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13 March 2023

An IETF Network Slice Topology YANG Data Model
draft-liu-teas-transport-network-slice-yang-06

Abstract

An IETF network slice may ~~use~~ rely upon an abstract topology to ~~describe~~capture the intended underlay for the ~~connectivities~~ connectivity between involved slice endpoints.

These ~~Abstract~~ abstract topologies may be exposed to ~~help the~~ customers to derive ~~request network~~ slice service requests ~~with shared resources amongst connections, and connections can be~~and identify connections to be activated within the slice as needed.

This document describes a YANG data model for managing ~~and controlling~~ abstract topologies for IETF network slices defined in RFC YYYY.

[RFC EDITOR NOTE: Please replace RFC YYYY with the RFC number of draft-ietf-teas-ietf-network-slices once it has been published.

Commented [BMI1]: More motivation is needed to justify why the internal structure of the underly (even filtered) should be exposed to a customer.

The filtered view may be useful for the NSC, though.

Commented [BMI2]: That is part of “managing”.

Commented [BMI3]: Consider grouping all the notes to the RFC Editor in one single place.

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1. Introduction

This document defines a YANG [RFC7950] data model for representing and~~,~~
managing~~, and controlling~~ IETF network slices [I-D.ietf-teas-ietf-network-slices] as abstract network
topologies~~, where the network slices are defined in [I-D.ietf-teas-ietf-network-slices]~~.

~~The~~ This ~~defined~~ data model can be exposed in ~~is~~ an interface between customers and
providers for configuration~~s~~ and state retrieval~~s~~, so as to support network slicing~~e as a~~ service~~s~~. Through this model, a customer can learn the slicing capabilities and the available resources of the provider. A customer can request, or eventually negotiate, with a network slicing
provider to create an instance. ~~The~~ A customer can ~~incrementally~~ update its requirements on individual topology elements in the slice

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Commented [BMI4]: No need to define new terms here as there is already one in the framework document.

Commented [BMI5]: You may first define what is a “slicing capability”

Commented [BMI6]: I’m not sure the provider will expose the available resources. I guess you meant capabilities and features it may offer (e.g., service functions).

instance, e.g., adding or removing a node or link, updating ~~desired~~requested ~~bandwidth~~ capacity of a link, and ~~retrieve~~ retrieving the operational states of these elements. With the help of other mechanisms and data models ~~defined in IETF~~, ~~the~~ telemetry information can be ~~published~~ shared ~~to~~ with the customer.

The YANG model defines technology-agnostic constructs common to network slicing ~~at network layers~~ of different technologies, e.g., IP/MPLS(-TP), OTN, and WDM. Therefore, this model may be used as a common base model on which other network slicing models, such as [I-D.ietf-ccamp-yang-otn-slicing], may augment ~~augments~~ with technology-specific constructs.

~~As described in Section 3 of [I-D.contreras-teas-slice-controller-models], the~~ The data model defined in this document complements the data model defined in [I-D.ietf-teas-ietf-network-slice-nbi-yang]. In addition to the provider's view, the data model defined in this document models the Type 2 service defined in [RFC8453].

The YANG data model in this document conforms to the Network Management Datastore Architecture (NMDA) [RFC8342].

2. Terminology

~~1~~2.1. Tree Diagram

The meanings of the symbols in the tree diagrams are defined in ~~Tree diagrams used in this document follow the notation defined in~~ [RFC8340].

1.2. Prefixes in Data Node Names

~~In this document, names of data nodes and other data model objects are prefixed using the standard prefix associated with the corresponding YANG imported modules, as shown in Table 1.~~ Table 1 lists the YANG prefixes that used in the data model.

Prefix	YANG Module	Reference
yang	ietf-yang-types	[RFC6991]
inet	ietf-inet-types	[RFC6991]
nt	ietf-network-topology	[RFC8345]
nw	ietf-network-topology	[RFC8345]
tet	ietf-te-topology	[RFC8795]
te-types	ietf-te-types	[RFC8776]
ns-topo	ietf-ns-topo	RFCXXXX

Commented [BMI7]: An SDP?

Commented [BMI8]: Do you mean a connectivity construct or an AC?

Commented [BMI9]: You may provide examples.

Commented [BMI10]: No need to be restrictive here.

