TEAS
Internet-Draft
Intended status: Standards Track
Expires: 27 November 2026

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26 May 2026

A YANG Data Model for the RFC 9543 Network Slice Service
draft-ietf-teas-ietf-network-slice-nbi-yang-26

Abstract

This document defines a YANG data model for RFC 9543 Network Slice Service. The model can be used in the Network Slice Service interface between a customer and a provider that offers RFC 9543 Network Slice Services.

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1. Introduction

[RFC9543] outlines a framework and an interface for Network Slice using IETF technologies, and it introduces the term "IETF Network Slice Service", referred to as RFC 9543 Network Slice Service. This document uses the term "Network Slice Service" to refer to this concept for brevity and consistency.

This document defines a YANG [RFC7950] data model for [RFC9543] Network Slice Service. The Network Slice Service Model (NSSM) can be used in the Network Slice Service Interface exposed by a provider to its customers (including for provider's internal use) in order to manage (e.g., subscribe, delete, or change) Network Slice Services. The agreed service will then trigger the appropriate Network Slice operation, such as instantiating, modifying, or deleting a Network Slice.

The NSSM focuses on the requirements of a Network Slice Service from the point of view of the customer, not how it is implemented within a provider network. As discussed in [RFC9543], the mapping between a Network Slice Service and its realization is implementation and deployment specific.

The NSSM is classified as a customer service model (Section 2 of [RFC8309]).

The NSSM conforms to the Network Management Datastore Architecture (NMDA) [RFC8342].

Editorial Note: (To be removed by RFC Editor)

This document contains several placeholder values that need to be replaced with finalized values at the time of publication. Please apply the following replacements:

* AAAA --> the assigned RFC value for this draft both in this draft and in the YANG models under the revision statement

* DDDD --> the assigned RFC value for [I-D.ietf-teas-rfc8776-update]

* The "revision" date in model, in the format XXXX-XX-XX, needs to be updated with the date the draft gets approved

2. Conventions and Definitions

The keywords "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, [RFC2119], [RFC8174] when, and only when, they appear in all capitals, as shown here.

The following terms are defined in [RFC6241] and are used in this specification:

* client

* configuration data

* state data

This document makes use of the terms defined in [RFC7950].

The tree diagrams used in this document follow the notation defined in [RFC8340].

This document also makes use of the terms defined in [RFC9543]:

* Customer: See Section 3.2 of [RFC9543].

* Customer Higher-level Operation System: See Section 6.3.1 of [RFC9543].

In addition, this document defines the following term:

* Connection Group: Refers to one or more Connectivity Constructs that are grouped for administrative purposes, such as the following:

  - Combine multiple Connectivity Constructs to support a set of well-known connectivity service types, such as bidirectional unicast service, multipoint-to-point (MP2P) service, or hub-and-spoke service.

  - Assign the same Service Level Objectives (SLOs)/Service Level Expectations (SLEs) policies to multiple Connectivity Constructs unless the SLOs/SLEs policy is explicitly overridden at the individual Connectivity Construct level.

  - Share specific SLO limits within multiple Connectivity Constructs.

2.1. Acronyms

The following acronyms are used in the document:

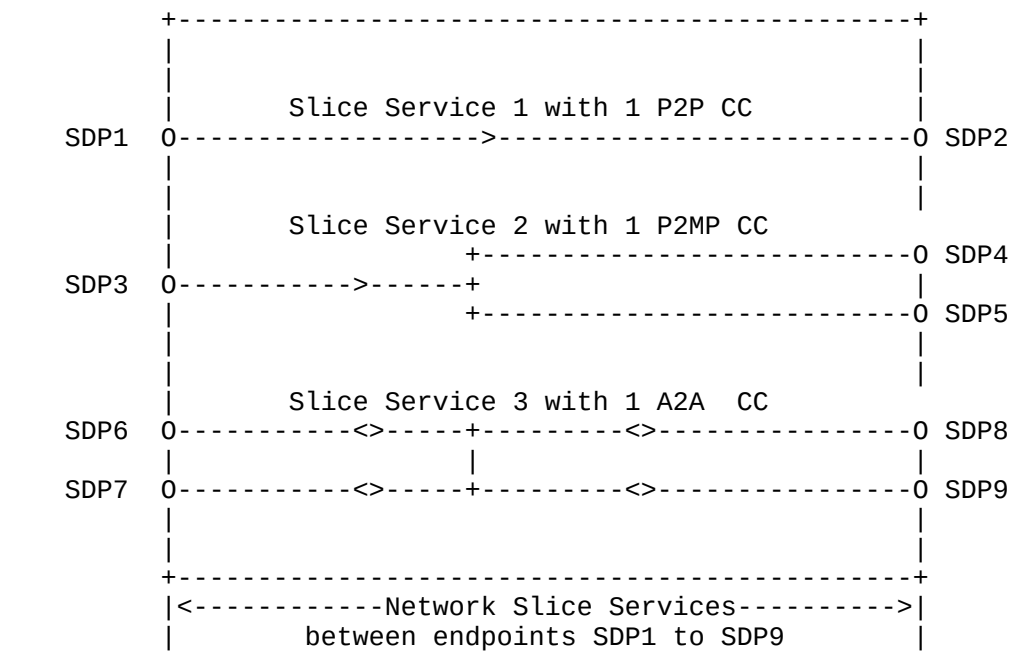
A2A	Any-to-any
AC	Attachment Circuit, as defined in Section 3.2 of [RFC9543]
CC	Connectivity Construct: See Sections 3.2 and 4.2.1 of [RFC9543]
CE	Customer Edge, see Section 3.2 of [RFC9543]
MTU	Maximum Transmission Unit
NSC	Network Slice Controller, defined in Section 6.3 of [RFC9543]
NSS	Network Slice Service, defined in Section 4.2 of [RFC9543]
NSSM	Network Slice Service Model, defined in this document
P2P	Point-to-point
P2MP	Point-to-multipoint
PE	Provider Edge, see Section 3.2 of [RFC9543]
QoS	Quality of Service
SDP	Service Demarcation Point, defined in Sections 3.2 and 5.2 [RFC9543]
SLE	Service Level Expectation, defined in Section 5.1.2 of [RFC9543]
SLO	Service Level Objective, defined in Section 5.1.1 of [RFC9543]

3. Network Slice Service Overview

As defined in Section 3.2 of [RFC9543], a Network Slice Service is specified in terms of a set of Service Demarcation Points (SDPs), a set of one or more Connectivity Constructs between subsets of these SDPs, and a set of Service Level Objectives (SLOs) and Service Level Expectations (SLEs) for each SDP sending to each Connectivity Construct. A communication type (point-to-point (P2P), point-to-multipoint (P2MP), or any-to-any (A2A)) is specified for each Connectivity Construct.

The SDPs serve as the Network Slice Service ingress/egress points. An SDP is identified by a unique identifier in the context of a Network Slice Service.

Examples of Network Slice Services that contain only one Connectivity Construct are shown in Figure 1.



CC: Connectivity Construct
O: Represents an SDP
----: Represents Connectivity Construct
< > : Inbound/outbound directions

Figure 1: Examples of Network Slice Services of Single Connectivity Construct

An example of Network Slice Services that contains multiple Connectivity Constructs is shown in Figure 2.

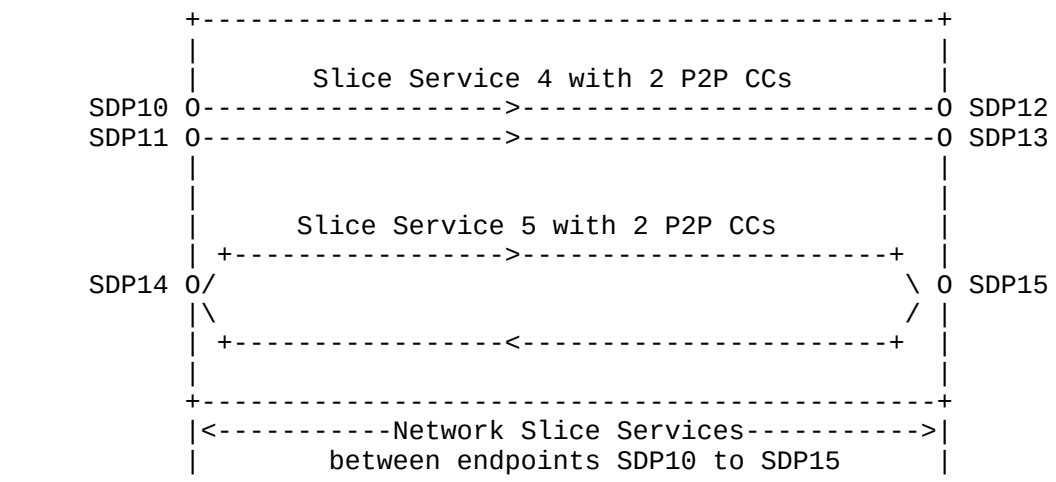


Figure 2: Examples of Network Slice Services of Multiple Connectivity Constructs

As shown in Figure 2, the Network Slice Service 4 contains two P2P Connectivity Constructs between the set of SDPs. The Network Slice Service 5 is a bidirectional unicast service between SDP14 and SDP15 that consists of two unidirectional P2P Connectivity Constructs.

4. Network Slice Service Model (NSSM) Usage

The NSSM can be used by a provider to expose its Network Slice Services, and by a customer to manage its Network Slices Services (e.g., request, delete, or modify). The details about how service requests are handled by a provider (specifically, a controller), including which network operations are triggered, are internal to the provider. The details of the Network Slices realization are hidden from customers.

The Network Slices are applicable to use cases, such as (but not limited to) 5G, network wholesale services, network infrastructure sharing among operators, Network Function Virtualization (NFV) connectivity, and Data Center interconnect. [I-D.ietf-teas-ietf-network-slice-use-cases] provides a more detailed description of the use cases for Network Slices.

A Network Slice Controller (NSC) is an entity that exposes the Network Slice Service Interface to customers to manage Network Slice Services. Typically, an NSC receives requests from its customer-facing interface (e.g., from a management system). During service creation, this interface can convey data objects that the Network Slice Service customer provides, describing the needed Network Slices Service in terms of SDPs, the associated Connectivity Constructs, and the service objectives that the customer wishes to be fulfilled. Depending on whether the requirements and authorization checks are successfully met, these service requirements are then translated into technology-specific actions that are implemented in the underlying network(s) using a network-facing interface. The details of how the Network Slices are put into effect are out of scope for this document.

As shown in Figure 3, the NSSM is used by the Customer Higher-level Operation System to communicate with an NSC for life cycle management of Network Slice Services including both enablement and monitoring. For example, in the 5G End-to-end network slicing use case, the 5G network slice orchestrator acts as the higher layer system to manage the Network Slice Services. The interface is used to support Network Slice management to facilitate end-to-end 5G network slice services.

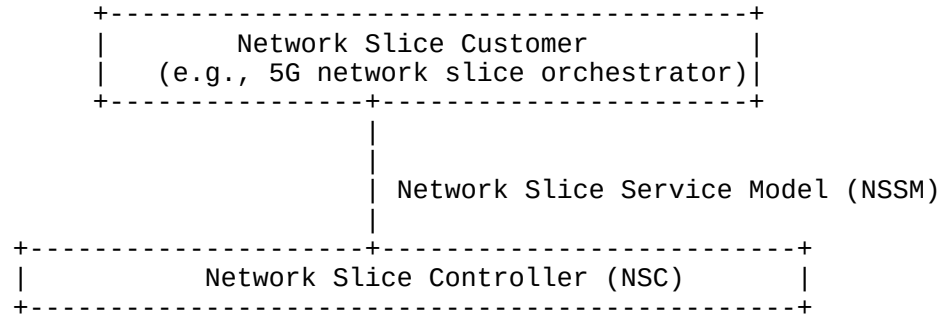


Figure 3: Network Slice Service Reference Architecture

Note: The NSSM can be used recursively (hierarchical mode), i.e., an NSS can map to child NSSes. As described in Section A.5 of [RFC9543], the Network Slice Service can support a recursive composite architecture that allows one layer of Network Slice Services to be used by other layers.

5. Network Slice Service Model (NSSM) Description

The NSSM, "ietf-network-slice-service", includes two main data nodes: "slo-sle-templates" and "slice-service" (Figure 4).

```
module: ietf-network-slice-service
  +--rw network-slice-services
     +--rw slo-sle-templates
     |  +--rw slo-sle-template* [id]
     |        ...
     +--rw slice-service* [id]
        +--rw id                              string
        +--rw description?                    string
        +--rw service-tags
        |     ...
        +--rw (slo-sle-policy)?
        |     ...
        +--rw test-only?                      empty
        +--rw status
        |     ...
        +--rw sdps
        |     ...
        +--rw connection-groups
        |     ...
        +--rw custom-topology
              ...
```

Figure 4: The NSSM Overall Tree Structure

The "slo-sle-templates" container is used by an NSC to maintain a set of common Network Slice SLO and SLE templates that apply to one or several Network Slice Services. Refer to Section 5.1 for further details on the properties of NSS templates.

The "slice-service" list includes the set of Network Slice Services that are maintained by a provider for a given customer. "slice-service" is the data structure that abstracts the Network Slice Service. Under the "slice-service", the "sdp" list is used to abstract the SDPs. The "connection-group" is used to abstract Connectivity Constructs between SDPs. Refer to Section 5.2 for further details on the properties of an NSS.

To ensure scalability of the Network Slice Service as the number of slices increases, "slo-sle-templates" can be utilized to reuse existing SLO/SLE policies. And the SDPs and connection constructs can be incrementally updated to minimize the overhead associated with frequent modifications.

5.1. SLO and SLE Templates

The "slo-sle-templates" container (Figure 5) is used by a Network Slice Service provider to define and maintain a set of common Network Slice Service templates that apply to one or several Network Slice Services. The templates are assumed to be known to both the customers and the provider. The exact definition of the templates is deployment specific.

```
+--rw slo-sle-templates
|  +--rw slo-sle-template* [id]
|     +--rw id              string
|     +--rw description?    string
|     +--rw template-ref?   slice-template-ref
|     +--rw slo-policy
|     |  +--rw metric-bound* [metric-type]
|     |  |  +--rw metric-type          identityref
|     |  |  +--rw metric-unit          string
|     |  |  +--rw value-description?   string
|     |  |  +--rw percentile-value?    percentile
|     |  |  +--rw bound?               uint64
|     |  +--rw availability?   identityref
|     |  +--rw mtu?            uint32
|     +--rw sle-policy
|        +--rw security*              identityref
|        +--rw isolation*             identityref
|        +--rw max-occupancy-level?   uint8
|        +--rw path-constraints
|           +--rw service-functions
|           +--rw diversity
|              +--rw diversity-type?
|                      te-types:te-path-disjointness
```

Figure 5: SLO SLE Templates Subtree Structure

The NSSM provides the SLO and SLE templates identifiers and templates, and the common attributes of the templates are defined in Section 5.1 of [RFC9543]. Standard templates provided by the provider as well as custom "service-slo-sle-policy" are defined, since there are many attributes defined and some attributes could vary with service requirements, e.g., bandwidth or latency. A customer may choose either a standard template provided by the provider or a customized "service-slo-sle-policy".

1. Standard template: The exact definition of the templates is deployment specific. The attributes configuration of a standard template is optional. When specifying attributes, a standard template can use "template-ref" to inherit some attributes of a predefined standard template and override the specific attributes.

2. Custom "service-slo-sle-policy": More description is provided in Section 5.2.3.

Figure 6 shows an example where two standard network slice templates are retrieved by the customers.

========== NOTE: '\' line wrapping per RFC 8792 ===========

```
{
  "ietf-network-slice-service:network-slice-services": {
    "slo-sle-templates": {
      "slo-sle-template": [
        {
          "id": "PLATINUM-template",
          "description": "Two-way bandwidth: 1 Gbps,\
                          95th percentile latency 50ms",
          "slo-policy": {
            "metric-bound": [
              {
                "metric-type": "two-way-bandwidth",
                "metric-unit": "Gbps",
                "bound": "1"
              },
              {
                "metric-type": "two-way-delay-percentile",
                "metric-unit": "milliseconds",
                "percentile-value": "95.000",
                "bound": "50"
              }
            ]
          },
          "sle-policy": {
            "isolation": ["traffic-isolation"]
          }
        },
        {
          "id": "GOLD-template",
          "description": "Two-way bandwidth: 1 Gbps,\
                          maximum latency 100ms",
          "slo-policy": {
            "metric-bound": [
```

```
                {
                  "metric-type": "two-way-bandwidth",
                  "metric-unit": "Gbps",
                  "bound": "1"
                },
                {
                  "metric-type": "two-way-delay-maximum",
                  "metric-unit": "milliseconds",
                  "bound": "100"
                }
              ]
            },
            "sle-policy": {
              "isolation": ["traffic-isolation"]
            }
          }
        ]
      }
    }
  }
```

Figure 6: Example of Template Retrieval

Figure 6 uses folding as defined in [RFC8792] for long lines.

5.2. Network Slice Services

The "slice-service" (Figure 7) is the data structure that abstracts a Network Slice Service. Each "slice-service" is uniquely identified within an NSC by "id".

```
     +--rw slice-service* [id]
        +--rw id                              string
        +--rw description?                    string
        +--rw service-tags
        |     ...
        +--rw (slo-sle-policy)?
        |     ...
        +--rw test-only?                      empty
        +--rw status
        |     ...
        +--rw sdps
        |     ...
        +--rw connection-groups
        |     ...
        +--rw custom-topology
              ...
```

Figure 7: Network Slice Service Subtree Structure

A Network Slice Service has the following main data nodes:

* "description": Provides a textual description of a Network Slice Service.

* "service-tags": Indicates a management tag (e.g., "customer name") that is used to correlate the operational information of Customer Higher-level Operation System and Network Slices. It might be used by a Network Slice Service provider to provide additional information to an NSC during the operation of the Network Slices. For example, adding tags with "customer name" when multiple actual customers use the same Network Slice Service. Another use case for "service-tag" might be for a provider to provide additional attributes to an NSC which might be used during the realization of Network Slice Services such as type of services (e.g., use Layer 2 or Layer 3 technology for the realization). These additional attributes can also be used by an NSC for various purposes such as monitoring and assurance of the Network Slice Services where the NSC can issue notifications to the customer system. All these attributes are optional.

* "slo-sle-policy": Defines SLO and SLE policies for the "slice-service". More details are provided in Section 5.2.3.

* "test-only": Is used to check the feasibility of the service before instantiating a Network Slice Service in a network. More details are provided in Section 5.2.6.

* "status": Indicates both the operational and administrative status of a Network Slice Service. Mismatches between the admin/oper status can be used as an indicator to detect Network Slice Service anomalies.

* "sdps": Represents a set of SDPs that are involved in the Network Slice Service. More details are provided in Section 5.2.1.

* "connection-groups": Abstracts the connections to the set of SDPs of the Network Slice Service.

* "custom-topology": Represents custom topology constraints for the Network Slice Service. More details are provided in Section 5.2.5

5.2.1. Service Demarcation Points

A Network Slice Service involves two or more SDPs. A Network Slice Service can be modified by adding new "sdp"s.

```
   +--rw sdps
      +--rw sdp* [id]
         +--rw id                          string
         +--rw description?                string
         +--rw geo-location
         |     ...
         +--rw node-id?                    string
         +--rw sdp-ip-address*             inet:ip-address
         +--rw tp-ref?                     leafref
         +--rw service-match-criteria
         |     ...
         +--rw incoming-qos-policy
         |     ...
         +--rw outgoing-qos-policy
         |     ...
         +--rw sdp-peering
         |     ...
         +--rw ac-svc-ref*
         |       ac-svc:attachment-circuit-reference
         +--rw ce-mode?                    boolean
         +--rw attachment-circuits
         |     ...
         +--rw status
         |     ...
         +--ro sdp-monitoring
               ...
```

Figure 8: SDP Subtree Structure

Section 5.2 of [RFC9543] describes four possible ways in which an SDP may be placed:

* Within a CE

* Provider-facing ports on a CE

* Customer-facing ports on a PE

* Within a PE

Although there are four options, they can be categorized into two categories: CE-based or PE-based.

In the four options, the Attachment Circuit (AC) may be part of the Network Slice Service or may be external to it. Based on the AC definition in Section 5.2 of [RFC9543], the customer and provider may agree on a per {Network Slice Service, Connectivity Construct, and SLOs/SLEs} basis to police or shape traffic on the AC in both the

ingress (CE to PE) direction and egress (PE to CE) direction, which ensures that the traffic is within the capacity profile that is agreed in a Network Slice Service. Excess traffic is dropped by default, unless specific out-of-profile policies are agreed between the customer and the provider.

To abstract the SDP options and SLOs/SLEs profiles, an SDP has the following characteristics:

* "id": Uniquely identifies the SDP within an NSC. The identifier is a string that allows any encoding for the local administration of the Network Slice Service.

* "geo-location": Indicates SDP location information, which helps the NSC to identify an SDP.

* "node-id": A reference to the node that hosts the SDP, which helps the NSC to identify an SDP. This document assumes that the Customer Higher-level Operation System can obtain the node information, PE and CE, prior to the service requests. For example, Service Attachment Points (SAPs) [RFC9408] can obtain PE-related node information. The implementation details are left to the NSC provider.

