an integer number of bytes
            >= 1522MTU.";
    }
    description
        "Container for l2 technology.";

```



```

    }
    description
        "grouping for l2 technology.";
}

grouping site-ip-connection {
    container ip-connection {
        container ipv4 {
            leaf address-allocation-type {
                type identityref {
                    base address-allocation-type;
                }
            }
            description
                "Defines how addresses are allocated.
                If there is no value for address
                allocation type, then the ipv4 is not enabled.";
        }
        container dhcp {
            container primary-subnet {
                leaf ip-prefix {
                    type inet:ipv4-prefix;
                }
                description
                    "IPv4 address prefix and mask length between 0 and 31,
                    in bits.";
            }
            leaf default-router {
                type inet:ip-address;
            }
            description
                "Address of default router.";
        }
        leaf-list provider-addresses {
            type inet:ipv4-address;
        }
        description
            "the Service Provider IPv4 Addresses MUST be within the
            specified IPv4 Prefix.";
    }
    leaf subscriber-address {
        type inet:ip-address;
    }
    description
        "subscriber IPv4 Addresses: Non-empty list

```

```

    }
    leaf-list reserved-ip-prefix {
        type inet:ip-prefix;
        description
            "List of IPv4 Prefixes, possibly empty";
    }
    description
        "Primary Subnet List";
}
list secondary-subnet {
    key "ip-prefix";
    leaf ip-prefix {
        type inet:ipv4-prefix;
        description
            "IPv4 address prefix and mask length between 0 and 31,
            in bits";
    }
    leaf-list provider-addresses {
        type inet:ipv4-address;
        description
            "Service Provider IPv4 Addresses: Non-empty list
            of IPv4 addresses";
    }
    leaf-list reserved-ip-prefix {
        type inet:ipv4-prefix;
        description
            "List of IPv4 Prefixes, possibly empty";
    }
    description
        "Secondary Subnet List";
}
description
    "DHCP allocated addresses related parameters.";
}
container static {
    container primary-subnet {
        leaf ip-prefix {
            type inet:ipv4-prefix;
            description
                "IPv4 address prefix and mask length between 0 and 31,
                in bits.";
        }
    }
    leaf default-router {
        type inet:ip-address;
        description
            "Address of default router.";
    }
}

```

```
    leaf-list provider-addresses {
      type inet:ipv4-address;
      description
        "the Service Provider IPv4 Addresses MUST be within the
        specified IPv4 Prefix.";
    }
    leaf subscriber-address {
      type inet:ip-address;
      description
        "subscriber IPv4 Addresses: Non-empty list
        of IPv4 addresses";
    }
    leaf-list reserved-ip-prefix {
      type inet:ip-prefix;
      description
        "List of IPv4 Prefixes, possibly empty";
    }
  }
  description
    "Primary Subnet List";
}
list secondary-subnet {
  key "ip-prefix";
  leaf ip-prefix {
    type inet:ipv4-prefix;
    description
      "IPv4 address prefix and mask length between 0 and 31,
      in bits";
  }
  leaf-list provider-addresses {
    type inet:ipv4-address;
    description
      "Service Provider IPv4 Addresses: Non-empty list
      of IPv4 addresses";
  }
  leaf-list reserved-ip-prefix {
    type inet:ipv4-prefix;
    description
      "List of IPv4 Prefixes, possibly empty";
  }
  description
    "Secondary Subnet List";
}
description
  "Static configuration related parameters.";
}
description
```

```
    "IPv4-specific parameters.";
}
```

```
container ipv6 {
  leaf address-allocation-type {
    type identityref {
      base address-allocation-type;
    }
    description
      "Defines how addresses are allocated.
       If there is no value for address
       allocation type, then the ipv6 is not enabled.";
  }
  container dhcp {
    list subnet {
      key "ip-prefix";
      leaf ip-prefix {
        type inet:ipv6-prefix;
        description
          "IPv6 address prefix and prefix length between 0 and
           128";
      }
      leaf-list provider-addresses {
        type inet:ipv6-address;
        description
          "Non-empty list of IPv6 addresses";
      }
      leaf-list reserved-ip-prefix {
        type inet:ipv6-prefix;
        description
          "List of IPv6 Prefixes, possibly empty";
      }
      description
        "Subnet List";
    }
    description
      "DHCP allocated addresses related parameters.";
  }
  container slaac {
    list subnet {
      key "ip-prefix";
      leaf ip-prefix {
```

```

    type inet:ipv6-prefix;
    description
        "IPv6 address prefix and prefix length of 64 ";
}
leaf-list provider-addresses {
    type inet:ipv6-address;
    description
        "Non-empty list of IPv6 addresses";
}

```

```

    leaf-list reserved-ip-prefix {
        type inet:ipv6-prefix;
        description
            "List of IPv6 Prefixes, possibly empty";
    }
    description
        "Subnet List";
}
description
    "DHCP allocated addresses related parameters.";
}
container static {
    list subnet {
        key "ip-prefix";
        leaf ip-prefix {
            type inet:ipv6-prefix;
            description
                "IPv6 address prefix and prefix length between 0 and
                128";
        }
        leaf-list provider-addresses {
            type inet:ipv6-address;
            description
                "Non-empty list of IPv6 addresses";
        }
        leaf-list reserved-ip-prefix {
            type inet:ipv6-prefix;
            description
                "List of IPv6 Prefixes, possibly empty";
        }
    }
    description
        "Subnet List";
}

```