Commented [BMI11]: No need for an external ref here.

Commented [BMI12]: But draft-contreras says that this document is not exposed to a customer.

```
+----------+----------------------+-----------+
```

Table 1: Prefixes and Corresponding YANG Modules

RFC Editor Note: Please replace XXXX with the RFC number assigned to this document. Please remove this note.

Commented [BMI13]: See the previous comment about the notes to the RFC Editor.

2. Modeling Considerations

An IETF network slice topology is modeled as a network topology defined in [RFC8345], with augmentations. A new network type "network-slice" is defined in this document. When a network topology data instance contains the network-slice network type, it represents an instance of an IETF network slice topology.

Commented [BMI14]: Great to see that you use the same name as in draft-ietf-opsawg-sap.

2.1. Relationships to ~~Related~~ Other Topology Models

~~There are several related YANG data models that have been defined in IETF.~~ Some of these are:

Commented [BMI15]: Not sure this brings much

Network Topology Model: Defined in [RFC8345].

Network Slicing Model: Defined in [I-D.ietf-teas-ietf-network-slice-nbi-yang].

OTN Slicing: Defined in [I-D.ietf-ccamp-yang-otn-slicing].

Commented [BMI16]: Not used in the document

Figure 1 shows the relationships among these models. The box of dotted lines denotes the model defined in this document.

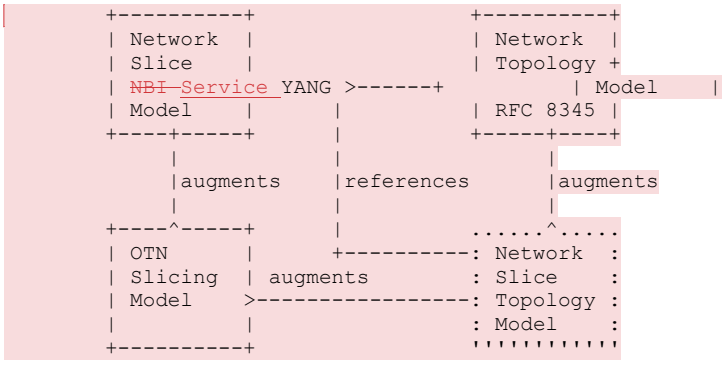

Figure 1: Model Relationships

Commented [BMI17]: The SAP model is missing in this figure.

2.2. ACTN for Network Slicing

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Since ACTN topology data models are based on the network topology model defined in [RFC8345], the augmentations defined in this document are effective augmentations to the ACTN topology data models, resulting in making the ACTN framework [RFC8453] and data models [I-D.ietf-teas-actn-yang] capable of slicing networks with the required network characteristics.

3. Model Applicability

~~There are many technologies to achieve network slicing.~~ The data model defined in this document can be used to ~~configure~~ manage resource-based network slices, where the resources of a network slice ~~is~~are represented in the form of an abstract network topology, which can then be mapped to a network resource partition (NRP) according to the scenarios defined in [I-D.ietf-teas-ietf-network-slices].

Network slices may be abstracted differently depending on the requirement contained in the ~~configuration~~ service request provided by the slice customer. For example, ~~A~~a customer may request a network slice to provide ~~just~~ connectivity between specified endpoints, in which case the network slice can be represented as a set of endpoint-to-endpoint links, with each link formed by an end-to-end tunnel across the underlying transport networks. The resources associated with each link of the slice is reserved and commissioned in the underlying physical network upon the completion of configuring the network slice and all the links are active.

~~Alternatively a~~A network slice ~~can~~ may also be represented as an abstract topology when the customer requests the slice to share resources between multiple endpoints and to use the resources on demand. The abstract topology may consist of virtual nodes and virtual links, and their associated resources are reserved but not commissioned across the underlying transport networks. The customer can later commission resources within the slice dynamically using the ~~NBI~~ slice service interface provided by the service provider.

According to [I-D.ietf-teas-ietf-network-slices], the IETF Network Slice service customer might ask for some level of control of, e.g., to customize the service paths in a network slice. The abstract topology defined in this ~~draft~~ document could serve to enable this capability and optimize the resource utilization for network slice connections activated on top of the abstract topology.