* "sdp-ip-address": The SDP IP addresses, which help the NSC to identify an SDP.

* "tp-ref": A reference to a Termination Point (TP) in the custom topology defined in Section 5.2.5.

* "service-match-criteria": Defines matching policies for the Network Slice Service traffic to apply on a given SDP.

* "incoming-qos-policy" and "outgoing-qos-policy": Sets the incoming and outgoing QoS policies to apply on a given SDP, including QoS policy and specific ingress and egress traffic limits to ensure access security. When applied in the incoming direction, the policy is applicable to the traffic that passes through the AC from the customer network or from another provider’s network to the Network Slice. When applied in the outgoing direction, the policy is applied to the traffic from the Network Slice towards the customer network or towards another provider’s network. If an SDP has multiple ACs, the "rate-limits" of "attachment-circuit" can be set to an AC specific value, but the rate cannot exceed the "rate-limits" of the SDP. If an SDP only contains a single AC, then the "rate-limits" of "attachment-circuit" is the same with the SDP. The definition of AC refers to Section 5.2 [RFC9543].

* "sdp-peering": Specifies the peers and peering protocols for an SDP to exchange control-plane information, e.g., Layer 1 signaling protocol or Layer 3 routing protocols, etc. As shown in Figure 9

```
+--rw sdp-peering
|  +--rw peer-sap-id*   string
|  +--rw protocols
```

Figure 9: SDP Peering Subtree Structure

  - "peer-sap-id": Indicates the references to the remote endpoints of attachment circuits. This information can be used for correlation purposes, such as identifying Service Attachment Points (SAPs) defined in [RFC9408], which defines a model of an abstract view of the provider network topology that contains the points from which the services can be attached.

  - "protocols": Serves as an augmentation target. Appendix A shows an example where BGP and static routing are augmented to the model.

* "ac-svc-ref": Refers to the ACs that have been created, which is defined in Section 5.2 of [RFC9834]. When both "ac-svc-ref" and the attributes of "attachment-circuits" are defined, the "ac-svc-ref" may take precedence or act as the parent AC depending on the use cases.

* "ce-mode": A flag node that marks the SDP is located on the CE.

* "attachment-circuits": Specifies the list of ACs by which the service traffic is received. This is an optional SDP attribute. When an SDP has multiple ACs and some AC specific attributes are needed, each "attachment-circuit" can specify attributes, such as interface specific IP addresses, service MTU, and other attributes.

* "status": Enables the control of the administrative status and reporting of the operational status of the SDP. These status values can be used as indicators to detect SDP anomalies.

* "sdp-monitoring": Provides SDP bandwidth statistics.

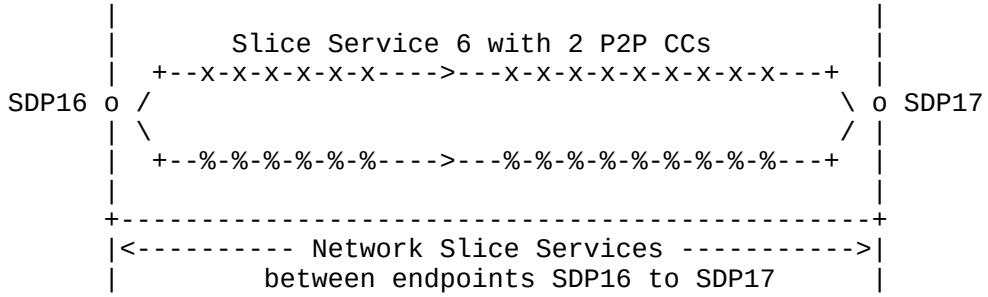
Depending on the requirements of different cases, "service-match-criteria" can be used for the following purposes:

* Specify the AC type: physical or logical connection.

* Distinguish the SDP traffic if the SDP is located in the CE or PE.

* Distinguish the traffic of different Connection Groups (CGs) or Connectivity Constructs (CCs) when multiple CGs/CCs of different SLO/SLE may be set up between the same pair of SDPs, as illustrated in Figure 10. Traffic needs to be explicitly mapped into the Network Slice's specific Connectivity Construct. The policies, "service-match-criteria", are based on the values in which combination of Layer 2 and Layer 3 header and payload fields within a packet to identify to which {Network Slice Service, Connectivity Construct, and SLOs/SLEs} that packet is assigned. For example, VLAN ([IEEE802.1Q]), C-VLAN/S-VLAN ([IEEE802.1ad]), or IP addresses.

* Define specific out-of-profile policies: The customer may choose to use an explicit "service-match-criteria" to map any SDP's traffic or a subset of the SDP's traffic to a specific Connection Group or Connectivity Construct. If a subset of traffic is matched (e.g., "dscp" and/or IP addresses) and mapped to a Connectivity Construct, the customer may choose to add a subsequent "match-any" to explicitly map the remaining SDP traffic to a separate Connectivity Construct. If the customer chooses to implicitly map remaining traffic and if there are no additional Connectivity Constructs where the "sdp/id" source is specified, then that traffic will be dropped.



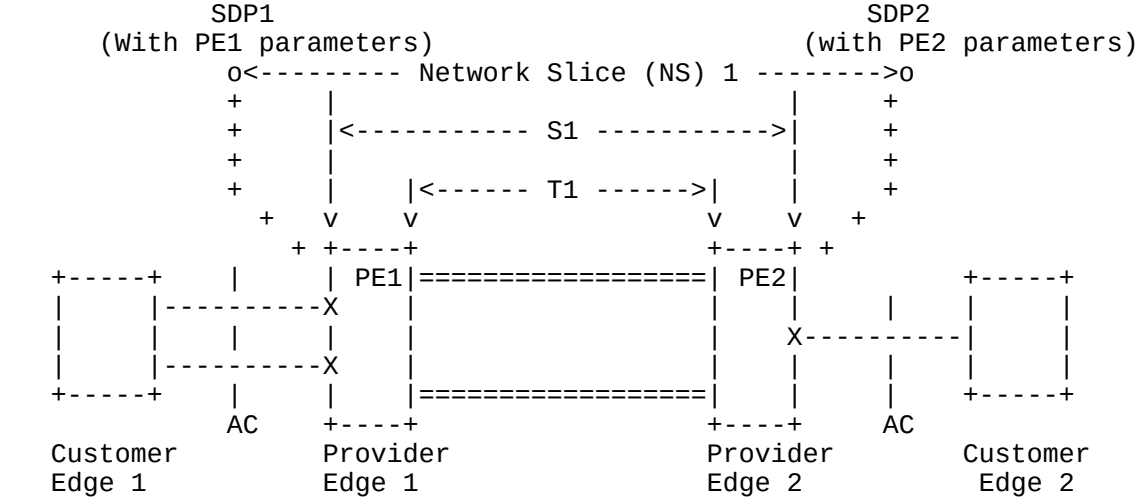
- "x": Match DSCP
- "%": Match destination-ip-prefix

Figure 10: Application of Match Criteria

If an SDP is placed at the port of a CE or PE, and there is only one single Connectivity Construct with a source at the SDP, traffic can be implicitly mapped to this Connectivity Construct since the AC information (e.g., VLAN tag) can be used to unambiguously identify the traffic and the SDP is the only source of the connectivity-construct. Appendix B.1 shows an example of both the implicit and explicit approaches. While explicit matching is optional in some use cases, it provides a more clear and readable implementation, but the choice is left to the operator.

Figure 11 and Figure 12 provide examples that illustrate the use of SDP options. How an NSC realizes the mapping is out of scope for this document.

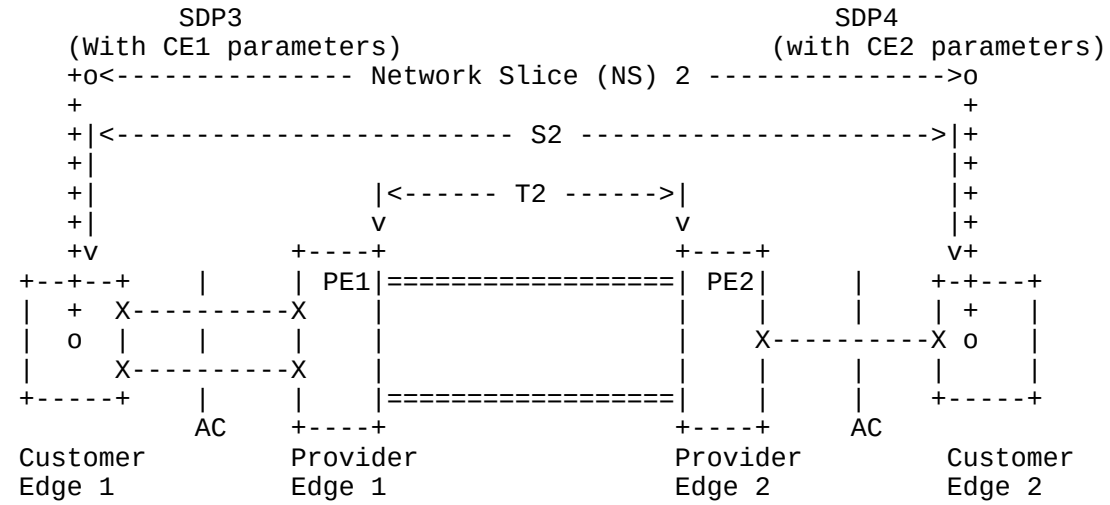
* SDPs at customer-facing ports on the PEs: As shown in Figure 11, a customer of the Network Slice Service would like to connect two SDPs to satisfy specific service needs, e.g., network wholesale services. In this case, the Network Slice SDPs are mapped to customer-facing ports of PE nodes. The NSC uses "node-id" (PE device ID), "attachment-circuits", or "ac-svc-ref" to map SDPs to the customer-facing ports on the PEs.



Legend:
o: Representation of an SDP
+: Mapping of an SDP to customer-facing ports on the PE
X: Physical interfaces used for realization of the NS Service
S1: L0/L1/L2/L3 services used for realization of NS Service
T1: Tunnels used for realization of NS Service

Figure 11: An Example of SDPs Placing at PEs

* SDPs within CEs: As shown in Figure 12, a customer of the Network Slice Service would like to connect two SDPs to provide connectivity between transport portion of 5G RAN to 5G Core network functions. In this scenario, the NSC uses "node-id" (CE device ID), "geo-location", "sdp-ip-address" (IP address of SDP for management), "service-match-criteria" (VLAN tag), "attachment-circuits" or "ac-svc-ref" (CE ACs) to map SDPs to the CE. The NSC can use these CE parameters (and optionally other information to uniquely identify a CE within an NSC, such as "peer-sap-id" [RFC9408]) to retrieve the corresponding PE device, interface and AC mapping details to complete the Network Slice Service provisioning.



Legend:
o: Representation of an SDP
+: Mapping of an SDP to CE
X: Physical interfaces used for realization of the NS Service
S2: L0/L1/L2/L3 services used for realization of the NS Service
T2: Tunnels used for realization of NS Service

Figure 12: An Example of SDPs Placing at CEs

5.2.2. Connectivity Constructs

Section 4.2.1 of [RFC9543] defines the basic Connectivity Construct (CC) and CC types of a Network Slice Service, including P2P, P2MP, and A2A.

A Network Slice Service involves one or more Connectivity Constructs. The "connection-groups" container is used to abstract CC, CC groups, and their SLOs/SLEs policies and the structure is shown in Figure 13.

```
+--rw connection-groups
   +--rw connection-group* [id]
      +--rw id                                  string
      +--rw connectivity-type?
      |       identityref
      +--rw (slo-sle-policy)?
      |  +--:(standard)
      |  |     ...
      |  +--:(custom)
      |        ...
      +--rw service-slo-sle-policy-override?
      |       identityref
      +--rw connectivity-construct* [id]
      |  +--rw id
      |  |       string
      |  +--rw (type)?
      |  |     ...
      |  +--rw (slo-sle-policy)?
      |  |     ...
      |  +--rw service-slo-sle-policy-override?
      |  |       identityref
      |  +--rw status
      |  |     ...
```

Figure 13: Connection Groups Subtree Structure

The description of the "connection-groups" data nodes is as follows:

* "connection-group": Represents a group of CCs. In the case of hub and spoke connectivity of the Slice Service, it may be inefficient when there are a large number of SDPs with multiple CCs. As illustrated in Appendix B.3, "connectivity-type" of "ietf-vpn-common:hub-spoke" and "connection-group-sdp-role" of "ietf-vpn-common:hub-role" or "ietf-vpn-common:spoke-role" can be specified [RFC9181]. Another use is for optimizing "slo-sle-policy" configurations, treating CCs with the same SLO and SLE characteristics as a Connection Group such that the Connectivity Construct can inherit the SLO/SLE from the group if not explicitly defined.

* "connectivity-type": Indicates the type of the Connection Group, extending "vpn-common:vpn-topology" specified [RFC9181] with the NS connectivity type, e.g., P2P or P2MP.

* "connectivity-construct": Represents single Connectivity Construct, and "slo-sle-policy" under it represents the per-Connectivity Construct SLO and SLE requirements.

* "slo-sle-policy" and "service-slo-sle-policy-override": The details of "slo-sle-policy" are defined in Section 5.2.3.

5.2.3. SLO and SLE Policy

As defined in Section 5 of [RFC9543], the SLO and SLE policy of the Network Slice Services define some common attributes.

"slo-sle-policy" is used to represent these SLO and SLE policies. During the creation of a Network Slice Service, the policy can be specified either by a standard SLO and SLE template or a customized SLO and SLE policy.

Two types of precedence rules are defined to resolve conflicts when assigning policies to a Network Slice Service, Connection Group "connection group", or Connectivity Construct "connectivity-construct".

Scope-based Precedence: In case of conflicts, policies with a narrower scope (e.g., subset of a Network Slice Service) take precedence over policies with a broader scope (e.g., Network Slice Service). The precedence order is as follows (from highest to lowest precedence):

* Connectivity-construct at an individual sending SDP

* Connectivity-construct

* Connection-group

* Slice-level

For example, a policy assigned at the sending SDP level takes precedence over a policy assigned at the connectivity-construct level, which in turn takes precedence over a slice-level policy. Appendix B.5 gives an example of the preceding policy, which shows a Slice Service having an A2A connectivity as default and several specific SLO connections.

Explicit Precedence: "service-slo-sle-policy-override" node is designed to enable the complete or partial replacement of an existing "slo-sle-policy" with new values for complex SLO-SLE requirements. For example, if a particular "connection-group" or a "connectivity-construct" has a unique bandwidth or latency setting, that are different from those defined in the Slice Service, a new set of SLOs/SLEs with full or partial override can be applied.

In a partial override, only the newly specified parameters replace those in the original template, while pre-existing unspecified parameters remain unchanged.

In a full override, all pre-existing parameters are removed, and a new set of SLOs/SLEs is applied.

The SLO attributes include performance metric attributes, availability, and MTU. The SLO structure is shown in Figure 14. Figure 27 shows an example "slice5" with a custom network slice "slo-policy".

```
+--rw slo-policy
|  +--rw metric-bound* [metric-type]
|  |  +--rw metric-type
|  |  |       identityref
|  |  +--rw metric-unit          string
|  |  +--rw value-description?   string
|  |  +--rw percentile-value?
|  |  |       percentile
|  |  +--rw bound?               uint64
|  +--rw availability?   identityref
|  +--rw mtu?            uint16
```

Figure 14: SLO Policy Subtree Structure

The list "metric-bound" supports the generic performance metric variations and the combinations and each "metric-bound" could specify a particular "metric-type". "metric-type" is defined with YANG identity and supports the following options:

"one-way-bandwidth": Indicates the guaranteed minimum bandwidth between any two SDPs. The bandwidth is unidirectional.

"two-way-bandwidth": Indicates the guaranteed minimum bandwidth between any two SDPs. The bandwidth is bidirectional.

"shared-bandwidth": Indicates the shared SLO bandwidth bound, which is the limit on the bandwidth that can be shared among a group of Connectivity Constructs of a Slice Service.

"one-way-delay-maximum": Indicates the maximum one-way latency between two SDPs, defined in [RFC7679].

"two-way-delay-maximum": Indicates the maximum round-trip latency between two SDPs, defined in [RFC2681].

"one-way-delay-percentile": Indicates the percentile objective of the one-way latency between two SDPs ([RFC7679]).

"two-way-delay-percentile": Indicates the percentile objective of the round-trip latency between two SDPs (See [RFC2681]).

"one-way-delay-variation-maximum": Indicates the jitter constraint of the slice maximum permissible delay variation, and is measured by the difference in the one-way latency between sequential packets in a flow, as defined in [RFC3393].

"two-way-delay-variation-maximum": Indicates the jitter constraint of the slice maximum permissible delay variation, and is measured by the difference in the two-way latency between sequential packets in a flow, as defined in [RFC3393].

"one-way-delay-variation-percentile": Indicates the percentile objective of the delay variation, and is measured by the difference in the one-way latency between sequential packets in a flow, as defined in [RFC3393].

"two-way-delay-variation-percentile": Indicates the percentile objective of the delay variation, and is measured by the difference in the two-way latency between sequential packets in a flow, as defined in [RFC5481].

"one-way-packet-loss": Indicates maximum permissible packet loss rate (See [RFC7680], which is defined by the ratio of packets dropped to packets transmitted between two SDPs.

"two-way-packet-loss": Indicates maximum permissible packet loss rate (See [RFC7680], which is defined by the ratio of packets dropped to packets transmitted between two SDPs.

"availability": Specifies service availability defined as the ratio of uptime to the sum of uptime and downtime, where uptime is the time the Network Slice is available in accordance with the SLOs associated with it.

"mtu": Specifies the maximum length of Layer 2 data packets of the Slice Service, in bytes. If the customer sends packets that are longer than the requested service MTU, the network may discard them

(or for IPv4, fragment them). This service MTU takes precedence over the MTUs of all ACs. The value needs to be smaller than or equal to the minimum MTU value of all ACs in the SDPs.

As shown in Figure 15, the following SLEs data nodes are defined.

"security": The security leaf-list defines the list of security functions that the customer requests the operator to apply to traffic between the two SDPs, including authentication, encryption, etc., which is defined in Section 5.1.2.1 [RFC9543].

"isolation": Specifies the isolation types that a customer expects, as defined in Section 8 of [RFC9543].

"max-occupancy-level": Specifies the number of flows that the operator admits (See Section 5.1.2.1 of [RFC9543]).

"path-constraints": Specifies the path constraints the customer requests for the Network Slice Service, including geographic restrictions and diversity which is defined in Section 5.1.2.1 of [RFC9543].

```
+--rw sle-policy
   +--rw security*              identityref
   +--rw isolation*             identityref
   +--rw max-occupancy-level?   uint8
   +--rw path-constraints
      +--rw service-functions
      +--rw diversity
         +--rw diversity-type?
                 te-types:te-path-disjointness
```

Figure 15: SLE Policy Subtree Structure

5.2.4. Network Slice Service Performance Monitoring

The operation and performance status of Network Slice Services is also a key component of the NSSM. The model provides SLO monitoring information with the following granularity:

* Per SDP: The incoming and outgoing bandwidths of an SDP are specified in "sdp-monitoring" under the "sdp".

* Per Connectivity Construct: The delay, delay variation, and packet loss status are specified in "connectivity-construct-monitoring" under the "connectivity-construct".

* Per Connection Group: The delay, delay variation, and packet loss status are specified in "connection-group-monitoring" under the "connection-group".

[RFC8639] and [RFC8641] define a subscription mechanism and a push mechanism for YANG datastores. These mechanisms currently allow the user to subscribe to notifications on a per-client basis and specify either periodic or on-demand notifications. By specifying subtree filters or xpath filters to "sdp", "connectivity-construct", or "connection-group", so that only interested contents will be sent. The example in Figure 24 shows the way for a customer to subscribe to the monitoring information for a particular Network Slice Service.

Additionally, a customer can use the NSSM to obtain a snapshot of the Network Slice Service performance status through [RFC8040] or [RFC6241] interfaces. For example, retrieve the per-connectivity-construct data by specifying "connectivity-construct" as the filter in the RESTCONF GET request.

5.2.5. Custom Topology Constraints

A Slice Service customer might request for some level of control over the topology or resource constraints. "custom-topology" is defined as an augmentation target that references the context topology. The leaf "network-ref" under this container is used to reference a predefined topology as a customized topology constraint for a Network Slice Service. Section 1 of [RFC8345] defines a general abstract topology concept to accommodate both the provider’s resource capability and the customer’s preferences. The abstract topology is a topology that contains abstract topological elements (nodes, links, and termination points).

This document defines only the minimum attributes of a custom topology, which can be extended based on the implementation requirements.

The following nodes are defined for the custom topology:

"custom-topology": This container serves as an augmentation target for the Slice Service topology context, which can be multiple. This node is located directly under the "slice-service" list.

"network-ref": This leaf is under the container "custom-topology",

which is defined to reference a predefined topology as a customized topology constraint for a Network Slice Service, e.g., a SAP topology to request SDP feasibility checks on SAPs network described in Section 3 of [RFC9408], an abstract Traffic Engineering (TE) topology defined in Section 3.13 of [RFC8795] to customize the service paths in a Network Slice Service.