```

    }
    leaf subscriber-address {
        type inet:ipv6-address;
        description
            "IPv6 address or Not Specified.";
    }
    description
        "Static configuration related parameters.";
}
description
    "Describes IPv6 addresses used.";
}
description
    "IPv6-specific parameters.";
}
description

```

```

    "This grouping defines IP connection parameters.";
}

container sdwan-svc {
    container vpn-services {
        list vpn-service {
            key "vpn-id";
            uses vpn-service;
            description
                "List for SD-WAN";
        }
        description
            "Container for SD-WAN VPN service";
    }
    container sites {
        list site {
            key "site-id";
            leaf site-id {
                type svc-id;
                description
                    "Site Name";
            }
        }
        list device {
            key "name";
            leaf name {

```

```

        type string;
        description
            "Device Name";
    }
    leaf type {
        type identityref {
            base device-type;
        }
        description
            "Device Type: virtual or physical CE";
    }
    description
        "List for device";
}
list lan-access {
    key "name";
    leaf name {
        type string;
        description
            "lan access link name";
    }
    uses site-l2-technology;
    uses site-ip-connection;
}

```

```

        description
            "container for lan access";
    }
    list wan-access {
        key "name";
        leaf name {
            type string;
            description
                "wan access link name";
        }
        leaf access-type {
            type identityref {
                base access-type;
            }
            description
                "Access type: Internet, private VPN or cellular";
        }
        leaf access-provider {

```

```

        type string;
        description
            "Specifies the name of provider";
    }
    container bandwidth {
        leaf input-bandwidth {
            type uint64;
            description
                "input bandwidth";
        }
        leaf output-bandwidth {
            type uint64;
            description
                "output bandwidth";
        }
        description
            "Container for bandwidth";
    }
    uses site-l2-technology;
    uses site-ip-connection;
    description
        "container for wan access";
}
description
    "List for site";
}
description
    "Container for sites";
}
description

```

```

        "Top-level container for the SD-WAN services.";
    }
}

```

<CODE ENDS>

7. Security Considerations

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as NETCONF [[RFC6241](#)] or RESTCONF [[RFC8040](#)]. The lowest NETCONF layer

is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The NETCONF access control model [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in this YANG module that are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability.

8. IANA Considerations

IANA has assigned a new URI from the "IETF XML Registry" [RFC3688].

URI: urn:ietf:params:xml:ns:yang:ietf-sdwan-svc
Registrant Contact: The IESG
XML: N/A; the requested URI is an XML namespace.

IANA has recorded a YANG module name in the "YANG Module Names" registry [RFC6020] as follows:

Name: ietf-sdwan-svc
Namespace: urn:ietf:params:xml:ns:yang:ietf-sdwan-svc
Prefix: sdwan-svc
Reference: RFC xxxx

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9. Appendix 1: Terminology Mapping between MEF SD-WAN Service Attributes and IETF SD-WAN model

SD-WAN Service Attributes and Services [MEF70-Draft-R1], defines the

SD-WAN service attributes and services for SD-WAN service delivery. These service attributes can be used for communication between subscribers and services to deliver SD-WAN services while this draft defines a YANG data model for SD-WAN service delivery communicated between customer and service provider. The purpose of both work is very similar.

The below table shows the terminology mapping. The YANG model retains most parameter definition name but adjusts some of the structure to reserve space for future augmentation. For example, the model defines "vpn-service" and "lan-access" as a list, which can accommodate the case where the current MEF service attribute restricts only one VPN per customer and one LAN access and future extension to multiple VPN or LAN accesses per customer.

IETF SD-WAN Service model	MEF70 R1 SD-WAN Services Term	
SD-WAN VPN	SD-WAN Virtual Connection (SWVC)	
SD-WAN VPN Endpoint	SWVC End Point	
Site	User Network Interface(UNI)	
lan-access	UNI link Attributes	
wan-access	TBD(Underlay connectivity)	

10. Appendix 2: IETF OSE model vs IETF SD-WAN model

SD-WAN OSE service delivery model [[I-D.wood-rtgwg-sdwan-ose-yang](#)] defines two SD-WAN OSE Open SD-WAN Exchange (OSE) service YANG modules to enable the orchestrator in the enterprise network to implement SD-WAN inter-domain reachability and connectivity services and application aware traffic steering services. Although the OSE YANG model is also a service model instead of being a device model, this model is mainly used for interoperability between multiple SD-WAN domains and service consistency. The differences are shown as follows:

IETF OSE service model	IETF SD-WAN Service model	
Domain SD-WAN controller facing	customer-facing	
Inter OSE GW connectivity service	unaware of SD-WAN domain in	
Inter SD-WAN domain	one SP network	
	Inter-SD-WAN Service Provider	
	TBD	
SLA aware dynamic Path selection	static Primary/Backup selection	

For the SLA based dynamic path selection policy, the OSE service model uses a similar application classification criteria, but at the same time it will collect the relevant status of the traffic SLA profiles and, based on the measurements calculated from the collected information, the primary or secondary path will be selected.

```

+--primary-backup
  +--rw path-values
    +--rw sla-values
      +--rw latency?          uint32
      +--rw jitter?           uint32
      +--rw packet-loss-rate? uint32

```

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[12. Contributors](#)

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