In the example shown in Figure 2, two network resource partitions are created by the provider to support ~~the~~ two network slice service ~~topology~~ requests from ~~the~~ its customers. In realizing the network resource partitions, node virtualization is used to separate and allocate resources in physical devices. Two virtual routers VR1 and VR2 are created over physical router R1, and two virtual routers VR3 and VR4 are created over physical router R2, respectively. Each of the virtual routers, as a partition of the physical router, takes a portion of the resources such as ports and memory in the physical router. Depending on the requirements and the implementations, they may share certain resources such as processors, ASICs, and switch fabric.

The network slice topology intent requested by the customers is then mapped to a corresponding network resource partition. The provider

Commented [BMI18]: Which scenarios?

Commented [BMI19]: It would be better to include an example to assess that.

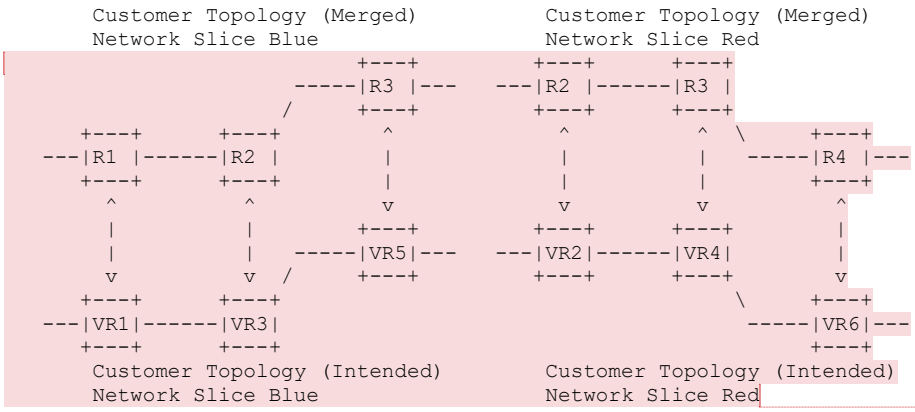
Commented [BMI20]: You may indicate that virtualization is not mandatory and that this is used here for illustration purposes.

Commented [BMI21]: Is the intent of this document to cover these aspects?

Commented [BMI22]: You should map this to the connectivity construct.

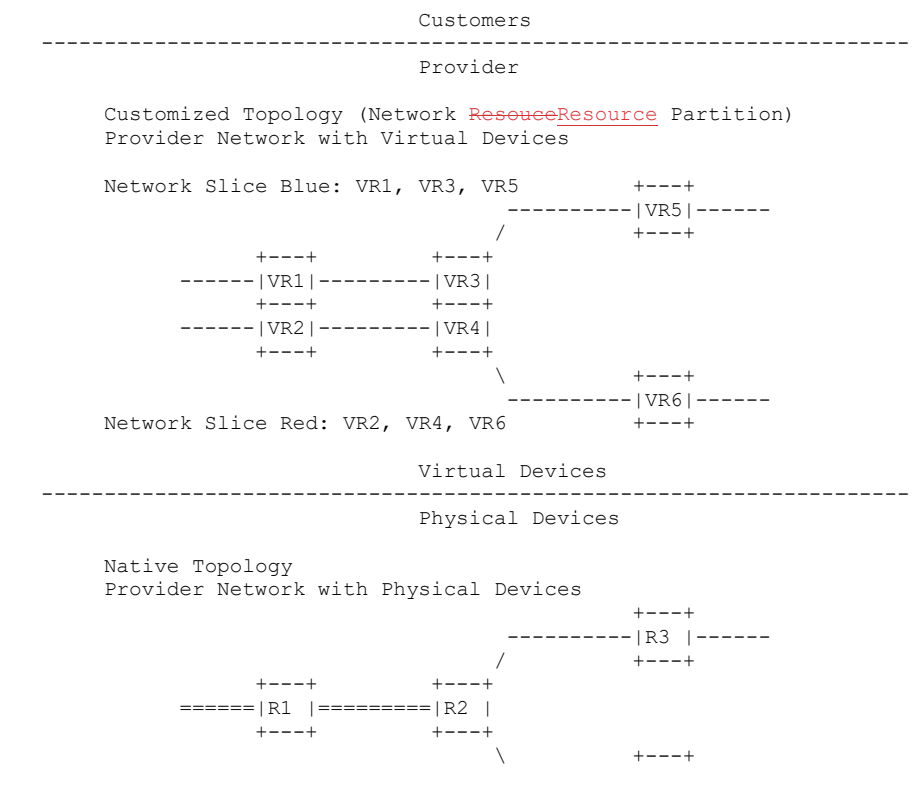
also reports the operational state of the ~~topology~~customized network, which shows the resources that are allocated. Customers can process the requested topology and integrate it with their own topology.