"tp-ref": A reference to a Termination Point (TP) in the custom topology, under the list "sdp", can be used to associate an SDP with a TP of the customized topology. The example TPs could be parent termination points of the SAP topology.

5.2.6. Network Slice Service Feasibility Check

A Network Slice Service customer may request to check the feasibility of a request before instantiating or modifying a Network Slice Service, e.g., network resources such as service access points for service delivery. In such a case, this document introduces a "test-only" mode (semantics derived from NETCONF [RFC6241] test operation), which differs from standard management operations.

A "test-only" Network Slice Service is configured as usual with the associated per slice SLOs/SLEs. The NSC computes the feasible Connectivity Constructs to the configured SLOs/SLEs. This computation does not create the Network Slice or reserve any resources in the provider’s network, it simply computes the resulting Network Slice based on the request. The Network Slice "admin-status" and the Connection Groups or Connectivity Construct list are used to convey the result. For example, "admin-up" can be used to indicate a status of success. Customers can query the "test-only" Connectivity Constructs attributes, or can subscribe to be notified when the Connectivity Constructs status change. If the check fails, the feedback is conveyed through the "rejected" value of "admin-status", indicating the reasons for the failure, such as insufficient resources or constraint violation.

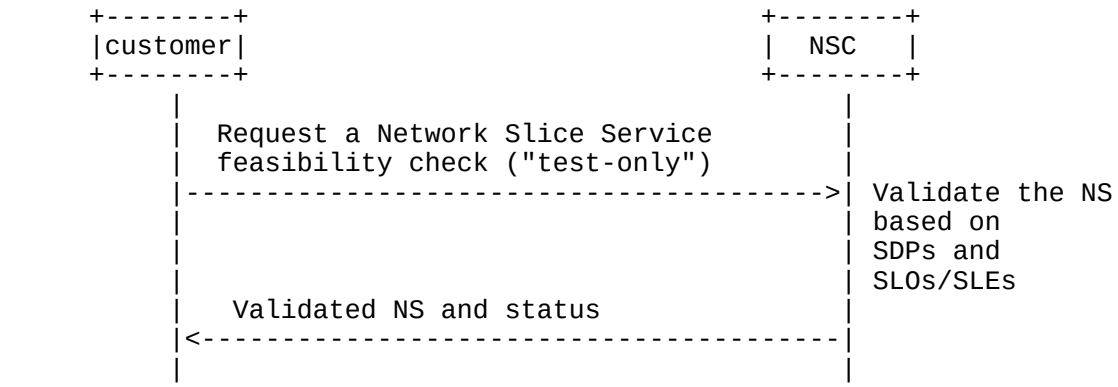
As defined in Section 6.3 of [RFC9543] for multi-domain requirements, when a Network Slice spans multiple administrative domains, the ’test-only’ mode relies on the NSC to aggregate and validate information across these domains. This could include:

1. Validating end-to-end Network Slice requests to ensure they can be realized across all domains.

2. Checking resource availability and constraints within each domain to confirm feasibility.

3. Identifying potential conflicts or bottlenecks between domains that may impact the Network Slice's performance or realization.

The "test-only" applies only if the data model is used with a protocol that does not intrinsically support such operation, e.g., [RFC8040]. When using NETCONF, the "test-only" value of the <test-option> parameter in the <edit-config> operation (Section 7.2 of [RFC6241]) also applies.



NS: Network Slice

Figure 16: An Example of NSS Feasibility Check

6. Network Slice Service Module

The "ietf-network-slice-service" module uses types defined in [RFC9911], [RFC8294], [RFC8345], [RFC8519], [RFC9179], [RFC9181], [RFC9833], [RFC9834], and [I-D.ietf-teas-rfc8776-update].

<CODE BEGINS> file "ietf-network-slice-service@2026-05-27.yang"

```
module ietf-network-slice-service {
  yang-version 1.1;
  namespace
    "urn:ietf:params:xml:ns:yang:ietf-network-slice-service";
  prefix ietf-nss;

  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 9911: Common YANG Types";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
```

```
        "RFC 8294: Common YANG Data Types for the Routing Area";
    }
    import ietf-yang-types {
      prefix yang;
      reference
        "RFC 9911: Common YANG Data Types";
    }
    import ietf-geo-location {
      prefix geo;
      reference
        "RFC 9179: A YANG Grouping for Geographic Locations";
    }
    import ietf-vpn-common {
      prefix vpn-common;
      reference
        "RFC 9181: A Common YANG Data Model for Layer 2 and Layer 3
                   VPNs";
    }
    import ietf-network {
      prefix nw;
      reference
        "RFC 8345: A YANG Data Model for Network Topologies";
    }
    import ietf-network-topology {
      prefix nt;
      reference
        "RFC 8345: A YANG Data Model for Network
                   Topologies, Section 6.2";
    }
    import ietf-ac-common {
      prefix ac-common;
      reference
        "RFC 9833: A Common YANG Data Model for Attachment Circuits";
    }
    import ietf-ac-svc {
      prefix ac-svc;
      reference
        "RFC 9834: YANG Data Models for Bearers and 'Attachment
                   Circuits'-as-a-Service (ACaaS)";
    }
    import ietf-te-types {
      prefix te-types;
      reference
        "RFC DDDD: Common YANG Types for Traffic Engineering";
    }
    import ietf-te-packet-types {
      prefix te-packet-types;
      reference
```

```
        "RFC DDDD: Common YANG Data Types for Traffic Engineering";
    }

    organization
      "IETF Traffic Engineering Architecture and Signaling (TEAS)
       Working Group";
    contact
      "WG Web:  <https://datatracker.ietf.org/wg/teas/>
       WG List:  <mailto:teas@ietf.org>

       Editor: Bo Wu
               <lana.wubo@huawei.com>
       Editor: Dhruv Dhody
               <dhruv.ietf@gmail.com>
       Editor: Reza Rokui
               <rrokui@ciena.com>
       Editor: Tarek Saad
               <tsaad@cisco.com>
       Editor: John Mullooly
               <jmullool@cisco.com>";
    description
      "This YANG module defines a service model for the RFC 9543
       Network Slice Service.

       Copyright (c) 2026 IETF Trust and the persons identified as
       authors of the code.  All rights reserved.

       Redistribution and use in source and binary forms, with or
       without modification, is permitted pursuant to, and subject to
       the license terms contained in, the Revised BSD License set
       forth in Section 4.c of the IETF Trust's Legal Provisions
       Relating to IETF Documents
       (https://trustee.ietf.org/license-info).

       This version of this YANG module is part of RFC AAAA; see the
       RFC itself for full legal notices.";

    revision 2026-05-27 {
      description
        "Initial revision.";
      reference
        "RFC AAAA: A YANG Data Model for the RFC 9543 Network Slice
         Service";
    }

    /* Identities */

    identity service-tag-type {
```

```
      description
        "Base identity of Network Slice Service tag type, which is
         used for management purposes, such as classification
         (e.g., customer names) and policy constraints
         (e.g., Layer 2 or Layer 3 technology realization).";
    }

    identity customer {
      base service-tag-type;
      description
        "The Network Slice Service customer name tag type,
         e.g., adding tags with 'customer name' when multiple actual
         customers use the same Network Slice Service.";
    }

    identity service {
      base service-tag-type;
      description
        "The Network Slice Service tag type, which can indicate the
         technical constraints used during service realization
         (for example, Layer 2 or Layer 3 technologies).";
    }

    identity opaque {
      base service-tag-type;
      description
        "An opaque type, which can be used for future use,
         such as filtering of services.";
    }

    identity attachment-circuit-tag-type {
      description
        "Base identity for the Attachment Circuit tag type.";
    }

    identity vlan-id {
      base attachment-circuit-tag-type;
      description
        "Identity for VLAN ID tag type, 802.1Q dot1Q.";
      reference
        "IEEE Std 802.1Q: IEEE Standard for Local and Metropolitan
                          Area Networks--Bridges and Bridged
                          Networks";
    }

    identity cvlan-id {
      base attachment-circuit-tag-type;
      description
```

```
        "Identity for C-VLAN ID tag type, 802.1ad QinQ VLAN IDs.";
      reference
        "IEEE Std 802.1ad: IEEE Standard for Local and Metropolitan
                           Area Networks---Virtual Bridged Local
                           Area Networks---Amendment 4: Provider
                           Bridges";
    }

    identity svlan-id {
      base attachment-circuit-tag-type;
      description
        "Identity for S-VLAN ID tag type, 802.1ad QinQ VLAN IDs.";
      reference
        "IEEE Std 802.1ad: IEEE Standard for Local and Metropolitan
                           Area Networks---Virtual Bridged Local
                           Area Networks---Amendment 4: Provider
                           Bridges";
    }

    identity ip-address-mask {
      base attachment-circuit-tag-type;
      description
        "Identity for IP address mask tag type.";
    }

    identity service-isolation-type {
      description
        "Base identity for Network Slice Service isolation type.";
    }

    identity traffic-isolation {
      base service-isolation-type;
      description
        "Specify the requirement for separating the traffic of the
         customer's Network Slice Service from other services,
         which may be provided by the service provider using VPN
         technologies, such as L3VPN, L2VPN, EVPN, or others.";
    }

    identity service-security-type {
      description
        "Base identity for Network Slice Service security type.";
    }

    identity authentication {
      base service-security-type;
      description
        "Indicates that the Slice Service requires authentication.";
```

```
  }

  identity integrity {
    base service-security-type;
    description
      "Indicates that the Slice Service requires data integrity.";
  }

  identity encryption {
    base service-security-type;
    description
      "Indicates that the Slice Service requires data encryption.";
  }

  identity point-to-point {
    base vpn-common:vpn-topology;
    description
      "Identity for point-to-point Network Slice
       Service connectivity.";
  }

  identity point-to-multipoint {
    base vpn-common:vpn-topology;
    description
      "Identity for point-to-multipoint Network Slice
       Service connectivity.";
  }

  identity multipoint-to-multipoint {
    base vpn-common:vpn-topology;
    description
      "Identity for multipoint-to-multipoint Network Slice
       Service connectivity.";
  }

  identity multipoint-to-point {
    base vpn-common:vpn-topology;
    description
      "Identity for multipoint-to-point Network Slice
       Service connectivity.";
  }

  identity sender-role {
    base vpn-common:role;
    description
      "Indicates that an SDP is acting as a sender.";
  }
```

```
  identity receiver-role {
    base vpn-common:role;
    description
      "Indicates that an SDP is acting as a receiver.";
  }

  identity service-slo-metric-type {
    description
      "Base identity for Network Slice Service SLO metric type.";
  }

  identity one-way-bandwidth {
    base service-slo-metric-type;
    description
      "SLO bandwidth metric. Minimum guaranteed bandwidth between
       two SDPs at any time and is measured unidirectionally.";
  }

  identity two-way-bandwidth {
    base service-slo-metric-type;
    description
      "SLO bandwidth metric. Minimum guaranteed bandwidth between
       two SDPs at any time.";
  }

  identity shared-bandwidth {
    base service-slo-metric-type;
    description
      "The shared SLO bandwidth bound. It is the limit on the
       bandwidth that can be shared among a group of
       Connectivity Constructs of a Slice Service.";
  }

  identity one-way-delay-maximum {
    base service-slo-metric-type;
    description
      "The SLO objective of this metric is the upper bound of network
       delay when transmitting between two SDPs.";
    reference
      "RFC 7679: A One-Way Delay Metric for IP Performance
                 Metrics (IPPM)";
  }

  identity one-way-delay-percentile {
    base service-slo-metric-type;
    description
      "The SLO objective of this metric is percentile objective of
       network delay when transmitting between two SDPs.
```

```
          The metric is defined in RFC7679.";
        reference
          "RFC 7679: A One-Way Delay Metric for IP Performance
                     Metrics (IPPM)";
      }

      identity two-way-delay-maximum {
        base service-slo-metric-type;
        description
          "SLO two-way delay is the upper bound of network delay when
           transmitting between two SDPs";
        reference
          "RFC 2681: A Round-trip Delay Metric for IPPM";
      }

      identity two-way-delay-percentile {
        base service-slo-metric-type;
        description
          "The SLO objective of this metric is the percentile
           objective of network delay when the traffic transmitting
           between two SDPs.";
        reference
          "RFC 2681: A Round-trip Delay Metric for IPPM";
      }

      identity one-way-delay-variation-maximum {
        base service-slo-metric-type;
        description
          "The SLO objective of this metric is maximum bound of the
           difference in the one-way delay between sequential packets
           between two SDPs.";
        reference
          "RFC 3393: IP Packet Delay Variation Metric for IP Performance
                     Metrics (IPPM)";
      }

      identity one-way-delay-variation-percentile {
        base service-slo-metric-type;
        description
          "The SLO objective of this metric is the percentile objective
           in the one-way delay between sequential packets between two
           SDPs.";
        reference
          "RFC 3393: IP Packet Delay Variation Metric for IP Performance
                     Metrics (IPPM)";
      }

      identity two-way-delay-variation-maximum {
```

```
    base service-slo-metric-type;
    description
      "SLO two-way delay variation is the difference in the
       round-trip delay between sequential packets between two
       SDPs.";
    reference
      "RFC 5481: Packet Delay Variation Applicability Statement";
  }

  identity two-way-delay-variation-percentile {
    base service-slo-metric-type;
    description
      "The SLO objective of this metric is the percentile objective
       in the round-trip delay between sequential packets between
       two SDPs.";
    reference
      "RFC 5481: Packet Delay Variation Applicability Statement";
  }

  identity one-way-packet-loss {
    base service-slo-metric-type;
    description
      "This metric type refers to the ratio of packets dropped
       to packets transmitted between two SDPs in one-way.";
    reference
      "RFC 7680: A One-Way Loss Metric for IP Performance
                 Metrics (IPPM)";
  }

  identity two-way-packet-loss {
    base service-slo-metric-type;
    description
      "This metric type refers to the ratio of packets dropped
       to packets transmitted between two SDPs in two-way.";
    reference
      "RFC 7680: A One-Way Loss Metric for IP Performance
                 Metrics (IPPM)";
  }

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

  identity six-nines {
    base availability-type;
    description
      "Specifies the availability level: 99.9999%";
```

```
  }

  identity five-nines {
    base availability-type;
    description
      "Specifies the availability level: 99.999%";
  }

  identity four-nines {
    base availability-type;
    description
      "Specifies the availability level: 99.99%";
  }

  identity three-nines {
    base availability-type;
    description
      "Specifies the availability level: 99.9%";
  }

  identity two-nines {
    base availability-type;
    description
      "Specifies the availability level: 99%";
  }

  identity service-match-type {
    description
      "Base identity for Network Slice Service traffic
       match type.";
  }

  identity phy-interface {
    base service-match-type;
    description
      "Uses the physical interface as match criteria for
       Slice Service traffic.";
  }

  identity vlan {
    base service-match-type;
    description
      "Uses the VLAN ID as match criteria for the Slice Service
       traffic.";
  }

  identity label {
    base service-match-type;
```

```
      description
        "Uses the MPLS label as match criteria for the Slice Service
         traffic.";
    }

    identity source-ip-prefix {
      base service-match-type;
      description
        "Uses source IP prefix as match criteria for the Slice Service
         traffic. Examples of 'value' of this match type are
         '192.0.2.0/24' and '2001:db8::1/64'.";
    }

    identity destination-ip-prefix {
      base service-match-type;
      description
        "Uses destination IP prefix as match criteria for the Slice
         Service traffic. Examples of 'value' of this match type are
         '203.0.113.1/32' and '2001:db8::2/128'.";
    }

    identity dscp {
      base service-match-type;
      description
        "Uses DSCP field in the IP packet header as match criteria
         for the Slice Service traffic.";
    }

    identity acl {
      base service-match-type;
      description
        "Uses Access Control List (ACL) as match criteria
         for the Slice Service traffic.";
      reference
        "RFC 8519: YANG Data Model for Network Access Control
                   Lists (ACLs)";
    }

    identity any {
      base service-match-type;
      description
        "Matches any Slice Service traffic.";
    }

    identity slo-sle-policy-override {
      description
        "Base identity for SLO/SLE policy override options.";
    }
```

```
  identity full-override {
    base slo-sle-policy-override;
    description
      "The SLO/SLE policy defined at the child level overrides a
       parent SLO/SLE policy, which means that no SLO/SLEs are
       inherited from parent if a child SLO/SLE policy exists.";
  }

  identity partial-override {
    base slo-sle-policy-override;
    description
      "The SLO/SLE policy defined at the child level updates the
       parent SLO/SLE policy. For example, if a specific SLO is
       defined at the child level, that specific SLO overrides
       the one inherited from a parent SLO/SLE policy, while all
       other SLOs in the parent SLO-SLE policy still apply.";
  }

  /* Typedef */

  typedef percentage {
    type uint8 {
      range "0..100";
    }
    description
      "Integer indicating a percentage value.";
  }

  typedef percentile {
    type decimal64 {
      fraction-digits 3;
      range "0..100";
    }
    description
      "The percentile is a value between 0 and 100
       to 3 decimal places, e.g., 10.000, 99.900,99.990, etc.
       For example, for a given one-way delay measurement,
       if the percentile is set to 95.000 and the 95th percentile
       one-way delay is 2 milliseconds, then the 95 percent of
       the sample value is less than or equal to 2 milliseconds.";
  }

  typedef ns-compute-status {
    type te-types:te-common-status;
    description
      "A type definition for representing the Network Slice
       compute status. Note that all statuses apart from up and down
       are considered as unknown.";
```

```
  }

  typedef slice-template-ref {
    type leafref {
      path "/ietf-nss:network-slice-services"
         + "/ietf-nss:slo-sle-templates"
         + "/ietf-nss:slo-sle-template"
         + "/ietf-nss:id";
    }
    description
      "This type is used by data models that need to reference
       Network Slice templates.";
  }

  typedef slice-service-ref {
    type leafref {
      path
        "/ietf-nss:network-slice-services/ietf-nss:slice-service"
      + "/ietf-nss:id";
    }
    description
      "Defines a reference to a slice service that can be used
       by other modules.";
  }

  /* Groupings */

  grouping service-slos {
    description
      "A reusable grouping for directly measurable objectives of
       a Slice Service.";
    container slo-policy {
      description
        "Contains the SLO policy.";
      list metric-bound {
        key "metric-type";
        description
          "List of Slice Service metric bounds.";
        leaf metric-type {
          type identityref {
            base service-slo-metric-type;
          }
          description
            "Identifies SLO metric type of the Slice Service.";
        }
        leaf metric-unit {
          type string;
          mandatory true;
```

```
            description
              "The metric unit of the parameter. For example,
               for time units, where the options are hours, minutes,
               seconds, milliseconds, microseconds, and nanoseconds;
               for bandwidth units, where the options are bps, Kbps,
               Mbps, Gbps; for the packet loss rate unit,
               the options can be a percentage.";
          }
          leaf value-description {
            type string;
            description
              "The description of the provided value.";
          }
          leaf percentile-value {
            type percentile;
            description
              "The percentile value of the metric type.";
          }
          leaf bound {
            type uint64;
            description
              "The bound on the Slice Service connection metric.
               When set to zero, this indicates an unbounded
               upper limit for the specific metric-type.";
          }
        }
        leaf availability {
          type identityref {
            base availability-type;
          }
          description
            "Service availability level.";
        }
        leaf mtu {
          type uint32;
          units "bytes";
          description
            "Specifies the maximum length of Layer 2 data
             packets of the Slice Service.
             If the customer sends packets that are longer than the
             requested service MTU, the network may discard them
             (or for IPv4, fragment them).
             This service MTU takes precedence over the MTUs of
             all Attachment Circuits (ACs). The value needs to be
             less than or equal to the minimum MTU value of
             all ACs in the SDPs.";
        }
      }
```

```
    }

    grouping service-sles {
      description
        "A reusable grouping for indirectly measurable objectives of
         a Slice Service.";
      container sle-policy {
        description
          "Contains the SLE policy.";
        leaf-list security {
          type identityref {
            base service-security-type;
          }
          description
            "The security functions (e.g., ‘authentication‘ and
             ‘encryption‘) that the customer requests the operator to
             apply to traffic between the two SDPs.";
        }
        leaf-list isolation {
          type identityref {
            base service-isolation-type;
          }
          description
            "The Slice Service isolation requirement.";
        }
        leaf max-occupancy-level {
          type uint8 {
            range "1..100";
          }
          description
            "The maximal occupancy level specifies the number of flows
             to be admitted and optionally a maximum number of
             countable resource units (e.g., IP or MAC addresses)
             a Network Slice Service can consume.";
        }
        container path-constraints {
          description
            "Container for the policy of path constraints
             applicable to the Slice Service.";
          container service-functions {
            description
              "Container for the policy of service function
               applicable to the Slice Service.";
          }
          container diversity {
            description
              "Container for the policy of disjointness
               applicable to the Slice Service.";
```

```
            leaf diversity-type {
              type te-types:te-path-disjointness;
              description
                "The type of disjointness on Slice Service, i.e.,
                 across all Connectivity Constructs.";
            }
          }
        }
      }
    }

    grouping slice-service-template {
      description
        "A reusable grouping for Slice Service templates.";
      container slo-sle-templates {
        description
          "Contains a set of Slice Service templates.";
        list slo-sle-template {
          key "id";
          description
            "List for SLO and SLE template identifiers.";
          leaf id {
            type string;
            description
              "Identification of the Service Level Objective (SLO)
               and Service Level Expectation (SLE) template to be used.
               Local administration meaning.";
          }
          leaf description {
            type string;
            description
              "Describes the SLO and SLE policy template.";
          }
          leaf template-ref {
            type slice-template-ref;
            description
              "The reference to a standard template. When set it
                indicates the base template over which further
                SLO/SLE policy changes are made.";
          }
          uses service-slos;
          uses service-sles;
        }
      }
    }

    grouping service-slo-sle-policy {
      description
```

```
        "Slice service policy grouping.";
      choice slo-sle-policy {
        description
          "Choice for SLO and SLE policy template.
           Can be standard template or customized template.";
        case standard {
          description
            "Standard SLO template.";
          leaf slo-sle-template {
            type slice-template-ref;
            description
              "Standard SLO and SLE template to be used.";
          }
        }
        case custom {
          description
            "Customized SLO and SLE template.";
          container service-slo-sle-policy {
            description
              "Contains the SLO and SLE policy.";
            leaf description {
              type string;
              description
                "Describes the SLO and SLE policy.";
            }
            uses service-slos;
            uses service-sles;
          }
        }
      }
    }

    grouping service-qos {
      description
        "Grouping for the Slice Service QoS policy.";
      container incoming-qos-policy {
        description
          "The QoS policy imposed on ingress direction of the traffic,
           from the customer network or from another provider's
           network.";
        leaf qos-policy-name {
          type string;
          description
            "The name of the QoS policy that is applied to the
             Attachment Circuit. The name can reference a QoS
             profile that is pre-provisioned on the device.";
        }
        container rate-limits {
```

```
          description
            "Container for the asymmetric traffic control.";
          uses ac-common:bandwidth-parameters;
          container classes {
            description
              "Container for service class bandwidth control.";
            list cos {
              key "cos-id";
              description
                "List of Class of Services.";
              leaf cos-id {
                type uint8;
                description
                  "Identifier of the CoS, indicated by
                   a Differentiated Services Code Point
                   (DSCP) or a CE-CLAN CoS (802.1p)
                   value in the service frame.";
                reference
                  "IEEE Std 802.1Q: Bridges and Bridged
                                    Networks";
              }
              uses ac-common:bandwidth-parameters;
            }
          }
        }
      }
      container outgoing-qos-policy {
        description
          "The QoS policy imposed on egress direction of the traffic,
           towards the customer network or towards another
           provider's network.";
        leaf qos-policy-name {
          type string;
          description
            "The name of the QoS policy that is applied to the
             Attachment Circuit. The name can reference a QoS
             profile that is pre-provisioned on the device.";
        }
        container rate-limits {
          description
            "The rate-limit imposed on outgoing traffic.";
          uses ac-common:bandwidth-parameters;
          container classes {
            description
              "Container for classes.";
            list cos {
              key "cos-id";
              description
```

```
                "List of Class of Services.";
              leaf cos-id {
                type uint8;
                description
                  "Identifier of the CoS, indicated by
                   a Differentiated Services Code Point
                   (DSCP) or a CE-CLAN CoS (802.1p)
                   value in the service frame.";
                reference
                  "IEEE Std 802.1Q: Bridges and Bridged
                                    Networks";
              }
              uses ac-common:bandwidth-parameters;
            }
          }
        }
      }
    }

    grouping service-slo-sle-policy-override {
      description
        "Slice Service policy override grouping.";
      leaf service-slo-sle-policy-override {
        type identityref {
          base slo-sle-policy-override;
        }
        description
          "SLO/SLE policy override option.";
      }
    }

    grouping connectivity-construct-monitoring-metrics {
      description
        "Grouping for Connectivity Construct monitoring metrics.";
      uses
        te-packet-types:one-way-performance-metrics-gauge-packet;
      uses
        te-packet-types:two-way-performance-metrics-gauge-packet;
    }

    /* Main Network Slice Services Container */

    container network-slice-services {
      description
        "Contains a list of Network Slice Services";
      uses slice-service-template;
      list slice-service {
        key "id";
```

```
        description
          "A Slice Service is identified by a service id.";
        leaf id {
          type string;
          description
            "A unique Slice Service identifier within an NSC.";
        }
        leaf description {
          type string;
          description
            "Textual description of the Slice Service.";
        }
        container service-tags {
          description
            "Container for a list of service tags for management
             purposes, such as policy constraints
             (e.g., Layer 2 or Layer 3 technology realization),
             classification (e.g., customer names, opaque values).";
          list tag-type {
            key "tag-type";
            description
              "The service tag list.";
            leaf tag-type {
              type identityref {
                base service-tag-type;
              }
              description
                "Slice Service tag type, e.g., realization technology
                 constraints, customer name, or other customer-defined
                 opaque types.";
            }
            leaf-list tag-type-value {
              type string;
              description
                "The tag values, e.g., 5G customer names when multiple
                 customers share the same Slice Service in 5G scenario,
                 or Slice realization technology (such as Layer 2 or
                 Layer 3).";
            }
          }
        }
        uses service-slo-sle-policy;
        leaf test-only {
          type empty;
          description
            "When present, this is a feasibility check. That is, no
             resources are reserved in the network.";
        }
```

```
          uses ac-common:service-status;
          container sdps {
            description
              "Slice Service SDPs.";
            list sdp {
              key "id";
              min-elements 2;
              description
                "List of SDPs in this Slice Service.";
              leaf id {
                type string;
                description
                  "The unique identifier of the SDP within the scope of
                   an NSC.";
              }
              leaf description {
                type string;
                description
                  "Provides a description of the SDP.";
              }
              uses geo:geo-location;
              leaf node-id {
                type string;
                description
                  "A unique identifier of an edge node of the SDP
                   within the scope of the NSC.";
              }
              leaf-list sdp-ip-address {
                type inet:ip-address;
                description
                  "IPv4 or IPv6 address of the SDP.";
              }
              leaf tp-ref {
                type leafref {
                  path
                    "/nw:networks/nw:network[nw:network-id="
                  + "current()/../../../custom-topology/network-ref]/"
                  + "nw:node/nt:termination-point/nt:tp-id";
                }
                description
                  "A reference to Termination Point (TP) in the custom
                   topology";
                reference
                  "RFC 8345: A YANG Data Model for Network Topologies";
              }
              container service-match-criteria {
                description
                  "Describes the Slice Service match criteria.";
```

```
            list match-criterion {
              key "index";
              description
                "List of the Slice Service traffic match criteria.";
              leaf index {
                type uint32;
                description
                  "The identifier of a match criteria.";
              }
              list match-type {
                key "type";
                description
                  "List of the Slice Service traffic match types.";
                leaf type {
                  type identityref {
                    base service-match-type;
                  }
                  description
                    "Indicates the match type of the entry in the
                     list of the Slice Service match criteria.";
                }
                choice value {
                  description
                    "Choice for value of the match type.";
                  case interface {
                    when "derived-from-or-self"
                       + "(type,'ietf-nss:phy-interface')" {
                      description
                        "Match type is a physical interface.";
                    }
                    leaf-list interface-name {
                      type string;
                      description
                        "Physical interface name for the
                         match criteria.";
                    }
                  }
                  case vlan {
                    when "derived-from-or-self"
                       + "(type, 'ietf-nss:vlan')" {
                      description
                        "Match type is a VLAN ID.";
                    }
                    leaf-list vlan {
                      type uint16 {
                        range "0..4095";
                      }
                      description
```

```
          "VLAN ID value for the match criteria.";
      }
    }
    case label {
      when "derived-from-or-self"
         + "(type, 'ietf-nss:label')" {
        description
          "Match type is an MPLS label.";
      }
      leaf-list label {
        type rt-types:mpls-label;
        description
          "MPLS label value for the match
           criteria.";
      }
    }
    case ip-prefix {
      when
        "derived-from-or-self"
      + "(type, 'ietf-nss:source-ip-prefix') or "
      + "derived-from-or-self"
      + "(type, 'ietf-nss:destination-ip-prefix')" {
        description
          "Match type is an IP prefix.";
      }
      leaf-list ip-prefix {
        type inet:ip-prefix;
        description
          "IP prefix value for the match criteria.";
      }
    }
    case dscp {
      when "derived-from-or-self"
         + "(type, 'ietf-nss:dscp')" {
        description
          "Match type is a DSCP value.";
      }
      leaf-list dscp {
        type inet:dscp;
        description
          "DSCP value for the match criteria.";
      }
    }
    case acl {
      when "derived-from-or-self"
         + "(type, 'ietf-nss:acl')" {
        description
          "Match type is an ACL name.";
```

```
            }
            leaf-list acl-name {
              type string {
                length "1..64";
              }
              description
                "ACL name value for the match
                 criteria.";
            }
          }
          /* Add more cases as needed for other
          match types */
        }
      }
      leaf target-connection-group-id {
        type leafref {
          path
            "../../../../../ietf-nss:connection-groups"
          + "/ietf-nss:connection-group"
          + "/ietf-nss:id";
        }
        mandatory true;
        description
          "Reference to the Slice Service Connection Group.";
      }
      leaf connection-group-sdp-role {
        type identityref {
          base vpn-common:role;
        }
        default "vpn-common:any-to-any-role";
        description
          "Specifies the role of SDP in the Connection Group
           When the service connection type is MP2MP,
           such as hub and spoke service connection type.
           In addition, this helps to create Connectivity
           Construct automatically, rather than explicitly
           specifying each one.";
      }
      leaf target-connectivity-construct-id {
        type leafref {
          path
            "../../../../../ietf-nss:connection-groups"
          + "/ietf-nss:connection-group[ietf-nss:id="
          + "current()/../target-connection-group-id]"
          + "/ietf-nss:connectivity-construct/ietf-nss:id";
        }
        description
          "Reference to a Network Slice Connectivity
```

```
                Construct.";
            }
          }
        }
        uses service-qos;
        container sdp-peering {
          description
            "Describes SDP peering attributes.";
          leaf-list peer-sap-id {
            type string;
            description
              "Indicates the reference to the remote endpoints of
               the Attachment Circuits. This information can be
               used for correlation purposes, such as identifying
               SAPs of provider equipments when requesting
               a service with CE based SDP attributes.";
            reference
              "RFC 9408: A YANG Network Data Model for Service
               Attachment Points (SAPs)";
          }
          container protocols {
            description
              "Serves as an augmentation target.
               Protocols can be augmented into this container,
               e.g., BGP or static routing.";
          }
        }
        leaf-list ac-svc-ref {
          type ac-svc:attachment-circuit-reference;
          description
            "A reference to the ACs that have been created before
             the slice creation.";
          reference
            "RFC 9834: YANG Data Models for Bearers and
              'Attachment Circuits'-as-a-Service (ACaaS)";
        }
        leaf ce-mode {
          type boolean;
          description
            "When set to 'true', this indicates the SDP is located
             on the CE.";
        }
        container attachment-circuits {
          description
            "List of Attachment Circuits.";
          list attachment-circuit {
            key "id";
            description
```

```
                  "The Network Slice Service SDP Attachment Circuit
                   related parameters.";
                leaf id {
                  type string;
                  description
                    "The identifier of Attachment Circuit.";
                }
                leaf description {
                  type string;
                  description
                    "The Attachment Circuit's description.";
                }
                leaf ac-svc-ref {
                  type ac-svc:attachment-circuit-reference;
                  description
                    "A reference to the AC service that has been
                     created before the slice creation.";
                  reference
                    "RFC 9834: YANG Data Models for Bearers and
                      'Attachment Circuits'-as-a-Service (ACaaS)";
                }
                leaf ac-node-id {
                  type string;
                  description
                    "The Attachment Circuit node ID in the case of
                     multi-homing.";
                }
                leaf ac-tp-id {
                  type string;
                  description
                    "The termination port ID of the
                     Attachment Circuit.";
                }
                leaf ac-ipv4-address {
                  type inet:ipv4-address;
                  description
                    "The IPv4 address of the AC.";
                }
                leaf ac-ipv4-prefix-length {
                  type uint8 {
                    range "0..32";
                  }
                  description
                    "The length of the IPv4 subnet prefix.";
                }
                leaf ac-ipv6-address {
                  type inet:ipv6-address;
                  description
```

```
        "The IPv6 address of the AC.";
      }
      leaf ac-ipv6-prefix-length {
        type uint8 {
          range "0..128";
        }
        description
          "The length of IPv6 subnet prefix.";
      }
      leaf mtu {
        type uint32;
        units "bytes";
        description
          "Maximum size of the Slice Service Layer 2 data
           packet that can traverse an SDP.";
      }
      container ac-tags {
        description
          "Container for the Attachment Circuit tags.";
        list ac-tag {
          key "tag-type";
          description
            "The Attachment Circuit tag list.";
          leaf tag-type {
            type identityref {
              base attachment-circuit-tag-type;
            }
            description
              "The Attachment Circuit tag type.";
          }
          leaf-list tag-type-value {
            type string;
            description
              "The Attachment Circuit tag values.
               For example, the tag may indicate
               multiple VLAN identifiers.";
          }
        }
      }
      uses service-qos;
      container sdp-peering {
        description
          "Describes SDP peering attributes.";
        leaf peer-sap-id {
          type string;
          description
            "Indicates a reference to the remote endpoints
             of an Attachment Circuit. This information can
```

```
                    be used for correlation purposes, such as
                    identifying a Service Attachment Point (SAP)
                    of a provider equipment when requesting a
                    service with CE based SDP attributes.";
                  reference
                    "RFC 9408: A YANG Network Data Model for
                               Service Attachment Points (SAPs)";
                }
                container protocols {
                  description
                    "Serves as an augmentation target.
                     Protocols can be augmented into this container,
                     e.g., BGP or static routing.";
                }
              }
              uses ac-common:service-status;
            }
          }
          uses ac-common:service-status;
          container sdp-monitoring {
            config false;
            description
              "Container for SDP monitoring metrics.";
            leaf incoming-bw-value {
              type yang:gauge64;
              units "bps";
              description
                "Indicates the absolute value of the incoming
                 bandwidth at an SDP from the customer network or
                 from another provider's network.";
            }
            leaf incoming-bw-percent {
              type percentage;
              units "percent";
              description
                "Indicates a percentage of the incoming bandwidth
                 at an SDP from the customer network or
                 from another provider's network.";
            }
            leaf outgoing-bw-value {
              type yang:gauge64;
              units "bps";
              description
                "Indicates the absolute value of the outgoing
                 bandwidth at an SDP towards the customer network or
                 towards another provider's network.";
            }
            leaf outgoing-bw-percent {
```

```
                type percentage;
                units "percent";
                description
                  "Indicates a percentage of the outgoing bandwidth
                   at an SDP towards the customer network or towards
                   another provider's network.";
              }
            }
          }
        }
        container connection-groups {
          description
            "Contains Connection Groups.";
          list connection-group {
            key "id";
            description
              "List of Connection Groups.";
            leaf id {
              type string;
              description
                "The Connection Group identifier.";
            }
            leaf connectivity-type {
              type identityref {
                base vpn-common:vpn-topology;
              }
              default "vpn-common:any-to-any";
              description
                "Connection Group connectivity type.";
            }
            uses service-slo-sle-policy;
            /* Per Connection Group SLO/SLE policy
             * overrides the per Slice SLO/SLE policy.
             */
            uses service-slo-sle-policy-override;
            list connectivity-construct {
              key "id";
              description
                "List of Connectivity Constructs.";
              leaf id {
                type string;
                description
                  "The Connectivity Construct identifier.";
              }
              choice type {
                default "p2p";
                description
                  "Choice for Connectivity Construct type.";
```

```
                case p2p {
                  description
                    "P2P Connectivity Construct.";
                  leaf p2p-sender-sdp {
                    type leafref {
                      path "../../../../sdps/sdp/id";
                    }
                    description
                      "Reference to a sender SDP.";
                  }
                  leaf p2p-receiver-sdp {
                    type leafref {
                      path "../../../../sdps/sdp/id";
                    }
                    description
                      "Reference to a receiver SDP.";
                  }
                }
                case p2mp {
                  description
                    "P2MP Connectivity Construct.";
                  leaf p2mp-sender-sdp {
                    type leafref {
                      path "../../../../sdps/sdp/id";
                    }
                    description
                      "Reference to a sender SDP.";
                  }
                  leaf-list p2mp-receiver-sdp {
                    type leafref {
                      path "../../../../sdps/sdp/id";
                    }
                    description
                      "Reference to a receiver SDP.";
                  }
                }
                case a2a {
                  description
                    "A2A Connectivity Construct.";
                  list a2a-sdp {
                    key "sdp-id";
                    description
                      "List of included A2A SDPs.";
                    leaf sdp-id {
                      type leafref {
                        path "../../../../../sdps/sdp/id";
                      }
                      description
```

```
                        "Reference to an SDP.";
                      }
                      uses service-slo-sle-policy;
                    }
                  }
                }
                uses service-slo-sle-policy;
                /* Per Connectivity Construct SLO/SLE policy
                 * overrides the per slice SLO/SLE policy.
                 */
                uses service-slo-sle-policy-override;
                uses ac-common:service-status;
                container connectivity-construct-monitoring {
                  config false;
                  description
                    "SLO status per Connectivity Construct.";
                  uses connectivity-construct-monitoring-metrics;
                }
              }
              container connection-group-monitoring {
                config false;
                description
                  "SLO status per Connection Group.";
                uses connectivity-construct-monitoring-metrics;
              }
            }
          }
          container custom-topology {
            description
              "Serves as an augmentation target.
               Container for custom topology, which is indicated by the
               referenced topology predefined, e.g., an abstract RFC8345
               topology.";
            uses nw:network-ref;
          }
        }
      }
    }
    <CODE ENDS>
```

Figure 17: Network Slice Service YANG Module

7. Security Considerations

This section is modeled after the template described in Section 3.7.1 of [RFC9907].

The "ietf-network-slice-service" YANG module defines a data model that is designed to be accessed via YANG-based management protocols, such as the Network Configuration Protocol (NETCONF) [RFC6241] and RESTCONF [RFC8040]. These YANG-based management protocols (1) have to use a secure transport layer (e.g., Secure Shell (SSH) [RFC4252], TLS [RFC8446], and QUIC [RFC9000]) and (2) have to use mutual authentication.

Servers MUST verify that requesting clients are entitled to access and manipulate a given Network Slice Service. The Network Configuration Access Control Model (NACM) [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 these YANG modules that are writable/creatable/deletable (i.e., config true, which is the default). All writable data nodes are likely to be reasonably sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) and delete operations to these data nodes without proper protection or authentication can have a negative effect on network operations. Specifically, the following subtrees and data nodes have particular sensitivities/vulnerabilities in the "ietf-network-slice-service" module:

* /ietf-network-slice-service/network-slice-services/slo-sle-templates

This subtree specifies the Network Slice Service SLO templates and SLE templates. Modifying the configuration in the subtree will change the related Network Slice Service configuration in the future. By making such modifications, a malicious attacker may degrade the Slice Service functions configured at a certain time in the future.

* /ietf-network-slice-service/network-slice-services/slice-service

The entries in the list above include the whole network configurations corresponding with the Network Slice Service which the higher management system requests, and indirectly create or modify the PE or P device configurations. Unexpected changes to these entries could lead to service disruption and/or network misbehavior.

Some of the readable data nodes in these YANG modules may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes. Specifically, the following subtrees and data nodes have particular sensitivity/vulnerability in the "ietf-network-slice-service" module:

* /ietf-network-slice-service/network-slice-services/slo-sle-templates

Unauthorized access to the subtree may disclose the SLO and SLE templates of the Network Slice Service.

* /ietf-network-slice-service/network-slice-services/slice-service

Unauthorized access to the subtree may disclose the operation status information of the Network Slice Service.

* /ietf-network-slice-service/network-slice-services/slice-service/service-tags

Unauthorized access to the subtree may disclose privacy data such as customer names of the Network Slice Service.

8. IANA Considerations

This document requests to register the following URI in the IETF XML registry [RFC3688]:

URI: urn:ietf:params:xml:ns:yang:ietf-network-slice-service
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

This document requests to register the following YANG module in the YANG Module Names registry [RFC6020].

Name: ietf-network-slice-service
Namespace: urn:ietf:params:xml:ns:yang:ietf-network-slice-service
Prefix: ietf-nss
Maintained by IANA? N
Reference: RFC AAAA

9. Acknowledgments

The authors wish to thank Mohamed Boucadair, Kenichi Ogaki, Sergio Belotti, Qin Wu, Yao Zhao, Eric Grey, Daniele Ceccarelli, Ryan Hoffman, Adrian Farrel, Aihua Guo, Italo Busi, and many others for their helpful comments and suggestions.

Thanks to Ladislav Lhotka for the YANG Doctors review.

Thanks to Alvaro Retana and Susan Hares for the rtgdir reviews, Per Andersson for the opsdir review, Mike Ounsworth for the secdir review, Kyle Rose for the tsvdir review, and Ines Robles for the genart review.

Thanks to Mahesh Jethanandani, Gorry Fairhurst, Eric Vyncke, Ketan Talaulikar, Erik Kline, Mike Bishop, Deb Cooley, and Paul Wouters for the IESG review.