As an example, Appendix B. shows the JSON encoded data instances of the customer topology intent for Network Slice Blue.



Commented [BMI23]: Not sure what does this mean.

Commented [BMI24]: Is this the provider's topo?



```
                                          ----------|R4 |------
                                                    +---+
```

Figure 2: Network Slicing Topologies for Virtualization

Commented [BMI25]: The link-id used in the appendix are not shown in this figure.

4. YANG Model Overview

The following constructs and attributes are defined within the YANG model:

* Network topology, which represent set of shared, reserved resources organized as a virtual topology between all of the endpoints. A customer could use such a network topology to define detailed connectivity path traversing the topology, and allow sharing of resources between its multiple endpoint pairs.

Commented [BMI26]: We need to map this to SDPs, ancillary SDPs, etc.

* Service-level objectives (SLOs) associated with different objects, including node, link, termination point of the topology.

5. Model Tree Structure

module: ietf-ns-topo

```
  augment /nw:networks/nw:network/nw:network-types:
    +--rw network-slice!
  augment /nw:networks/nw:network:
    +--rw (slo-sle-policy)?
       +--:(standard)
       |  +--rw slo-sle-template?         leafref
       +--:(custom)
          +--rw service-slo-sle-policy
             +--rw description?              string
             +--rw metric-bounds
             |  +--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 security*                  identityref
             +--rw isolation?                 identityref
             +--rw max-occupancy-level?       uint8
             +--rw mtu?                       uint16
             +--rw steering-constraints
             |  +--rw path-constraints
             |  +--rw service-function
             |  +--rw disjointness?
             |          te-types:te-path-disjointness
             +--rw optimization-criterion?   identityref
             +--rw resize-requirement?       identityref
             +--rw service-info?             string
  augment /nw:networks/nw:network/nw:node:
    +--rw (slo-sle-policy)?

       +--:(standard)
       |  +--rw slo-sle-template?         leafref
       +--:(custom)
          +--rw service-slo-sle-policy
```

Commented [BMI27]: How this information is used? As the same structure is also provided for the node/link, who ensures that the provided information is coherent? Which one takes precedence when there are conflicts?

```
            +--rw description?              string
            +--rw metric-bounds
            |  +--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 security*                  identityref
            +--rw isolation?                 identityref
            +--rw max-occupancy-level?       uint8
            +--rw mtu?                       uint16
            +--rw steering-constraints
            |  +--rw path-constraints
            |  +--rw service-function
            |  +--rw disjointness?
            |          te-types:te-path-disjointness
            +--rw optimization-criterion?    identityref
            +--rw resize-requirement?        identityref
            +--rw service-info?              string
  augment /nw:networks/nw:network/nw:node/nt:termination-point:
    +--rw (slo-sle-policy)?
       +--:(standard)
       |  +--rw slo-sle-template?         leafref
       +--:(custom)
          +--rw service-slo-sle-policy
             +--rw description?              string
             +--rw metric-bounds
             |  +--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 security*                 identityref
             +--rw isolation?                identityref
             +--rw max-occupancy-level?      uint8
             +--rw mtu?                      uint16
             +--rw steering-constraints
             |  +--rw path-constraints
             |  +--rw service-function
             +--rw optimization-criterion?   identityref
             +--rw resize-requirement?       identityref
             +--rw service-info?             string
  augment /nw:networks/nw:network/nt:link:
    +--rw (slo-sle-policy)?
       +--:(standard)
       |  +--rw slo-sle-template?         leafref
       +--:(custom)
          +--rw service-slo-sle-policy
             +--rw description?              string
             +--rw metric-bounds
             |  +--rw metric-bound* [metric-type]
             |     +--rw metric-type          identityref
             |     +--rw metric-unit          string
             |     +--rw value-description?   string
             |     +--rw percentile-value?    percentile
             |     +--rw bound?               uint64
```

Commented [BMI28]: How is this relevant at the node level?