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11.3. References

Appendix A. Augmentation Considerations

The NSSM defines the minimum attributes of Slice Services. In some scenarios, further extension, e.g., the definition of AC technology specific attributes and the "isolation" SLE characteristics are required.

For AC technology specific attributes, if the customer and provider need to agree, through configuration, on the technology parameter values, such as the protocol types and protocol parameters between the PE and the CE. The following shows an example where BGP and static routing are augmented to the Network Slice Service model. The protocol types and definitions can reference [RFC9833].

```
module: ietf-network-slice-service-proto-ex
  augment /ietf-nss:network-slice-services/ietf-nss:slice-service
            /ietf-nss:sdps/ietf-nss:sdp/ietf-nss:sdp-peering
            /ietf-nss:protocols:
    +--rw bgp
    |  +--rw name?             string
    |  +--ro local-as?         inet:as-number
    |  +--rw peer-as?          inet:as-number
    |  +--rw address-family?   identityref
    +--rw static-routing-ipv4
    |  +--rw lan?        inet:ipv4-prefix
    |  +--rw lan-tag?    string
    |  +--rw next-hop?   union
    |  +--rw metric?     uint32
    +--rw static-routing-ipv6
       +--rw lan?        inet:ipv6-prefix
       +--rw lan-tag?    string
       +--rw next-hop?   union
       +--rw metric?     uint32
```

Figure 18: Example YANG Tree Augmenting SDP Peering Protocols

In some scenarios, for example, when multiple Slice Services share one or more ACs, independent AC services, defined in [RFC9834], can be used.

For "isolation" SLE characteristics, the following identities can be defined.

```
identity service-interference-isolation-dedicated {
  base service-isolation-type;
  description
    "Specify the requirement that the Slice Service is not impacted
     by the existence of other customers or services in the same
     network, which may be provided by the service provider using
     dedicated network resources, similar to a dedicated
     private network.";
}
```

Figure 19: Example "isolation" Identity Augmentation

Appendix B. Examples of Network Slice Services

B.1. Example-1: Two A2A Slice Services with Different Match Approaches

Figure 20 shows an example of two Network Slice Service instances where the SDPs are the customer-facing ports on the PE:

* Network Slice 1 on SDP1, SDP11a, and SDP4, with an A2A connectivity type. This is an L3 Slice Service that uses the uniform low latency "slo-sle-template" policy between all SDPs. These SDPs will also have AC eBGP peering sessions with unmanaged CE elements (not shown) using an AC augmentation model such as the one shown above.

* Network Slice 2 on SDP2, SDP11b, with A2A connectivity type. This is an L3 Slice Service that uses the uniform high bandwidth "slo-sle-template" policy between all SDPs.

Slice 1 uses the explicit match approach for mapping SDP traffic to a "connectivity-construct", while slice 2 uses the implicit approach. Both approaches are supported. The "slo-sle-templates" templates are known to the customer.

Note: These two slices both use service-tags of "L3". This "service-tag" is operator defined and has no specific meaning in the YANG model other than to give a hint to the NSC on the service expectation being L3 forwarding. This tag may be omitted in other examples, as its usage depends entirely on the needs of the operator and the NSC.

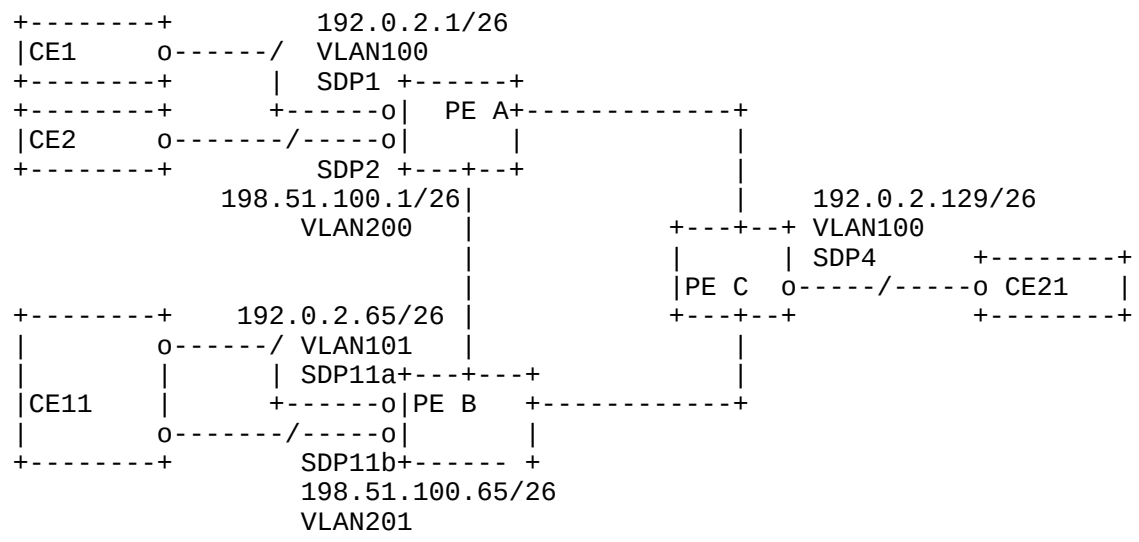

Figure 20: Example of Two A2A Slice Services

Figure 21 shows an example YANG JSON data for the body of the Network Slice Service instances request.

```
   ============== NOTE: '\' line wrapping per RFC 8792 ===============
   <CODE BEGINS>
   {
     "ietf-network-slice-service:network-slice-services": {
       "slo-sle-templates": {
         "slo-sle-template": [
           {
             "id": "high-BW-template",
             "description": "take the highest BW forwarding path"
           },
           {
             "id": "low-latency-template",
             "description": \
   "lowest possible latency forwarding behavior"
           }
         ]
       },
       "slice-service": [
         {
           "id": "slice1",
           "description": "example slice1",
           "service-tags": {
             "tag-type": [
               {
                 "tag-type": "service",
                 "tag-type-value": [
                   "L3"
                 ]
               }
             ]
           },
           "slo-sle-template": "low-latency-template",
           "status": {
             "admin-status": {
               "status": "ietf-vpn-common:admin-up"
             }
           },
           "sdps": {
             "sdp": [
               {
                 "id": "1",
                 "node-id": "PE-A",
                 "service-match-criteria": {
                   "match-criterion": [
                     {
                       "index": 1,
                       "match-type": [
                         {
```

```
                        "type": "any"
                      }
                    ],
                    "target-connection-group-id": "matrix1",
                    "target-connectivity-construct-id": "1"
                  }
                ]
              },
              "attachment-circuits": {
                "attachment-circuit": [
                  {
                    "id": "ac1",
                    "description": "AC1 connected to device 1",
                    "ac-node-id": "PE-A",
                    "ac-tp-id": "GigabitEthernet5/0/0/0.100",
                    "ac-ipv4-address": "192.0.2.1",
                    "ac-ipv4-prefix-length": 26,
                    "ac-tags": {
                      "ac-tag": [
                        {
                          "tag-type": "vlan-id",
                          "tag-type-value": [
                            "100"
                          ]
                        }
                      ]
                    }
                  }
                ]
              }
            },
            {
              "id": "3a",
              "node-id": "PE-B",
              "service-match-criteria": {
                "match-criterion": [
                  {
                    "index": 1,
                    "match-type": [
                      {
                        "type": "any"
                      }
                    ],
                    "target-connection-group-id": "matrix1",
                    "target-connectivity-construct-id": "1"
                  }
                ]
              },
```

```
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac3a",
                      "description": "AC3a connected to device 3",
                      "ac-node-id": "PE-B",
                      "ac-tp-id": "GigabitEthernet8/0/0/4.101",
                      "ac-ipv4-address": "192.0.2.65",
                      "ac-ipv4-prefix-length": 26,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "101"
                            ]
                          }
                        ]
                      }
                    }
                  ]
                }
              },
              {
                "id": "4",
                "node-id": "PE-C",
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "any"
                        }
                      ],
                      "target-connection-group-id": "matrix1",
                      "target-connectivity-construct-id": "1"
                    }
                  ]
                },
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac4",
                      "description": "AC4 connected to device 4",
                      "ac-node-id": "PE-C",
                      "ac-tp-id": "GigabitEthernet4/0/0/3.100",
                      "ac-ipv4-address": "192.0.2.129",
```

```
                    "ac-ipv4-prefix-length": 26,
                    "ac-tags": {
                      "ac-tag": [
                        {
                          "tag-type": "vlan-id",
                          "tag-type-value": [
                            "100"
                          ]
                        }
                      ]
                    }
                  }
                ]
              }
            }
          ]
        },
        "connection-groups": {
          "connection-group": [
            {
              "id": "matrix1",
              "connectivity-type": "ietf-vpn-common:any-to-any",
              "connectivity-construct": [
                {
                  "id": "1",
                  "a2a-sdp": [
                    {
                      "sdp-id": "1"
                    },
                    {
                      "sdp-id": "3a"
                    },
                    {
                      "sdp-id": "4"
                    }
                  ]
                }
              ]
            }
          ]
        }
      },
      {
        "id": "slice2",
        "description": "example slice2",
        "service-tags": {
          "tag-type": [
            {
```

```
                "tag-type": "service",
                "tag-type-value": [
                  "L3"
                ]
              }
            ]
          },
          "slo-sle-template": "high-BW-template",
          "status": {
            "admin-status": {
              "status": "ietf-vpn-common:admin-up"
            }
          },
          "sdps": {
            "sdp": [
              {
                "id": "2",
                "node-id": "PE-A",
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac2",
                      "description": "AC2 connected to device 2",
                      "ac-node-id": "PE-A",
                      "ac-tp-id": "GigabitEthernet7/0/0/3.200",
                      "ac-ipv4-address": "198.51.100.1",
                      "ac-ipv4-prefix-length": 26,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "100"
                            ]
                          }
                        ]
                      }
                    }
                  ]
                }
              },
              {
                "id": "3b",
                "node-id": "PE-B",
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac3b",
```

```
                        "description": "AC3b connected to device 3",
                        "ac-node-id": "PE-B",
                        "ac-tp-id": "GigabitEthernet8/0/0/4.201",
                        "ac-ipv4-address": "198.51.100.65",
                        "ac-ipv4-prefix-length": 26,
                        "ac-tags": {
                          "ac-tag": [
                            {
                              "tag-type": "vlan-id",
                              "tag-type-value": [
                                "201"
                              ]
                            }
                          ]
                        }
                      }
                    ]
                  }
                }
              ]
            },
            "connection-groups": {
              "connection-group": [
                {
                  "id": "matrix2",
                  "connectivity-type": "ietf-vpn-common:any-to-any",
                  "connectivity-construct": [
                    {
                      "id": "1",
                      "a2a-sdp": [
                        {
                          "sdp-id": "2"
                        },
                        {
                          "sdp-id": "3b"
                        }
                      ]
                    }
                  ]
                }
              ]
            }
          }
        ]
      }
    }
    <CODE ENDS>
```

Figure 21: Example of a Message Body to Create Two A2A Slice Services

B.2. Example-2: Two P2P Slice Services with Different Match Approaches

Figure 22 shows an example of two Network Slice Service instances where the SDPs are the customer-facing ports on the PE:

* Network Slice 3 on SDP5 and SDP7a with P2P connectivity type. This is an L2 Slice Service that uses the uniform low-latency "slo-sle-template" policies between the SDPs. A connectivity-group level slo-policy has been applied with a delay-based metric bound of 10ms which will apply to both connectivity-constructs.

* Network Slice 4 on SDP6 and SDP7b, with P2P connectivity type. This is an L2 Slice Service that uses the high bandwidth "slo-sle-template" policies between the SDPs. Traffic from SDP6 and SDP7b is requesting a bandwidth of 1000Mbps, while in the reverse direction from SDP7b to SDP6, 5000Mbps is being requested.

Slice 3 uses the explicit match approach for mapping SDP traffic to a "connectivity-group", while slice 2 uses the implicit approach. Both approaches are supported.

Note: These two slices both use service-tags of "L2". This "service-tag" is operator defined and simply indicateas L2 forwarding expectation to the NSC. This tag may be omitted in other examples, as its usage depends on the needs of the operator and the NSC.

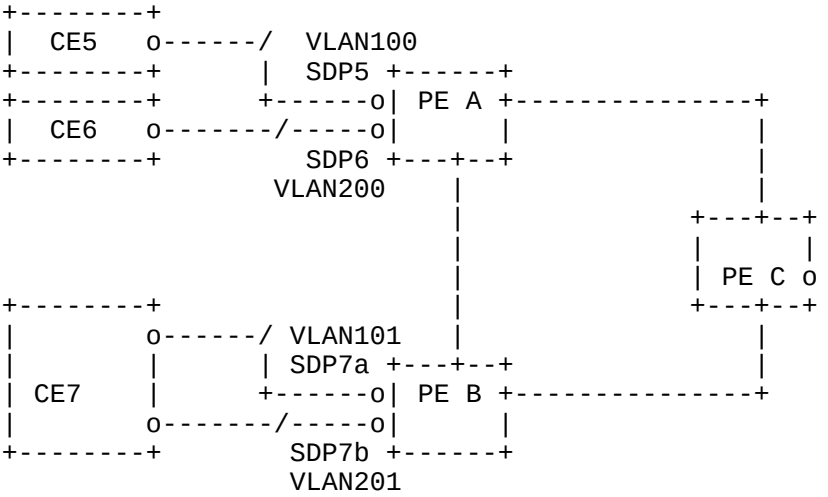

Figure 22: Example of Two P2P Slice Services

Figure 23 shows an example YANG JSON data for the body of the Network Slice Service instances request.

```
============== NOTE: '\' line wrapping per RFC 8792 ===============
<CODE BEGINS>
{
  "ietf-network-slice-service:network-slice-services": {
    "slo-sle-templates": {
      "slo-sle-template": [
        {
          "id": "high-BW-template",
          "description": "take the highest BW forwarding path"
        },
        {
          "id": "low-latency-template",
          "description": \
"lowest possible latency forwarding behavior"
        }
      ]
    },
    "slice-service": [
      {
        "id": "slice3",
        "description": "example slice3",
        "service-tags": {
          "tag-type": [
            {
              "tag-type": "service",
              "tag-type-value": [
                "L2"
              ]
            }
          ]
        },
        "slo-sle-template": "low-latency-template",
        "status": {
          "admin-status": {
            "status": "ietf-vpn-common:admin-up"
          }
        },
        "sdps": {
          "sdp": [
            {
              "id": "5",
              "node-id": "PE-A",
              "service-match-criteria": {
                "match-criterion": [
                  {
```

```
            "index": 1,
            "match-type": [
              {
                "type": "any"
              }
            ],
            "target-connection-group-id": "matrix3"
          }
        ]
      },
      "attachment-circuits": {
        "attachment-circuit": [
          {
            "id": "ac5",
            "description": "AC5 connected to device 5",
            "ac-node-id": "PE-A",
            "ac-tp-id": "GigabitEthernet5/0/0/1",
            "ac-tags": {
              "ac-tag": [
                {
                  "tag-type": "vlan-id",
                  "tag-type-value": [
                    "100"
                  ]
                }
              ]
            }
          }
        ]
      }
    },
    {
      "id": "7a",
      "node-id": "PE-B",
      "service-match-criteria": {
        "match-criterion": [
          {
            "index": 1,
            "match-type": [
              {
                "type": "any"
              }
            ],
            "target-connection-group-id": "matrix3"
          }
        ]
      },
      "attachment-circuits": {
```

```
                "attachment-circuit": [
                  {
                    "id": "ac7a",
                    "description": "AC7a connected to device 7",
                    "ac-node-id": "PE-B",
                    "ac-tp-id": "GigabitEthernet8/0/0/5",
                    "ac-tags": {
                      "ac-tag": [
                        {
                          "tag-type": "vlan-id",
                          "tag-type-value": [
                            "200"
                          ]
                        }
                      ]
                    }
                  }
                ]
              }
            }
          ]
        },
        "connection-groups": {
          "connection-group": [
            {
              "id": "matrix3",
              "connectivity-type": "point-to-point",
              "service-slo-sle-policy": {
                "slo-policy": {
                  "metric-bound": [
                    {
                      "metric-type": "one-way-delay-maximum",
                      "metric-unit": "milliseconds",
                      "bound": "10"
                    }
                  ]
                }
              },
              "connectivity-construct": [
                {
                  "id": "1",
                  "p2p-sender-sdp": "5",
                  "p2p-receiver-sdp": "7a"
                },
                {
                  "id": "2",
                  "p2p-sender-sdp": "7a",
                  "p2p-receiver-sdp": "5"
```

```
                  }
                ]
              }
            ]
          }
        },
        {
          "id": "slice4",
          "description": "example slice4",
          "service-tags": {
            "tag-type": [
              {
                "tag-type": "service",
                "tag-type-value": [
                  "L2"
                ]
              }
            ]
          },
          "slo-sle-template": "high-BW-template",
          "status": {
            "admin-status": {
              "status": "ietf-vpn-common:admin-up"
            }
          },
          "sdps": {
            "sdp": [
              {
                "id": "6",
                "node-id": "PE-A",
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac6",
                      "description": "AC6 connected to device 6",
                      "ac-node-id": "PE-A",
                      "ac-tp-id": "GigabitEthernet7/0/0/4",
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "101"
                            ]
                          }
                        ]
                      }
                    }
```

```
                ]
              }
            },
            {
              "id": "7b",
              "node-id": "PE-B",
              "attachment-circuits": {
                "attachment-circuit": [
                  {
                    "id": "ac7b",
                    "description": "AC7b connected to device 7",
                    "ac-node-id": "PE-B",
                    "ac-tp-id": "GigabitEthernet8/0/0/5",
                    "ac-tags": {
                      "ac-tag": [
                        {
                          "tag-type": "vlan-id",
                          "tag-type-value": [
                            "201"
                          ]
                        }
                      ]
                    }
                  }
                ]
              }
            }
          ]
        },
        "connection-groups": {
          "connection-group": [
            {
              "id": "matrix4",
              "connectivity-type": "point-to-point",
              "connectivity-construct": [
                {
                  "id": "1",
                  "p2p-sender-sdp": "6",
                  "p2p-receiver-sdp": "7b",
                  "service-slo-sle-policy": {
                    "slo-policy": {
                      "metric-bound": [
                        {
                          "metric-type": "one-way-bandwidth",
                          "metric-unit": "Mbps",
                          "bound": "1000"
                        }
                      ]
```

```
                      }
                    }
                  },
                  {
                    "id": "2",
                    "p2p-sender-sdp": "7b",
                    "p2p-receiver-sdp": "6",
                    "service-slo-sle-policy": {
                      "slo-policy": {
                        "metric-bound": [
                          {
                            "metric-type": "one-way-bandwidth",
                            "metric-unit": "Mbps",
                            "bound": "5000"
                          }
                        ]
                      }
                    }
                  }
                ]
              }
            ]
          }
        }
      ]
    }
  }
<CODE ENDS>
```

Figure 23: Example of a Message Body to Create Two P2P Slice Services

The example shown in Figure 24 illustrates how a customer might subscribe to the monitoring information of "slice3" with the "establish-subscription" RPC [RFC8650]. The customer is interested in the operational and performance status of SDPs and Connectivity Constructs.

```
============== NOTE: '\' line wrapping per RFC 8792 ===============

POST /restconf/operations/ietf-subscribed-notifications:establish-\
                                      subscription
Host: example.com
Content-Type: application/yang-data+json

{
  "ietf-subscribed-notifications:input": {
    "ietf-yang-push:datastore": "ietf-datastores:running",
    "ietf-yang-push:datastore-subtree-filter": {
```

```
        "ietf-network-slice-service:network-slice-services": {
          "slice-service": [
            {
              "id": "slice3",
              "sdps": {
                "sdp": [
                  {
                    "id": "5",
                    "status": {
                      "oper-status": {
                        "status": {}
                      }
                    },
                    "sdp-monitoring": {
                      "incoming-bw-value": {},
                      "outgoing-bw-value": {}
                    }
                  },
                  {
                    "id": "7a",
                    "status": {
                      "oper-status": {
                        "status": {}
                      }
                    },
                    "sdp-monitoring": {
                      "incoming-bw-value": {},
                      "outgoing-bw-value": {}
                    }
                  }
                ]
              },
              "connection-groups": {
                "connection-group": [
                  {
                    "id": "matrix3",
                    "connectivity-type": "point-to-point",
                    "connectivity-construct": [
                      {
                        "id": "1",
                        "p2p-sender-sdp": "5",
                        "p2p-receiver-sdp": "7a",
                        "status": {
                          "oper-status": {
                            "status": "{}"
                          }
                        },
                        "connectivity-construct-monitoring": {
```

```
                        "one-way-min-delay": {},
                        "one-way-max-delay": {}
                      }
                    },
                    {
                      "id": "2",
                      "p2p-sender-sdp": "7a",
                      "p2p-receiver-sdp": "5",
                      "status": {
                        "oper-status": {
                          "status": {}
                        }
                      },
                      "connectivity-construct-monitoring": {
                        "one-way-min-delay": {},
                        "one-way-max-delay": {}
                      }
                    }
                  ]
                }
              ]
            }
          }
        ]
      }
    },
    "ietf-yang-push:periodic": {
      "period": "500"
    }
  }
}
```

Figure 24: Example of a Message Body to Subscribe Monitoring Information of the Slice Service

The example Figure 25 shows a snapshot of YANG JSON data for the body of operational and performance status of the Network Slice Service "slice3".