Commented [BMI29]: The description refers to topology-specific. How this is relevant to a node?

Formatted: Highlight

Formatted: Highlight

Commented [BMI30]: Why not using identityrefs

Formatted: Highlight

Formatted: Highlight

```
                +--rw security*                  identityref
                +--rw isolation?                 identityref
                +--rw max-occupancy-level?       uint8
                +--rw mtu?                       uint16
                +--rw steering-constraints
                |  +--rw path-constraints
                |  +--rw service-function
                |  +--rw disjointness?
                |          te-types:te-path-disjointness
                +--rw optimization-criterion?    identityref
                +--rw resize-requirement?        identityref
                +--rw service-info?              string
```

Figure 3: Tree diagram for network slice topology

6. YANG Modules

```
<CODE BEGINS> file "ietf-ns-topo@2023-03-11.yang"
   module ietf-ns-topo {
     yang-version 1.1;
     namespace
       "urn:ietf:params:xml:ns:yang:ietf-ns-topo";
     prefix "ns-topo";

     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";
     }
     import ietf-te-types {
       prefix "te-types";
       reference
         "RFC 8776: Traffic Engineering Common YANG Types";
     }

     import ietf-network-slice-service {
       prefix "ietf-nss";
       reference
         "draft-ietf-teas-ietf-network-slice-nbi-yang-00:
          IETF Network Slice Service YANG Model";
     }

     organization
       "IETF CCAMP Working Group";
     contact
       "WG Web: <http://tools.ietf.org/wg/ccamp/>
        WG List: <mailto:ccamp@ietf.org>

        Editor: Xufeng Liu
                <mailto:xufeng.liu.ietf@gmail.com>

        Editor: Italo Busi
                <mailto:italo.busi@huawei.com>
```

```
      Editor: Aihua Guo
              <mailto:aihuaguo.ietf@gmail.com>

      Editor: Sergio Belotti
              <mailto:sergio.belotti@nokia.com>

      Editor: Luis M. Contreras
              <mailto:luismiguel.contrerasmurillo@telefonica.com>";

    description
      "This module defines a base YANG data model for configuring
       generic network slices in optical transport networks, e.g.,
       Optical Transport Network (OTN).

       The model fully conforms to the Network Management Datastore
       Architecture (NMDA).

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       identified as authors of the code.  All rights reserved.

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       or without modification, is permitted pursuant to, and
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       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 XXXX; see
       the RFC itself for full legal notices.";

    revision 2023-03-11 {
      description "Initial revision";
      reference
        "RFC XXXX: IETF Network Slice Topology YANG Data Model";
    }

    /*
     * Identities
     */
    identity resize-option {
      description
        "Base identity for link or connectivity resizing options";
    }

    identity resize-none {
      base resize-option;
      description
        "Not resizable";
    }

    identity resize-with-hit {
      base resize-option;
      description
        "Resizable with traffic hits";
    }

    identity resize-hitless {
```

Commented [BMI31]: I guess this was copy/past from another module.

Commented [BMI32]: Already mentioned

Commented [BMI33]: I would elaborate to make the description meaningful.

Commented [BMI34]: That is ?

```
    base resize-option;
    description
      "Hitless resizable";
  }

  /*
   * Groupings
   */

  grouping ns-topo-slo-sle-policy {
    description
      "Policy grouping for Transport Network Slices.";
    leaf optimization-criterion {
        type identityref {
          base te-types:objective-function-type;
        }
        description
          "Optimization criterion applied to this topology.";
    }
    leaf resize-requirement {
      type identityref {
        base resize-option;
      }
      description
        "Indicates resizing requirements";
    }
    leaf service-info {
      type string;
      description
        "Describe type of services running on the slice. It may be
         useful information to help the slice controller to
         optimize resource allocation";
    }
  }

  grouping ns-topo-steering-constraints {
    description
      "Policy grouping for specifying steering constraints for
       Transport Network Slices.";

    leaf disjointness {
      type te-types:te-path-disjointness;
      description
        "Indicate the level of disjointness for slice
         resources.";
    }
  }

  /*
   * Augmented data nodes
   */
  /* network type augments */
  augment "/nw:networks/nw:network/nw:network-types" {
    description
      "Defines the Network Slice topology type.";
    container network-slice {
      presence "Indicates Network Slice topology";
      description
```

Commented [BMI35]: Idem as above. The description is not clear enough.

Commented [BMI36]: Can you provide examples?

Why not using identities for those?

Commented [BMI37]: Weird to have a grouping with one single node.

```
      "Its presence identifies the Network Slice type.";
  }
}

/* network topology augments */
augment "/nw:networks/nw:network" {
  when "./nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment topology configuration and state.";
  uses ietf-nss:service-slo-sle-policy;
}

augment "/nw:networks/nw:network" +
        "/ns-topo:slo-sle-policy" +
        "/ns-topo:custom" +
        "/ns-topo:service-slo-sle-policy" {
  when "../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment topology configuration and state.";
  uses ns-topo-slo-sle-policy;
}

augment "/nw:networks/nw:network" +
        "/ns-topo:slo-sle-policy" +
        "/ns-topo:custom" +
        "/ns-topo:service-slo-sle-policy" +
  "/ns-topo:steering-constraints" {
  when "../../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment topology configuration and state.";
  uses ns-topo-steering-constraints;
}

/* network node augments */
augment "/nw:networks/nw:network/nw:node" {
  when "../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment node configuration and state.";
  uses ietf-nss:service-slo-sle-policy;
}

augment "/nw:networks/nw:network/nw:node" +
        "/ns-topo:slo-sle-policy" +
        "/ns-topo:custom" +
        "/ns-topo:service-slo-sle-policy" {
  when "../../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment node configuration and state.";
  uses ns-topo-slo-sle-policy;
}

augment "/nw:networks/nw:network/nw:node" +
        "/ns-topo:slo-sle-policy" +
```

```
        "/ns-topo:custom" +
        "/ns-topo:service-slo-sle-policy" +
  "/ns-topo:steering-constraints" {
  when "../../../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description
  "Augment IETF network slice services to include steering
     constraints for nodes.";
  uses ns-topo-steering-constraints;
}

/* network node's termination point augments */
augment "/nw:networks/nw:network/nw:node" +
        "/nt:termination-point" {
  when "../../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment node configuration and state.";

uses ietf-nss:service-slo-sle-policy;
}

augment "/nw:networks/nw:network/nw:node" +
        "/nt:termination-point" +
        "/ns-topo:slo-sle-policy" +
        "/ns-topo:custom" +
        "/ns-topo:service-slo-sle-policy" {
  when "../../../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment node configuration and state.";

  uses ns-topo-slo-sle-policy;
}

/* network link augments */
augment "/nw:networks/nw:network/nt:link" {
  when "../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment link configuration and state.";
  uses ietf-nss:service-slo-sle-policy;
}

augment "/nw:networks/nw:network/nt:link" +
        "/ns-topo:slo-sle-policy" +
        "/ns-topo:custom" +
        "/ns-topo:service-slo-sle-policy" {
  when "../../nw:network-types/ns-topo:network-slice" {
    description "Augment only for Network Slice topology.";
  }
  description "Augment link configuration and state.";
  uses ns-topo-slo-sle-policy;
}

augment "/nw:networks/nw:network/nt:link" +
        "/ns-topo:slo-sle-policy" +
```

```
                "/ns-topo:custom" +
                "/ns-topo:service-slo-sle-policy" +
                "/ns-topo:steering-constraints" {
          when "../../../nw:network-types/ns-topo:network-slice" {
            description "Augment only for Network Slice topology.";
          }
          description
          "Augment IETF network slice services to include steering
             constraints for links within a resource-based transport
             network slice.";
          uses ns-topo-steering-constraints;
        }
      }
    <CODE ENDS>
```

Figure 4: YANG model for network slice topology

7. Manageability Considerations

To ensure the security and controllability of physical resource isolation, slice-based independent operation and management are required to achieve management isolation. Each network slice typically requires dedicated accounts, permissions, and resources for independent access and O&M. This mechanism is to guarantee the information isolation among slice tenants and to avoid resource conflicts. The access to slice management functions will only be permitted after successful security checks.