<CODE BEGINS>

```
{
  "ietf-network-slice-service:network-slice-services": {
    "slice-service": [
      {
        "id": "slice3",
        "description": "example slice3",
        "slo-sle-template": "low-latency-template",
        "status": {
```

```
            "oper-status": {
              "status": "ietf-vpn-common:op-up"
            }
          },
          "sdps": {
            "sdp": [
              {
                "id": "5",
                "node-id": "PE-A",
                "status": {
                  "oper-status": {
                    "status": "ietf-vpn-common:op-up"
                  }
                },
                "sdp-monitoring": {
                  "incoming-bw-value": "10000",
                  "outgoing-bw-value": "10000"
                }
              },
              {
                "id": "7a",
                "node-id": "PE-B",
                "status": {
                  "oper-status": {
                    "status": "ietf-vpn-common:op-up"
                  }
                },
                "sdp-monitoring": {
                  "incoming-bw-value": "10000",
                  "outgoing-bw-value": "10000"
                }
              }
            ]
          },
          "connection-groups": {
            "connection-group": [
              {
                "id": "matrix3",
                "connectivity-type": "point-to-point",
                "connectivity-construct": [
                  {
                    "id": "1",
                    "p2p-sender-sdp": "5",
                    "p2p-receiver-sdp": "7a",
                    "status": {
                      "oper-status": {
                        "status": "ietf-vpn-common:op-up"
                      }
```

```
                    },
                    "connectivity-construct-monitoring": {
                      "one-way-min-delay": "15",
                      "one-way-max-delay": "20"
                    }
                  },
                  {
                    "id": "2",
                    "p2p-sender-sdp": "7a",
                    "p2p-receiver-sdp": "5",
                    "status": {
                      "oper-status": {
                        "status": "ietf-vpn-common:op-up"
                      }
                    },
                    "connectivity-construct-monitoring": {
                      "one-way-min-delay": "15",
                      "one-way-max-delay": "20"
                    }
                  }
                ]
              }
            ]
          }
        },
        {
          "id": "slice4",
          "description": "example slice4",
          "slo-sle-template": "high-BW-template",
          "status": {
            "oper-status": {
              "status": "ietf-vpn-common:op-up"
            }
          },
          "sdps": {
            "sdp": [
              {
                "id": "6",
                "node-id": "PE-A",
                "status": {
                  "oper-status": {
                    "status": "ietf-vpn-common:op-up"
                  }
                },
                "sdp-monitoring": {
                  "incoming-bw-value": "10000000",
                  "outgoing-bw-value": "10000000"
                }
```

```
            },
            {
              "id": "7b",
              "node-id": "PE-B",
              "status": {
                "oper-status": {
                  "status": "ietf-vpn-common:op-up"
                }
              },
              "sdp-monitoring": {
                "incoming-bw-value": "10000000",
                "outgoing-bw-value": "10000000"
              }
            }
          ]
        },
        "connection-groups": {
          "connection-group": [
            {
              "id": "matrix4",
              "connectivity-type": "point-to-point",
              "connectivity-construct": [
                {
                  "id": "1",
                  "p2p-sender-sdp": "6",
                  "p2p-receiver-sdp": "7b",
                  "status": {
                    "oper-status": {
                      "status": "ietf-vpn-common:op-up"
                    }
                  },
                  "connectivity-construct-monitoring": {
                    "one-way-min-delay": "150",
                    "one-way-max-delay": "200"
                  }
                },
                {
                  "id": "2",
                  "p2p-sender-sdp": "7b",
                  "p2p-receiver-sdp": "6",
                  "status": {
                    "oper-status": {
                      "status": "ietf-vpn-common:op-up"
                    }
                  },
                  "connectivity-construct-monitoring": {
                    "one-way-min-delay": "150",
                    "one-way-max-delay": "200"
```

```
                      }
                    }
                  ]
                }
              ]
            }
          }
        }
      ]
    }
  }
  <CODE ENDS>
```

Figure 25: Example of a Message Body of a Snapshot of Monitoring of the Slice Service

B.3. Example-3: A Hub and Spoke Slice Service with a P2MP Connectivity Construct

Figure 26 shows an example of one Network Slice Service instance where the SDPs are the customer-facing ports on the PE:

Network Slice 5 is a hub-spoke slice with SDP14 as the hub and SDP11, SDP12, SDP13a, SDP13b as spokes. This is an L3 Slice Service that uses the uniform low-latency "slo-sle-template" policies between all spokes and the hub SDPs, but using an explicit set of SLO policies with a latency metric of 10ms for hub to spoke traffic.

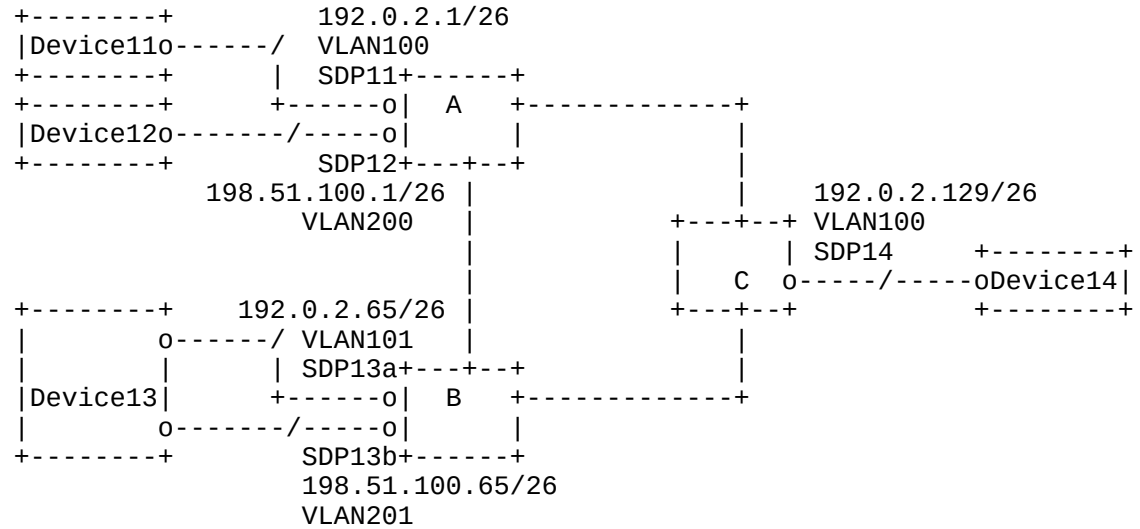

Figure 26: Example of A Hub and Spoke Slice Service

Figure 27 shows an example YANG JSON data for the body of the hub-spoke Network Slice Service instances request.

```
============== NOTE: '\' line wrapping per RFC 8792 ===============
<CODE BEGINS>
{
  "ietf-network-slice-service:network-slice-services": {
    "slo-sle-templates": {
      "slo-sle-template": [
        {
          "id": "high-BW-template",
          "description": "take the highest BW forwarding path"
        },
        {
          "id": "low-latency-template",
          "description": \
"lowest possible latency forwarding behavior"
        }
      ]
    },
    "slice-service": [
      {
        "id": "slice5",
        "description": "example slice5",
        "service-tags": {
          "tag-type": [
            {
              "tag-type": "service",
              "tag-type-value": [
                "L3"
              ]
            }
          ]
        },
        "service-slo-sle-policy": {
          "description": "video-policy",
          "slo-policy": {
            "metric-bound": [
              {
                "metric-type": "one-way-bandwidth",
                "metric-unit": "Mbps",
                "bound": "1000"
              },
              {
                "metric-type": "two-way-delay-maximum",
                "metric-unit": "milliseconds",
                "bound": "100"
              }
```

```
              ],
              "availability": "three-nines",
              "mtu": 1500
            }
          },
          "status": {
            "admin-status": {
              "status": "ietf-vpn-common:admin-up"
            }
          },
          "sdps": {
            "sdp": [
              {
                "id": "11",
                "node-id": "PE-A",
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "any"
                        }
                      ],
                      "target-connection-group-id": "matrix5",
                      "connection-group-sdp-role": \
   "ietf-vpn-common:spoke-role"
                    }
                  ]
                },
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac11",
                      "description": "AC11 connected to device 11",
                      "ac-node-id": "PE-A",
                      "ac-tp-id": "GigabitEthernet5/0/0/2",
                      "ac-ipv4-address": "192.0.2.1",
                      "ac-ipv4-prefix-length": 26,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "100"
                            ]
                          }
                        ]
```

```
                      }
                    }
                  ]
                }
              },
              {
                "id": "12",
                "node-id": "PE-A",
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "any"
                        }
                      ],
                      "target-connection-group-id": "matrix5",
                      "connection-group-sdp-role": \
  "ietf-vpn-common:spoke-role"
                    }
                  ]
                },
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac12",
                      "description": "AC12 connected to device 12",
                      "ac-node-id": "PE-A",
                      "ac-tp-id": "GigabitEthernet7/0/0/5",
                      "ac-ipv4-address": "198.51.100.1",
                      "ac-ipv4-prefix-length": 26,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "200"
                            ]
                          }
                        ]
                      }
                    }
                  ]
                }
              },
              {
                "id": "13a",
```

```
                "node-id": "PE-B",
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "any"
                        }
                      ],
                      "target-connection-group-id": "matrix5",
                      "connection-group-sdp-role": \
   "ietf-vpn-common:spoke-role"
                    }
                  ]
                },
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac13a",
                      "description": "AC13a connected to device 13",
                      "ac-node-id": "PE-B",
                      "ac-tp-id": "GigabitEthernet8/0/0/6",
                      "ac-ipv4-address": "192.0.2.65",
                      "ac-ipv4-prefix-length": 26,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "101"
                            ]
                          }
                        ]
                      }
                    }
                  ]
                }
              },
              {
                "id": "13b",
                "node-id": "PE-B",
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
```

```
                        "type": "any"
                      }
                    ],
                    "target-connection-group-id": "matrix5",
                    "connection-group-sdp-role": \
   "ietf-vpn-common:spoke-role"
                  }
                ]
              },
              "attachment-circuits": {
                "attachment-circuit": [
                  {
                    "id": "ac13b",
                    "description": "AC3b connected to device 13",
                    "ac-node-id": "PE-B",
                    "ac-tp-id": "GigabitEthernet8/0/0/4",
                    "ac-ipv4-address": "198.51.100.65",
                    "ac-ipv4-prefix-length": 26,
                    "ac-tags": {
                      "ac-tag": [
                        {
                          "tag-type": "vlan-id",
                          "tag-type-value": [
                            "201"
                          ]
                        }
                      ]
                    }
                  }
                ]
              }
            },
            {
              "id": "14",
              "node-id": "PE-C",
              "service-match-criteria": {
                "match-criterion": [
                  {
                    "index": 1,
                    "match-type": [
                      {
                        "type": "any"
                      }
                    ],
                    "target-connection-group-id": "matrix5",
                    "connection-group-sdp-role": \
   "ietf-vpn-common:hub-role"
                  }
```

```
            ]
          },
          "attachment-circuits": {
            "attachment-circuit": [
              {
                "id": "ac14",
                "description": "AC14 connected to device 14",
                "ac-node-id": "PE-C",
                "ac-tp-id": "GigabitEthernet4/0/0/3",
                "ac-ipv4-address": "192.0.2.129",
                "ac-ipv4-prefix-length": 26,
                "ac-tags": {
                  "ac-tag": [
                    {
                      "tag-type": "vlan-id",
                      "tag-type-value": [
                        "100"
                      ]
                    }
                  ]
                }
              }
            ]
          }
        }
      ]
    },
    "connection-groups": {
      "connection-group": [
        {
          "id": "matrix5",
          "connectivity-type": "ietf-vpn-common:hub-spoke",
          "connectivity-construct": [
            {
              "id": "1",
              "p2mp-sender-sdp": "14",
              "p2mp-receiver-sdp": [
                "11",
                "12",
                "13a",
                "13b"
              ],
              "service-slo-sle-policy": {
                "slo-policy": {
                  "metric-bound": [
                    {
                      "metric-type": "one-way-delay-maximum",
                      "metric-unit": "milliseconds",
```

```
                              "bound": "10"
                            }
                          ]
                        }
                      }
                    }
                  ]
                }
              ]
            }
          }
        ]
      }
    }
    <CODE ENDS>
```

Figure 27: Example of a Message Body to Create A Hub and Spoke Slice Service

B.4. Example-4: An A2A Slice Service with Multiple SLOs and DSCP Matching

Figure 28 shows an example of a Network slice instance where the SDPs are the customer-facing ports on the PE:

Network Slice 6 on SDP21, SDP23a, and SDP24, with A2A connectivity type. This is an L3 Slice Service that uses the uniform "standard" slo-sle-template policies between all SDPs. For traffic matching the DSCP of EF, a slo-sle-template policy of "low-latency" will be used. The slice uses the explicit match approach for mapping SDP traffic to a Connectivity Construct.

In some use cases, the Slice Service may also need to map traffic based on a combination of the DSCP and IP address, not DSCP only, which is shown in the example of "service-match-criteria" Figure 30.

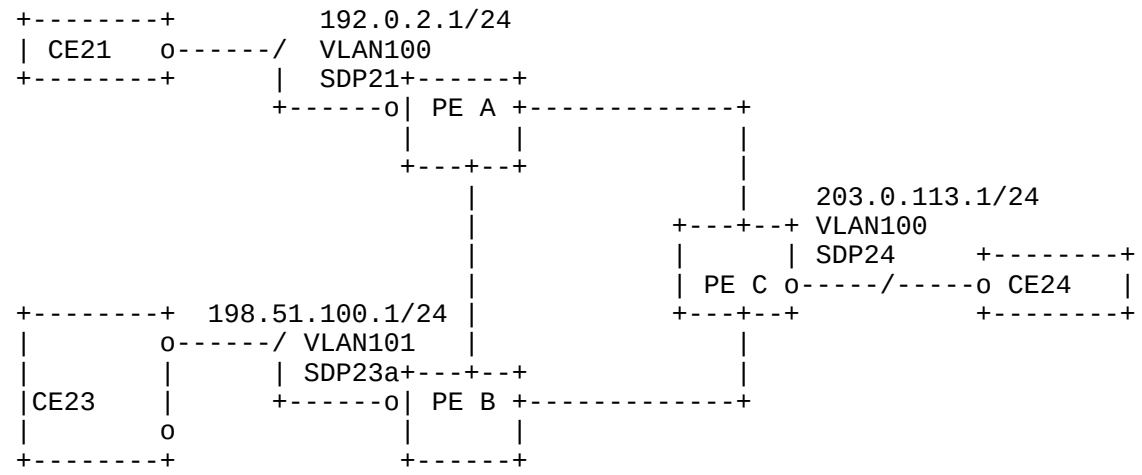

Figure 28: Example of An A2A Slice Service with DSCP Matching

Figure 29 shows an example YANG JSON data for the body of the Network Slice Service instances request.

```
============== NOTE: '\' line wrapping per RFC 8792 ===============
<CODE BEGINS>
{
  "ietf-network-slice-service:network-slice-services": {
    "slo-sle-templates": {
      "slo-sle-template": [
        {
          "id": "high-BW-template",
          "description": "take the highest BW forwarding path"
        },
        {
          "id": "low-latency-template",
          "description": \
"lowest possible latency forwarding behavior"
        },
        {
          "id": "standard-template",
          "description": "take the standard forwarding path"
        }
      ]
    },
    "slice-service": [
      {
        "id": "slice6",
        "description": "example slice6",
        "service-tags": {
```

```
            "tag-type": [
              {
                "tag-type": "service",
                "tag-type-value": [
                  "L3"
                ]
              }
            ]
          },
          "slo-sle-template": "standard-template",
          "status": {
            "admin-status": {
              "status": "ietf-vpn-common:admin-up"
            }
          },
          "sdps": {
            "sdp": [
              {
                "id": "21",
                "node-id": "PE-A",
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "dscp",
                          "dscp-value": [
                            46
                          ]
                        }
                      ],
                      "target-connection-group-id": "matrix6",
                      "target-connectivity-construct-id": "2"
                    },
                    {
                      "index": 2,
                      "match-type": [
                        {
                          "type": "any"
                        }
                      ],
                      "target-connection-group-id": "matrix6",
                      "target-connectivity-construct-id": "1"
                    }
                  ]
                },
                "attachment-circuits": {
```

```
                "attachment-circuit": [
                  {
                    "id": "ac21",
                    "description": "AC21 connected to device 21",
                    "ac-node-id": "PE-A",
                    "ac-tp-id": "GigabitEthernet5/0/0/0",
                    "ac-ipv4-address": "192.0.2.1",
                    "ac-ipv4-prefix-length": 24,
                    "ac-tags": {
                      "ac-tag": [
                        {
                          "tag-type": "vlan-id",
                          "tag-type-value": [
                            "100"
                          ]
                        }
                      ]
                    }
                  }
                ]
              }
            },
            {
              "id": "23a",
              "node-id": "PE-B",
              "service-match-criteria": {
                "match-criterion": [
                  {
                    "index": 1,
                    "match-type": [
                      {
                        "type": "dscp",
                        "dscp-value": [
                          46
                        ]
                      }
                    ],
                    "target-connection-group-id": "matrix6",
                    "target-connectivity-construct-id": "2"
                  },
                  {
                    "index": 2,
                    "match-type": [
                      {
                        "type": "any"
                      }
                    ],
                    "target-connection-group-id": "matrix6",
```

```
            "target-connectivity-construct-id": "1"
          }
        ]
      },
      "attachment-circuits": {
        "attachment-circuit": [
          {
            "id": "ac23a",
            "description": "AC23a connected to device 23",
            "ac-node-id": "PE-B",
            "ac-tp-id": "GigabitEthernet8/0/0/4",
            "ac-ipv4-address": "198.51.100.1",
            "ac-ipv4-prefix-length": 24,
            "ac-tags": {
              "ac-tag": [
                {
                  "tag-type": "vlan-id",
                  "tag-type-value": [
                    "101"
                  ]
                }
              ]
            }
          }
        ]
      }
    },
    {
      "id": "24",
      "node-id": "PE-C",
      "service-match-criteria": {
        "match-criterion": [
          {
            "index": 1,
            "match-type": [
              {
                "type": "dscp",
                "dscp-value": [
                  46
                ]
              }
            ],
            "target-connection-group-id": "matrix6",
            "target-connectivity-construct-id": "2"
          },
          {
            "index": 2,
            "match-type": [
```

```
                        {
                          "type": "any"
                        }
                      ],
                      "target-connection-group-id": "matrix6",
                      "target-connectivity-construct-id": "1"
                    }
                  ]
                },
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac24",
                      "description": "AC24 connected to device 24",
                      "ac-node-id": "PE-C",
                      "ac-tp-id": "GigabitEthernet4/0/0/3",
                      "ac-ipv4-address": "203.0.113.1",
                      "ac-ipv4-prefix-length": 24,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "100"
                            ]
                          }
                        ]
                      }
                    }
                  ]
                }
              }
            ]
          },
          "connection-groups": {
            "connection-group": [
              {
                "id": "matrix6",
                "connectivity-type": "ietf-vpn-common:any-to-any",
                "connectivity-construct": [
                  {
                    "id": "1",
                    "a2a-sdp": [
                      {
                        "sdp-id": "21"
                      },
                      {
                        "sdp-id": "23a"
```

```
                        },
                        {
                          "sdp-id": "24"
                        }
                      ]
                    },
                    {
                      "id": "2",
                      "a2a-sdp": [
                        {
                          "sdp-id": "21"
                        },
                        {
                          "sdp-id": "23a"
                        },
                        {
                          "sdp-id": "24",
                          "slo-sle-template": "low-latency-template"
                        }
                      ]
                    }
                  ]
                }
              ]
            }
          }
        ]
      }
    }
    <CODE ENDS>
```

Figure 29: Example of a Message Body to Create An A2A Slice Service with DSCP Matching

Figure 30 shows an example of "service-match-criteria" with a combination of both DSCP and IP Address for the Slice Service traffic matching.

```
<CODE BEGINS>
{
  "service-match-criteria": {
    "match-criterion": [
      {
        "index": 1,
        "match-type": [
          {
            "type": "dscp",
            "dscp-value": [
              46
            ]
          },
          {
            "type": " destination-ip-prefix",
            "ip-prefix": [
              "192.0.2.254"
            ]
          }
        ],
        "target-connection-group-id": "matrix6",
        "target-connectivity-construct-id": "2"
      }
    ]
  }
}
<CODE ENDS>
```

Figure 30: An Example of Match Criterion with Combination of DSCP and IP Address Matching

B.5. Example-5: An A2A Network Slice Service with SLO Precedence Policies

Figure 31 shows an example of a Network slice instance "slice-7" with four SDPs: SDP1, SDP2, SDP3 and SDP4 with A2A connectivity type. All SDPs are designated as customer-facing ports on the PE.

The service is realized using a single A2A Connectivity Construct, and a low-bandwidth "slo-sle-template" policy applied to SDP4 and SDP3, while a high-bandwidth "slo-sle-template" policy applied to SDP1 and SDP2. Notice that the "slo-sle-templates" at the Connectivity Construct level takes precedence over the one specified at the group level.