8. Security Considerations

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

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

There are a number of data nodes defined in this YANG module that are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. Considerations in Section 8 of [RFC8795] are also applicable to their subtrees in the module defined in this document.

Commented [BMI38]: You should call out those.

Some of the readable data nodes in this YANG module 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. Considerations in Section 8 of [RFC8795] are also applicable to their subtrees in the module defined in this document.

Commented [BMI39]: You should call out those with specific risks associated with them.

9. IANA Considerations

~~It is proposed to~~This document requests IANA to assign a new URI~~s~~ from the "IETF XML
Registry" [RFC3688] as follows:

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

This document ~~registers~~ requests IANA to register a YANG module in the YANG Module Names
registry [RFC6020].

name: ietf-ns-topo
namespace: urn:ietf:params:xml:ns:yang:ietf-ns-topo
prefix: ns-topo
maintained by IANA: N
reference: RFC XXXX

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Appendix A. Acknowledgments

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Appendix B. Data Tree for the Example in Section 3.1

B.1. Native Topology

This section contains an example of an instance data tree in the JSON encoding [RFC7951]. The example instantiates "ietf-network" for the topology of Network Slice Blue depicted in Figure 2.

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

{
  "ietf-network:networks": {
    "network": [
      {
        "network-id": "example:example-customized-blue-topology",
        "network-types": {
          "ietf-ns-topo:network-slice": {
          }
        },
        "node": [
          {
            "node-id": "example:VR1",
            "ietf-ns-topo:service-slo-sle-policy": {
              "isolation": "ietf-network-slice-service:service-isola\
tion-dedicated",
```

Commented [BMI40]: Should be normative

Commented [BMI41]: There si no data tree in this example.

Commented [BMI42]: ?

Commented [BMI43]: The id is a uri, not string.

Commented [BMI44]: Idem. The type is uri.

```
              "resize-requirement": "resize-hitless"
            },
            "ietf-network-topology:termination-point": [
              {
                "tp-id": "example:1-0-1"
              },
              {
                "tp-id": "example:1-3-1"
              }
            ]
          },
          {
            "node-id": "example:VR3",
            "ietf-ns-topo:service-slo-sle-policy": {
              "isolation": "ietf-network-slice-service:service-isola\
tion-shared",
              "resize-requirement": "resize-hitless"
            },
            "ietf-network-topology:termination-point": [
              {
                "tp-id": "example:3-1-1"
              },
              {
                "tp-id": "example:3-5-1"
              }
            ]
          },
          {
            "node-id": "example:VR5",
            "ietf-ns-topo:service-slo-sle-policy": {
              "isolation": "ietf-network-slice-service:service-isola\
tion-shared",
              "resize-requirement": "resize-hitless"
            },
            "ietf-network-topology:termination-point": [
              {
                "tp-id": "example:5-3-1"
              },
              {
                "tp-id": "example:5-0-1"
              }
            ]
          }
        ],
        "ietf-network-topology:link": [
          {
            "link-id": "example:VR1,example:1-0-1,,",
            "source": {
              "source-node": "example:VR1",
              "source-tp": "example:1-0-1"
            },
            "ietf-ns-topo:service-slo-sle-policy": {
              "metric-bounds": {
                "metric-bound": [
                  {
                    "metric-type": "ietf-network-slice-service:servi\
ce-slo-two-way-delay",
                    "metric-unit": "ms",
```

Commented [BMI45]: Idem as above.

```
                    "bound": 60
                  }
                ]
              },
              "isolation": "ietf-network-slice-service:service-isola\
tion-shared"
            }
          },
          {
            "link-id": ",,VR1,1-0-1",
            "destination": {
              "dest-node": "VR1",
              "dest-tp": "1-0-1"
            },
            "ietf-ns-topo:service-slo-sle-policy": {
              "metric-bounds": {
                "metric-bound": [
                  {
                    "metric-type": "ietf-network-slice-service:servi\
ce-slo-two-way-delay",
                    "metric-unit": "ms",
                    "bound": 60
                  }
                ]
              },
              "isolation": "ietf-network-slice-service:service-isola\
tion-dedicated"
            }
          },
          {
            "link-id": "VR1,1-3-1,VR3,3-1-1",
            "source": {
              "source-node": "VR1",
              "source-tp": "1-3-1"
            },
            "destination": {
              "dest-node": "VR3",
              "dest-tp": "3-1-1"
            },
            "ietf-ns-topo:service-slo-sle-policy": {
              "metric-bounds": {
                "metric-bound": [
                  {
                    "metric-type": "ietf-network-slice-service:servi\
ce-slo-two-way-delay",
                    "metric-unit": "ms",
                    "bound": 30
                  }
                ]
              },
              "isolation": "ietf-network-slice-service:service-isola\
tion-dedicated"
            }
          },
          {
            "link-id": "VR3,3-1-1,VR1,1-3-1",
            "source": {
              "source-node": "VR3",
```

Commented [BMI46]: As you already specified 60ms two-way delay for the reverse link, is it useful to have this one here?

Commented [BMI47]: uris

Commented [BMI48]: uris

Commented [BMI49]: uris

Commented [BMI50]: uris

```
                "source-tp": "3-1-1"
              },
              "destination": {
                "dest-node": "R1",
                "dest-tp": "1-3-1"
              },
              "ietf-ns-topo:service-slo-sle-policy": {
                "metric-bounds": {
                  "metric-bound": [
                    {
                      "metric-type": "ietf-network-slice-service:servi\
ce-slo-two-way-delay",
                      "metric-unit": "ms",
                      "bound": 30
                    }
                  ]
                },
                "isolation": "ietf-network-slice-service:service-isola\
tion-dedicated"
              }
            },
            {
              "link-id": "VR3,3-5-1,VR5,5-3-1",
              "source": {
                "source-node": "VR3",
                "source-tp": "3-5-1"
              },
              "destination": {
                "dest-node": "VR5",
                "dest-tp": "5-3-1"
              },
              "ietf-ns-topo:service-slo-sle-policy": {
                "metric-bounds": {
                  "metric-bound": [
                    {
                      "metric-type": "ietf-network-slice-service:servi\
ce-slo-two-way-delay",
                      "metric-unit": "ms",
                      "bound": 35
                    }
                  ]
                },
                "isolation": "ietf-network-slice-service:service-isola\
tion-dedicated"
              }
            },
            {
              "link-id": "VR5,5-3-1,VR3,3-5-1",
              "source": {
                "source-node": "VR5",
                "source-tp": "5-3-1"
              },
              "destination": {
                "dest-node": "VR3",
                "dest-tp": "3-5-1"
              },
              "ietf-ns-topo:service-slo-sle-policy": {
                "metric-bounds": {
```


Commented [BMI51]: as the metric is two-way delay, is it useful to have both directions included here?

```
                "metric-bound": [
                  {
                    "metric-type": "ietf-network-slice-service:servi\
ce-slo-two-way-delay",
                    "metric-unit": "ms",
                    "bound": 35
                  }
                ]
              },
              "isolation": "ietf-network-slice-service:service-isola\
tion-dedicated"
            }
          },
          {
            "link-id": "VR5,5-0-1,,",
            "source": {
              "source-node": "VR5",
              "source-tp": "5-0-1"
            },
            "ietf-ns-topo:service-slo-sle-policy": {
              "metric-bounds": {
                "metric-bound": [
                  {
                    "metric-type": "ietf-network-slice-service:servi\
ce-slo-two-way-delay",
                    "metric-unit": "ms",
                    "bound": 25
                  }
                ]
              },
              "isolation": "ietf-network-slice-service:service-isola\
tion-dedicated"
            }
          },
          {
            "link-id": ",,VR5,5-0-1",
            "destination": {
              "dest-node": "VR5",
              "dest-tp": "5-0-1"
            },
            "ietf-ns-topo:service-slo-sle-policy": {
              "metric-bounds": {
                "metric-bound": [
                  {
                    "metric-type": "ietf-network-slice-service:servi\
ce-slo-two-way-delay",
                    "metric-unit": "ms",
                    "bound": 25
                  }
                ]
              },
              "isolation": "ietf-network-slice-service:service-isola\
tion-dedicated"
            }
          }
        ],
        "ietf-ns-topo:service-slo-sle-policy": {
          "isolation": "ietf-network-slice-service:service-isolation\
```

```
    -dedicated",
              "optimization-criterion": "ietf-te-types:of-minimize-cost-\
    path"
            }
          }
        ]
      }
    }
```

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