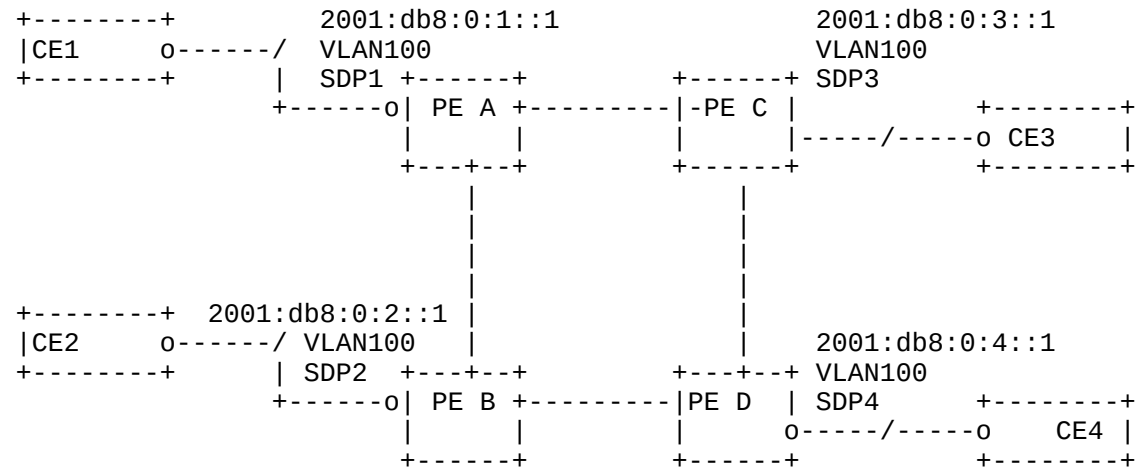

Figure 31: Example of An A2A Slice Service with SLO Precedence

Figure 32 shows an example YANG JSON data for the body of the Network Slice Service instances request.

```
============== NOTE: '\' line wrapping per RFC 8792 ===============
<CODE BEGINS>
{
  "ietf-network-slice-service:network-slice-services": {
    "slo-sle-templates": {
      "slo-sle-template": [
        {
          "id": "high-BW-template",
          "description": \
"take the highest BW forwarding path"
        },
        {
          "id": "low-BW-template",
          "description": "lowest BW forwarding behavior"
        }
      ]
    },
    "slice-service": [
      {
        "id": "slice-7",
        "description": "Example",
        "service-tags": {
          "tag-type": [
            {
              "tag-type": "customer",
              "tag-type-value": [
```

```
                "Customer-Example"
              ]
            },
            {
              "tag-type": "service",
              "tag-type-value": [
                "L3"
              ]
            }
          ]
        },
        "status": {
          "admin-status": {
            "status": "ietf-vpn-common:admin-up"
          }
        },
        "sdps": {
          "sdp": [
            {
              "id": "SDP1",
              "description": "Central Office 1 at location PE-A",
              "node-id": "PE-A",
              "sdp-ip-address": [
                "2001:db8:0:1::1"
              ],
              "service-match-criteria": {
                "match-criterion": [
                  {
                    "index": 1,
                    "match-type": [
                      {
                        "type": "vlan",
                        "vlan": [
                          100
                        ]
                      }
                    ],
                    "target-connection-group-id": "matrix1"
                  }
                ]
              },
              "attachment-circuits": {
                "attachment-circuit": [
                  {
                    "id": "AC-SDP1",
                    "description": "Device 1 to PE-A",
                    "ac-node-id": "PE-A",
                    "ac-tp-id": "GigabitEthernet1/0/0/0",
```

```
            "ac-ipv6-address": "2001:db8:0:1::1",
            "ac-ipv6-prefix-length": 64,
            "ac-tags": {
              "ac-tag": [
                {
                  "tag-type": "vlan-id",
                  "tag-type-value": [
                    "100"
                  ]
                }
              ]
            },
            "incoming-qos-policy": {
              "qos-policy-name": "QoS-Gold",
              "rate-limits": {
                "cir": "1000000",
                "cbs": "1000",
                "pir": "5000000",
                "pbs": "1000"
              }
            }
          }
        ]
      }
    },
    {
      "id": "SDP2",
      "description": "Central Office 2 at location PE-B",
      "node-id": "PE-B",
      "sdp-ip-address": [
        "2001:db8:0:2::1"
      ],
      "service-match-criteria": {
        "match-criterion": [
          {
            "index": 1,
            "match-type": [
              {
                "type": "vlan",
                "vlan": [
                  100
                ]
              }
            ],
            "target-connection-group-id": "matrix1"
          }
        ]
      },
```

```
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "AC-SDP2",
                      "description": "Device 2 to PE-B",
                      "ac-node-id": "PE-B",
                      "ac-tp-id": "GigabitEthernet2/0/0/0",
                      "ac-ipv6-address": "2001:db8:0:2::1",
                      "ac-ipv6-prefix-length": 64,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "100"
                            ]
                          }
                        ]
                      },
                      "incoming-qos-policy": {
                        "qos-policy-name": "QoS-Gold",
                        "rate-limits": {
                          "cir": "1000000",
                          "cbs": "1000",
                          "pir": "5000000",
                          "pbs": "1000"
                        }
                      }
                    }
                  ]
                }
              },
              {
                "id": "SDP3",
                "description": "Remote Office 1 at location PE-C",
                "node-id": "PE-C",
                "sdp-ip-address": [
                  "2001:db8:0:3::1"
                ],
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "vlan",
                          "vlan": [
                            100
```

```
                    ]
                  }
                ],
                "target-connection-group-id": "matrix1"
              }
            ]
          },
          "attachment-circuits": {
            "attachment-circuit": [
              {
                "id": "AC-SDP3",
                "description": "Device 3 to PE-C",
                "ac-node-id": "PE-C",
                "ac-tp-id": "GigabitEthernet3/0/0/0",
                "ac-ipv6-address": "2001:db8:0:3::1",
                "ac-ipv6-prefix-length": 64,
                "ac-tags": {
                  "ac-tag": [
                    {
                      "tag-type": "vlan-id",
                      "tag-type-value": [
                        "100"
                      ]
                    }
                  ]
                },
                "incoming-qos-policy": {
                  "qos-policy-name": "QoS-Gold",
                  "rate-limits": {
                    "cir": "1000000",
                    "cbs": "1000",
                    "pir": "5000000",
                    "pbs": "1000"
                  }
                }
              }
            ]
          }
        },
        {
          "id": "SDP4",
          "description": "Remote Office 2 at location PE-D",
          "node-id": "PE-D",
          "sdp-ip-address": [
            "2001:db8:0:4::1"
          ],
          "service-match-criteria": {
            "match-criterion": [
```

```
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "vlan",
                          "vlan": [
                            100
                          ]
                        }
                      ],
                      "target-connection-group-id": "matrix1"
                    }
                  ]
                },
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "AC-SDP4",
                      "description": "Device 4 to PE-D",
                      "ac-node-id": "PE-A",
                      "ac-tp-id": "GigabitEthernet4/0/0/0",
                      "ac-ipv6-address": "2001:db8:0:4::1",
                      "ac-ipv6-prefix-length": 64,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "100"
                            ]
                          }
                        ]
                      },
                      "incoming-qos-policy": {
                        "qos-policy-name": "QoS-Gold",
                        "rate-limits": {
                          "cir": "1000000",
                          "cbs": "1000",
                          "pir": "5000000",
                          "pbs": "1000"
                        }
                      }
                    }
                  ]
                }
              }
            ]
          },
```

```
          "connection-groups": {
            "connection-group": [
              {
                "id": "matrix1",
                "slo-sle-template": "low-BW-template",
                "connectivity-construct": [
                  {
                    "id": "1",
                    "a2a-sdp": [
                      {
                        "sdp-id": "SDP1",
                        "slo-sle-template": "high-BW-template"
                      },
                      {
                        "sdp-id": "SDP2",
                        "slo-sle-template": "high-BW-template"
                      },
                      {
                        "sdp-id": "SDP3"
                      },
                      {
                        "sdp-id": "SDP4"
                      }
                    ]
                  }
                ]
              }
            ]
          }
        ]
      }
    }
    <CODE ENDS>
```

Figure 32: Example of a Message Body to Create an A2A Slice Service with SLO Precedence

B.6. Example-6: SDP at CE, L3 A2A Slice Service

Figure 33 shows an example of one Network slice instance where the SDPs are located at the PE-facing ports on the CE:

* Network Slice 8 with SDP31 on CE Device1, SDP33 (with two ACs) on Device 3 and SDP34 on Device 4, with an A2A connectivity type. This is an L3 Slice Service that uses the uniform low-latency slo-sle-template policy between all SDPs.

* This example also introduces the optional attribute of "sdp-ip", which could be a loopback interface on the device. How this "sdp-ip" is used by the NSC is out-of-scope here, but, for example, this could be the management interface of the device. The SDP and AC details are from the perspective of the CE in this example. How the CE ACs are mapped to the PE ACs is up to the NSC implementation and out-of-scope in this example.

  SDP31 AC "id"=ac31, "node-id"=Device1, interface: GigabitEthernet0 vlan 100

  SDP33 AC "id"=ac33a, "node-id"=Device3, interface: GigabitEthernet0 vlan 101

  SDP33 AC "id"=ac33b, "node-id"=Device3, interface: GigabitEthernet1 vlan 201

  SDP34 AC "id"=ac34, "node-id"=Device4, interface: GigabitEthernet3 vlan 100

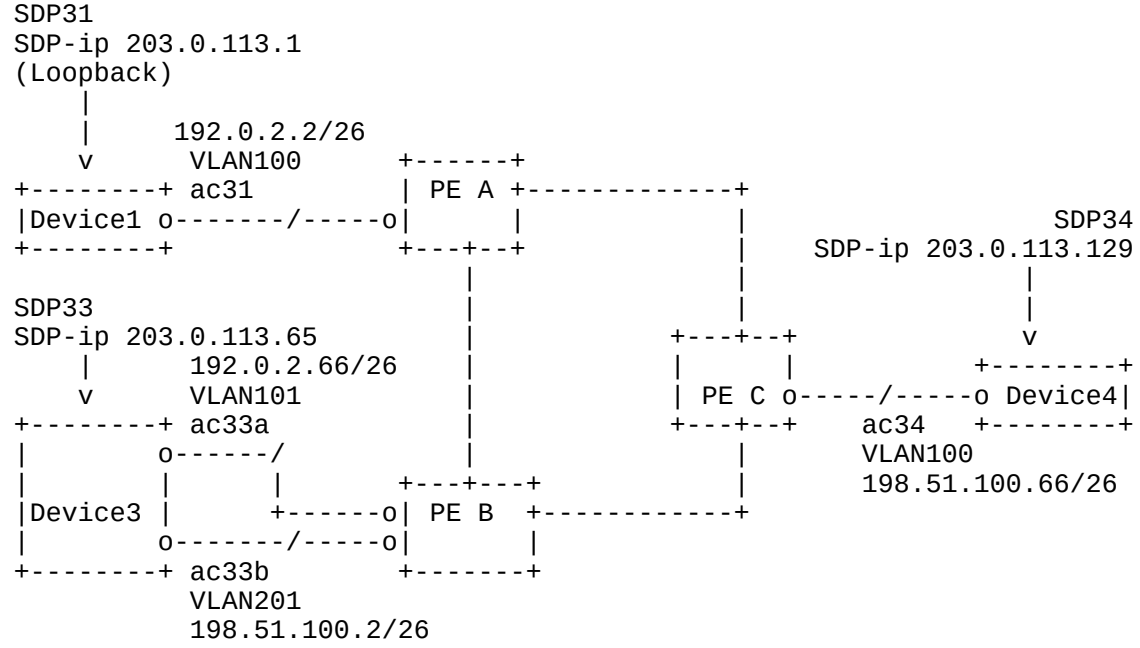

Figure 33: Example of an A2A Slice Service with CE Based SDP

Figure 34 shows an example YANG JSON data for the body of the Network Slice Service instances request.

```
   ============== NOTE: '\' line wrapping per RFC 8792 ===============
   <CODE BEGINS>
   {
     "ietf-network-slice-service:network-slice-services": {
       "slo-sle-templates": {
         "slo-sle-template": [
           {
             "id": "high-BW-template",
             "description": \
   "take the highest BW forwarding path"
           },
           {
             "id": "low-latency-template",
             "description": \
   "lowest possible latency forwarding behavior"
           }
         ]
       },
       "slice-service": [
         {
           "id": "slice8",
           "description": "slice-8",
           "service-tags": {
             "tag-type": [
               {
                 "tag-type": "service",
                 "tag-type-value": [
                   "L3"
                 ]
               }
             ]
           },
           "slo-sle-template": "low-latency-template",
           "status": {
             "admin-status": {
               "status": "ietf-vpn-common:admin-up"
             }
           },
           "sdps": {
             "sdp": [
               {
                 "id": "31",
                 "node-id": "Device-1",
                 "sdp-ip-address": [
                   "203.0.113.1"
                 ],
                 "service-match-criteria": {
                   "match-criterion": [
```

```
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "any"
                        }
                      ],
                      "target-connection-group-id": "matrix1",
                      "target-connectivity-construct-id": "1"
                    }
                  ]
                },
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac31",
                      "description": "AC1 connected to PE-A",
                      "ac-node-id": "Device-1",
                      "ac-tp-id": "GigabitEthernet0",
                      "ac-ipv4-address": "192.0.2.2",
                      "ac-ipv4-prefix-length": 26,
                      "ac-tags": {
                        "ac-tag": [
                          {
                            "tag-type": "vlan-id",
                            "tag-type-value": [
                              "100"
                            ]
                          }
                        ]
                      }
                    }
                  ]
                }
              },
              {
                "id": "33",
                "node-id": "Device-3",
                "sdp-ip-address": [
                  "203.0.113.65"
                ],
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "any"
```

```
                    }
                  ],
                  "target-connection-group-id": "matrix1",
                  "target-connectivity-construct-id": "1"
                }
              ]
            },
            "attachment-circuits": {
              "attachment-circuit": [
                {
                  "id": "ac33a",
                  "description": "AC33a connected to PE-B",
                  "ac-node-id": "Device-3",
                  "ac-tp-id": "GigabitEthernet0",
                  "ac-ipv4-address": "192.0.2.66",
                  "ac-ipv4-prefix-length": 26,
                  "ac-tags": {
                    "ac-tag": [
                      {
                        "tag-type": "vlan-id",
                        "tag-type-value": [
                          "101"
                        ]
                      }
                    ]
                  }
                },
                {
                  "id": "ac33b",
                  "description": "AC33b connected to PE-B",
                  "ac-node-id": "Device-3",
                  "ac-tp-id": "GigabitEthernet1",
                  "ac-ipv4-address": "198.51.100.2",
                  "ac-ipv4-prefix-length": 26,
                  "ac-tags": {
                    "ac-tag": [
                      {
                        "tag-type": "vlan-id",
                        "tag-type-value": [
                          "201"
                        ]
                      }
                    ]
                  }
                }
              ]
            }
          },
```

```
            {
              "id": "34",
              "node-id": "Device-4",
              "sdp-ip-address": [
                "203.0.113.129"
              ],
              "service-match-criteria": {
                "match-criterion": [
                  {
                    "index": 1,
                    "match-type": [
                      {
                        "type": "any"
                      }
                    ],
                    "target-connection-group-id": "matrix1",
                    "target-connectivity-construct-id": "1"
                  }
                ]
              },
              "attachment-circuits": {
                "attachment-circuit": [
                  {
                    "id": "ac34",
                    "description": "AC34 connected to PE-C",
                    "ac-node-id": "Device-4",
                    "ac-tp-id": "GigabitEthernet3",
                    "ac-ipv4-address": "198.51.100.66",
                    "ac-ipv4-prefix-length": 26,
                    "ac-tags": {
                      "ac-tag": [
                        {
                          "tag-type": "vlan-id",
                          "tag-type-value": [
                            "100"
                          ]
                        }
                      ]
                    }
                  }
                ]
              }
            }
          ]
        },
        "connection-groups": {
          "connection-group": [
            {
```

```
                "id": "matrix1",
                "connectivity-type": "ietf-vpn-common:any-to-any",
                "connectivity-construct": [
                  {
                    "id": "1",
                    "a2a-sdp": [
                      {
                        "sdp-id": "31"
                      },
                      {
                        "sdp-id": "33"
                      },
                      {
                        "sdp-id": "34"
                      }
                    ]
                  }
                ]
              }
            ]
          }
        }
      ]
    }
  }
  <CODE ENDS>
```

Figure 34: Example of a Message Body to Create an CE based A2A Slice Services

B.7. Example-7: SDP at CE, L3 A2A Slice Service with Network Abstraction

Figure 35 shows an example of one Network slice instance where the SDPs are located at the PE-facing ports on the CE.

In this example, it is assumed that the NSC already has circuit binding details between the CE and PE which were previously assigned (method is out-of-scope) or the NSC has mechanisms to determine this mapping. While the NSC capabilities are out-of-scope of this document, the NSC may use the CE device name, "sdp-id", "sdp-ip", AC "id" or the "peer-sap-id" to complete this AC circuit binding.

This example introduces the "peer-sap-id", which in this case, is an operator provided identifier that the slice requester can use for the NSC to identify the service attachment point (saps) in an abstracted way. How the NSC uses the "peer-sap-id" is out of scope of this document, but a possible implementation would be that the NSC was

previously provisioned with a "peer-sap-id" to PE device/interface/ VLAN mapping table. Alternatively, the NSC can request this mapping from an external database.

* Network Slice 9 with SDP31 on CPE Device1, SDP33 (with two ACs) on Device 3 and SDP34 on Device 4, with an A2A connectivity type. This is an L3 Slice Service that uses the uniform low-latency slo-sle-template policy between all SDPs.

  SDP31 AC "id"=ac31, "node-id"=Device1, "peer-sap-id"= example.com-circuitID-12345

  SDP33 AC "id"=ac33a, "node-id"=Device3, "peer-sap-id"=example.com-circuitID-67890

  SDP33 AC "id"=ac33b, "node-id"=Device3, "peer-sap-id"=example.com-circuitID-54321ABC

  SDP34 AC "id"=ac34, "node-id"=Device4, "peer-sap-id"=example.com-circuitID-9876

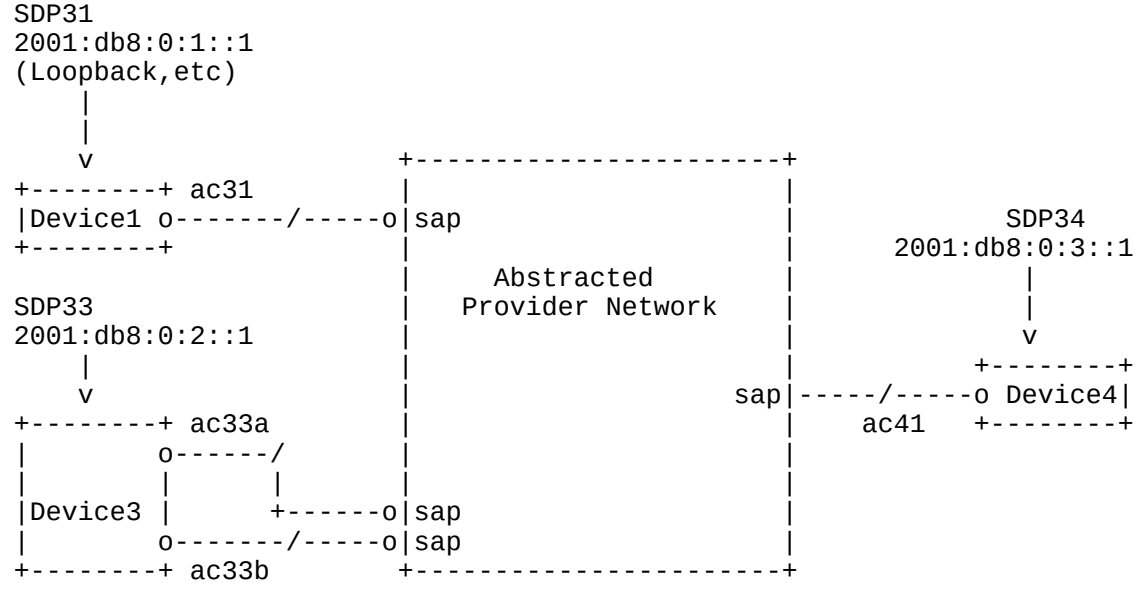

Figure 35: Example of a Message Body to Create an A2A CE Based Slice Service with Abstraction

Figure 36 shows an example YANG JSON data for the body of the Network Slice Service instances request.

```
   ============== NOTE: '\' line wrapping per RFC 8792 ===============
   <CODE BEGINS>
   {
     "ietf-network-slice-service:network-slice-services": {
       "slo-sle-templates": {
         "slo-sle-template": [
           {
             "id": "high-BW-template",
             "description": "take the highest BW forwarding path"
           },
           {
             "id": "low-latency-template",
             "description": \
   "lowest possible latency forwarding behavior"
           }
         ]
       },
       "slice-service": [
         {
           "id": "slice-9",
           "description": "example slice7",
           "service-tags": {
             "tag-type": [
               {
                 "tag-type": "service",
                 "tag-type-value": [
                   "L3"
                 ]
               }
             ]
           },
           "slo-sle-template": "low-latency-template",
           "status": {
             "admin-status": {
               "status": "ietf-vpn-common:admin-up"
             }
           },
           "sdps": {
             "sdp": [
               {
                 "id": "31",
                 "node-id": "Device-1",
                 "sdp-ip-address": [
                   "2001:db8:0:1::1"
                 ],
                 "service-match-criteria": {
                   "match-criterion": [
                     {
```

```
                    "index": 1,
                    "match-type": [
                      {
                        "type": "any"
                      }
                    ],
                    "target-connection-group-id": "matrix1"
                  }
                ]
              },
              "attachment-circuits": {
                "attachment-circuit": [
                  {
                    "id": "ac31",
                    "sdp-peering": {
                      "peer-sap-id": "example.com-circuitID-12345"
                    }
                  }
                ]
              }
            },
            {
              "id": "33",
              "node-id": "Device-3",
              "sdp-ip-address": [
                "2001:db8:0:2::1"
              ],
              "service-match-criteria": {
                "match-criterion": [
                  {
                    "index": 1,
                    "match-type": [
                      {
                        "type": "any"
                      }
                    ],
                    "target-connection-group-id": "matrix1",
                    "target-connectivity-construct-id": "1"
                  }
                ]
              },
              "attachment-circuits": {
                "attachment-circuit": [
                  {
                    "id": "ac33a",
                    "sdp-peering": {
                      "peer-sap-id": "example.com-circuitID-67890"
                    }
```

```
                    },
                    {
                      "id": "ac33b",
                      "sdp-peering": {
                        "peer-sap-id": "example.com-circuitID-54321ABC"
                      }
                    }
                  ]
                }
              },
              {
                "id": "34",
                "node-id": "Device-4",
                "sdp-ip-address": [
                  "2001:db8:0:3::1"
                ],
                "service-match-criteria": {
                  "match-criterion": [
                    {
                      "index": 1,
                      "match-type": [
                        {
                          "type": "any"
                        }
                      ],
                      "target-connection-group-id": "matrix1"
                    }
                  ]
                },
                "attachment-circuits": {
                  "attachment-circuit": [
                    {
                      "id": "ac34",
                      "sdp-peering": {
                        "peer-sap-id": "example.com-circuitID-9876"
                      }
                    }
                  ]
                }
              }
            ]
          },
          "connection-groups": {
            "connection-group": [
              {
                "id": "matrix1",
                "connectivity-type": "ietf-vpn-common:any-to-any",
                "connectivity-construct": [
```

```
                    {
                      "id": "1",
                      "a2a-sdp": [
                        {
                          "sdp-id": "31"
                        },
                        {
                          "sdp-id": "33"
                        },
                        {
                          "sdp-id": "34"
                        }
                      ]
                    }
                  ]
                }
              ]
            }
          }
        }
      ]
    }
  }
  <CODE ENDS>
```

Figure 36: Example of a Message Body to Create an A2A Slice Service with Abstraction

Appendix C. Complete Model Tree Structure

```
  module: ietf-network-slice-service
    +--rw network-slice-services
       +--rw slo-sle-templates
       |  +--rw slo-sle-template* [id]
       |     +--rw id              string
       |     +--rw description?    string
       |     +--rw template-ref?   slice-template-ref
       |     +--rw slo-policy
       |     |  +--rw metric-bound* [metric-type]
       |     |  |  +--rw metric-type          identityref
       |     |  |  +--rw metric-unit          string
       |     |  |  +--rw value-description?   string
       |     |  |  +--rw percentile-value?    percentile
       |     |  |  +--rw bound?               uint64
       |     |  +--rw availability?   identityref
       |     |  +--rw mtu?            uint32
       |     +--rw sle-policy
       |        +--rw security*             identityref
       |        +--rw isolation*            identityref
```

```
        |        +--rw max-occupancy-level?   uint8
        |        +--rw path-constraints
        |           +--rw service-functions
        |           +--rw diversity
        |              +--rw diversity-type?
        |                      te-types:te-path-disjointness
        +--rw slice-service* [id]
           +--rw id                                string
           +--rw description?                      string
           +--rw service-tags
           |  +--rw tag-type* [tag-type]
           |     +--rw tag-type          identityref
           |     +--rw tag-type-value*   string
           +--rw (slo-sle-policy)?
           |  +--:(standard)
           |  |  +--rw slo-sle-template?         slice-template-ref
           |  +--:(custom)
           |     +--rw service-slo-sle-policy
           |        +--rw description?   string
           |        +--rw slo-policy
           |        |  +--rw metric-bound* [metric-type]
           |        |  |  +--rw metric-type          identityref
           |        |  |  +--rw metric-unit          string
           |        |  |  +--rw value-description?   string
           |        |  |  +--rw percentile-value?    percentile
           |        |  |  +--rw bound?               uint64
           |        |  +--rw availability?   identityref
           |        |  +--rw mtu?            uint32
           |        +--rw sle-policy
           |           +--rw security*              identityref
           |           +--rw isolation*             identityref
           |           +--rw max-occupancy-level?   uint8
           |           +--rw path-constraints
           |              +--rw service-functions
           |              +--rw diversity
           |                 +--rw diversity-type?
           |                         te-types:te-path-disjointness
           +--rw test-only?                        empty
           +--rw status
           |  +--rw admin-status
           |  |  +--rw status?        identityref
           |  |  +--ro last-change?   yang:date-and-time
           |  +--ro oper-status
           |     +--ro status?        identityref
           |     +--ro last-change?   yang:date-and-time
           +--rw sdps
           |  +--rw sdp* [id]
           |     +--rw id                         string
```

```
|     +--rw description?              string
|     +--rw geo-location
|     |  +--rw reference-frame
|     |  |  +--rw alternate-system?    string
|     |  |  |       {alternate-systems}?
|     |  |  +--rw astronomical-body?   string
|     |  |  +--rw geodetic-system
|     |  |     +--rw geodetic-datum?    string
|     |  |     +--rw coord-accuracy?    decimal64
|     |  |     +--rw height-accuracy?   decimal64
|     |  +--rw (location)?
|     |  |  +--:(ellipsoid)
|     |  |  |  +--rw latitude?    decimal64
|     |  |  |  +--rw longitude?   decimal64
|     |  |  |  +--rw height?      decimal64
|     |  |  +--:(cartesian)
|     |  |     +--rw x?           decimal64
|     |  |     +--rw y?           decimal64
|     |  |     +--rw z?           decimal64
|     |  +--rw velocity
|     |  |  +--rw v-north?   decimal64
|     |  |  +--rw v-east?    decimal64
|     |  |  +--rw v-up?      decimal64
|     |  +--rw timestamp?         yang:date-and-time
|     |  +--rw valid-until?       yang:date-and-time
|     +--rw node-id?                  string
|     +--rw sdp-ip-address*           inet:ip-address
|     +--rw tp-ref?                   leafref
|     +--rw service-match-criteria
|     |  +--rw match-criterion* [index]
|     |     +--rw index                                uint32
|     |     +--rw match-type* [type]
|     |     |  +--rw type                    identityref
|     |     |  +--rw (value)?
|     |     |     +--:(interface)
|     |     |     |  +--rw interface-name*   string
|     |     |     +--:(vlan)
|     |     |     |  +--rw vlan*             uint16
|     |     |     +--:(label)
|     |     |     |  +--rw label*
|     |     |     |          rt-types:mpls-label
|     |     |     +--:(ip-prefix)
|     |     |     |  +--rw ip-prefix*        inet:ip-prefix
|     |     |     +--:(dscp)
|     |     |     |  +--rw dscp*             inet:dscp
|     |     |     +--:(acl)
|     |     |        +--rw acl-name*         string
|     |     +--rw target-connection-group-id          leafref
```

```
          |     |     +--rw connection-group-sdp-role?
          |     |     |       identityref
          |     |     +--rw target-connectivity-construct-id?   leafref
          |     +--rw incoming-qos-policy
          |     |  +--rw qos-policy-name?   string
          |     |  +--rw rate-limits
          |     |     +--rw cir?       uint64
          |     |     +--rw cbs?       uint64
          |     |     +--rw eir?       uint64
          |     |     +--rw ebs?       uint64
          |     |     +--rw pir?       uint64
          |     |     +--rw pbs?       uint64
          |     |     +--rw classes
          |     |        +--rw cos* [cos-id]
          |     |           +--rw cos-id    uint8
          |     |           +--rw cir?      uint64
          |     |           +--rw cbs?      uint64
          |     |           +--rw eir?      uint64
          |     |           +--rw ebs?      uint64
          |     |           +--rw pir?      uint64
          |     |           +--rw pbs?      uint64
          |     +--rw outgoing-qos-policy
          |     |  +--rw qos-policy-name?   string
          |     |  +--rw rate-limits
          |     |     +--rw cir?       uint64
          |     |     +--rw cbs?       uint64
          |     |     +--rw eir?       uint64
          |     |     +--rw ebs?       uint64
          |     |     +--rw pir?       uint64
          |     |     +--rw pbs?       uint64
          |     |     +--rw classes
          |     |        +--rw cos* [cos-id]
          |     |           +--rw cos-id    uint8
          |     |           +--rw cir?      uint64
          |     |           +--rw cbs?      uint64
          |     |           +--rw eir?      uint64
          |     |           +--rw ebs?      uint64
          |     |           +--rw pir?      uint64
          |     |           +--rw pbs?      uint64
          |     +--rw sdp-peering
          |     |  +--rw peer-sap-id*   string
          |     |  +--rw protocols
          |     +--rw ac-svc-ref*
          |     |       ac-svc:attachment-circuit-reference
          |     +--rw ce-mode?                  boolean
          |     +--rw attachment-circuits
          |     |  +--rw attachment-circuit* [id]
          |     |     +--rw id                        string
```

```
          |      |     +--rw description?             string
          |      |     +--rw ac-svc-ref?
          |      |     |       ac-svc:attachment-circuit-reference
          |      |     +--rw ac-node-id?              string
          |      |     +--rw ac-tp-id?                string
          |      |     +--rw ac-ipv4-address?         inet:ipv4-address
          |      |     +--rw ac-ipv4-prefix-length?   uint8
          |      |     +--rw ac-ipv6-address?         inet:ipv6-address
          |      |     +--rw ac-ipv6-prefix-length?   uint8
          |      |     +--rw mtu?                     uint32
          |      |     +--rw ac-tags
          |      |     |  +--rw ac-tag* [tag-type]
          |      |     |     +--rw tag-type          identityref
          |      |     |     +--rw tag-type-value*   string
          |      |     +--rw incoming-qos-policy
          |      |     |  +--rw qos-policy-name?   string
          |      |     |  +--rw rate-limits
          |      |     |     +--rw cir?       uint64
          |      |     |     +--rw cbs?       uint64
          |      |     |     +--rw eir?       uint64
          |      |     |     +--rw ebs?       uint64
          |      |     |     +--rw pir?       uint64
          |      |     |     +--rw pbs?       uint64
          |      |     |     +--rw classes
          |      |     |        +--rw cos* [cos-id]
          |      |     |           +--rw cos-id    uint8
          |      |     |           +--rw cir?      uint64
          |      |     |           +--rw cbs?      uint64
          |      |     |           +--rw eir?      uint64
          |      |     |           +--rw ebs?      uint64
          |      |     |           +--rw pir?      uint64
          |      |     |           +--rw pbs?      uint64
          |      |     +--rw outgoing-qos-policy
          |      |     |  +--rw qos-policy-name?   string
          |      |     |  +--rw rate-limits
          |      |     |     +--rw cir?       uint64
          |      |     |     +--rw cbs?       uint64
          |      |     |     +--rw eir?       uint64
          |      |     |     +--rw ebs?       uint64
          |      |     |     +--rw pir?       uint64
          |      |     |     +--rw pbs?       uint64
          |      |     |     +--rw classes
          |      |     |        +--rw cos* [cos-id]
          |      |     |           +--rw cos-id    uint8
          |      |     |           +--rw cir?      uint64
          |      |     |           +--rw cbs?      uint64
          |      |     |           +--rw eir?      uint64
          |      |     |           +--rw ebs?      uint64
```

```
|     |     |          +--rw pir?      uint64
|     |     |          +--rw pbs?      uint64
|     |     +--rw sdp-peering
|     |     |  +--rw peer-sap-id?   string
|     |     |  +--rw protocols
|     |     +--rw status
|     |        +--rw admin-status
|     |        |  +--rw status?        identityref
|     |        |  +--ro last-change?   yang:date-and-time
|     |        +--ro oper-status
|     |           +--ro status?        identityref
|     |           +--ro last-change?   yang:date-and-time
|     +--rw status
|     |  +--rw admin-status
|     |  |  +--rw status?        identityref
|     |  |  +--ro last-change?   yang:date-and-time
|     |  +--ro oper-status
|     |     +--ro status?        identityref
|     |     +--ro last-change?   yang:date-and-time
|     +--ro sdp-monitoring
|        +--ro incoming-bw-value?     yang:gauge64
|        +--ro incoming-bw-percent?   percentage
|        +--ro outgoing-bw-value?     yang:gauge64
|        +--ro outgoing-bw-percent?   percentage
+--rw connection-groups
|  +--rw connection-group* [id]
|     +--rw id                                  string
|     +--rw connectivity-type?                  identityref
|     +--rw (slo-sle-policy)?
|     |  +--:(standard)
|     |  |  +--rw slo-sle-template?
|     |  |          slice-template-ref
|     |  +--:(custom)
|     |     +--rw service-slo-sle-policy
|     |        +--rw description?   string
|     |        +--rw slo-policy
|     |        |  +--rw metric-bound* [metric-type]
|     |        |  |  +--rw metric-type          identityref
|     |        |  |  +--rw metric-unit          string
|     |        |  |  +--rw value-description?   string
|     |        |  |  +--rw percentile-value?    percentile
|     |        |  |  +--rw bound?               uint64
|     |        |  +--rw availability?   identityref
|     |        |  +--rw mtu?            uint32
|     |        +--rw sle-policy
|     |           +--rw security*             identityref
|     |           +--rw isolation*            identityref
|     |           +--rw max-occupancy-level?  uint8
```

```
          |     |          +--rw path-constraints
          |     |             +--rw service-functions
          |     |             +--rw diversity
          |     |                +--rw diversity-type?
          |     |                        te-types:te-path-disjointness
          |     +--rw service-slo-sle-policy-override?   identityref
          |     +--rw connectivity-construct* [id]
          |     |  +--rw id                                    string
          |     |  +--rw (type)?
          |     |  |  +--:(p2p)
          |     |  |  |  +--rw p2p-sender-sdp?
          |     |  |  |  |       -> ../../../../sdps/sdp/id
          |     |  |  |  +--rw p2p-receiver-sdp?
          |     |  |  |          -> ../../../../sdps/sdp/id
          |     |  |  +--:(p2mp)
          |     |  |  |  +--rw p2mp-sender-sdp?
          |     |  |  |  |       -> ../../../../sdps/sdp/id
          |     |  |  |  +--rw p2mp-receiver-sdp*
          |     |  |  |          -> ../../../../sdps/sdp/id
          |     |  |  +--:(a2a)
          |     |  |     +--rw a2a-sdp* [sdp-id]
          |     |  |        +--rw sdp-id
          |     |  |        |       -> ../../../../../sdps/sdp/id
          |     |  |        +--rw (slo-sle-policy)?
          |     |  |           +--:(standard)
          |     |  |           |  +--rw slo-sle-template?
          |     |  |           |          slice-template-ref
          |     |  |           +--:(custom)
          |     |  |              +--rw service-slo-sle-policy
          |     |  |                 +--rw description?   string
          |     |  |                 +--rw slo-policy
          |     |  |                 |  +--rw metric-bound*
          |     |  |                 |  |       [metric-type]
          |     |  |                 |  |  +--rw metric-type
          |     |  |                 |  |  |       identityref
          |     |  |                 |  |  +--rw metric-unit
          |     |  |                 |  |  |       string
          |     |  |                 |  |  +--rw value-description?
          |     |  |                 |  |  |       string
          |     |  |                 |  |  +--rw percentile-value?
          |     |  |                 |  |  |       percentile
          |     |  |                 |  |  +--rw bound?
          |     |  |                 |  |          uint64
          |     |  |                 |  +--rw availability?
          |     |  |                 |  |       identityref
          |     |  |                 |  +--rw mtu?           uint32
          |     |  |                 +--rw sle-policy
          |     |  |                    +--rw security*
```

```
          |      |  |                    |       identityref
          |      |  |                    +--rw isolation*
          |      |  |                    |       identityref
          |      |  |                    +--rw max-occupancy-level?
          |      |  |                    |       uint8
          |      |  |                    +--rw path-constraints
          |      |  |                       +--rw service-functions
          |      |  |                       +--rw diversity
          |      |  |                          +--rw diversity-type?
          |      |  |                                  te-types:
   te-path-disjointness
          |      |  +--rw (slo-sle-policy)?
          |      |  |  +--:(standard)
          |      |  |  |  +--rw slo-sle-template?
          |      |  |  |          slice-template-ref
          |      |  |  +--:(custom)
          |      |  |     +--rw service-slo-sle-policy
          |      |  |        +--rw description?   string
          |      |  |        +--rw slo-policy
          |      |  |        |  +--rw metric-bound* [metric-type]
          |      |  |        |  |  +--rw metric-type
          |      |  |        |  |  |       identityref
          |      |  |        |  |  +--rw metric-unit          string
          |      |  |        |  |  +--rw value-description?   string
          |      |  |        |  |  +--rw percentile-value?    percentile
          |      |  |        |  |  +--rw bound?               uint64
          |      |  |        |  +--rw availability?   identityref
          |      |  |        |  +--rw mtu?            uint32
          |      |  |        +--rw sle-policy
          |      |  |           +--rw security*             identityref
          |      |  |           +--rw isolation*            identityref
          |      |  |           +--rw max-occupancy-level?  uint8
          |      |  |           +--rw path-constraints
          |      |  |              +--rw service-functions
          |      |  |              +--rw diversity
          |      |  |                 +--rw diversity-type?
          |      |  |                         te-types:
   te-path-disjointness
          |      |  +--rw service-slo-sle-policy-override?
          |      |  |       identityref
          |      |  +--rw status
          |      |  |  +--rw admin-status
          |      |  |  |  +--rw status?        identityref
          |      |  |  |  +--ro last-change?   yang:date-and-time
          |      |  |  +--ro oper-status
          |      |  |     +--ro status?        identityref
          |      |  |     +--ro last-change?   yang:date-and-time
          |      |  +--ro connectivity-construct-monitoring
```

```
          |     |     +--ro one-way-min-delay?         yang:gauge64
          |     |     +--ro one-way-max-delay?         yang:gauge64
          |     |     +--ro one-way-delay-variation?   yang:gauge64
          |     |     +--ro one-way-packet-loss?       decimal64
          |     |     +--ro two-way-min-delay?         yang:gauge64
          |     |     +--ro two-way-max-delay?         yang:gauge64
          |     |     +--ro two-way-delay-variation?   yang:gauge64
          |     |     +--ro two-way-packet-loss?       decimal64
          |     +--ro connection-group-monitoring
          |        +--ro one-way-min-delay?         yang:gauge64
          |        +--ro one-way-max-delay?         yang:gauge64
          |        +--ro one-way-delay-variation?   yang:gauge64
          |        +--ro one-way-packet-loss?       decimal64
          |        +--ro two-way-min-delay?         yang:gauge64
          |        +--ro two-way-max-delay?         yang:gauge64
          |        +--ro two-way-delay-variation?   yang:gauge64
          |        +--ro two-way-packet-loss?       decimal64
          +--rw custom-topology
             +--rw network-ref?   -> /nw:networks/network/network-id
```

Appendix D. Comparison with the Design Choice of ACTN VN Model Augmentation

The difference between the ACTN VN model and the Network Slice Service requirements is that the Network Slice Service interface is a technology-agnostic interface, whereas the VN model is bound to the TE Topologies. The realization of the Network Slice does not necessarily require the slice network to support the TE technology.

The ACTN VN (Virtual Network) model introduced in [RFC9731] is the abstract customer view of the TE network. Its YANG structure includes four components:

* VN: A Virtual Network (VN) is a network provided by a service provider to a customer for use and two types of VN have been defined. The Type 1 VN can be seen as a set of edge-to-edge abstract links. Each link is an abstraction of the underlying network which can encompass edge points of the customer’s network, access links, intra-domain paths, and inter-domain links.

* AP: An AP is a logical identifier used to identify the access link which is shared between the customer and the IETF scoped Network.

* VN-AP: A VN-AP is a logical binding between an AP and a given VN.

* VN-member: A VN-member is an abstract edge-to-edge link between any two APs or VN-APs. Each link is formed as an E2E tunnel across the underlying networks.

The Type 1 VN can be used to describe Network Slice Service connection requirements. However, the Network Slice SLOs and Network Slice SDPs are not clearly defined and there’s no direct equivalent. For example, the SLO requirement of the VN is defined through the TE Topologies YANG model, but the TE Topologies model is related to a specific implementation technology. Also, VN-AP does not define "service-match-criteria" to specify a specific SDP belonging to a Network Slice Service.

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