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H. Zheng
I. Busi
Huawei Technologies
S. Belotti
V. Lopez
Nokia
Y. Xu
CAICT

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A YANG Data Model for Optical Transport Network (OTN) Tunnels and Label Switched Paths
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Abstract

This document describes the YANG data model for tunnels in OTN TE networks. The model can be used to do the configuration in order to establish the tunnel in OTN network. This work is independent with the control plane protocols.

About This Document

This note is to be removed before publishing as an RFC.

Status information for this document may be found at https://datatracker.ietf.org/doc/draft-ietf-ccamp-otn-tunnel-model/.

Discussion of this document takes place on the Common Control and Measurement Plane Working Group mailing list (mailto:ccamp@ietf.org), which is archived at https://mailarchive.ietf.org/arch/browse/ccamp/. Subscribe at https://www.ietf.org/mailman/listinfo/ccamp/.

Source for this draft and an issue tracker can be found at https://github.com/haomianzheng/IETF-ACTN-YANG-Model.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

OTN transport networks, specified in [ITU-T_G.709], can carry various types of client signals. In many cases, the client signal is carried over an OTN tunnel across connected domains in a multi-domain network.

This document provides YANG model for creating OTN tunnel. The model augments the generic TE Tunnel model specified in [I-D.ietf-teas-yang-te].

The YANG module ietf-otn-tunnel defined in this document conforms to the Network Management Datastore Architecture (NMDA) defined in [RFC8342].

1.1. Terminology and Notations

Refer to [I-D.ietf-ccamp-otn-topo-yang] for the OTN specific terms terms used in this document.

The following terms are defined in [RFC7950] and are not redefined here:

* client
* server
* augment
* data model
* data node

The following terms are defined in [RFC6241] and are not redefined here:

* configuration data
* state data

The terminology for describing YANG data models is found in [RFC7950].

1.2. Tree Diagram

A simplified graphical representation of the data model is used in Section 3 of this this document. The meaning of the symbols in these diagrams is defined in [RFC8340].

1.3. Prefix 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 the following table.

Prefix	YANG module	Reference
l1-types	ietf-layer1-types	[RFC YYYY]
otn-tnl	ietf-otn-tunnel	RFC XXXX
te	ietf-te	[RFC ZZZZ]

Table 1: Prefixes and corresponding YANG modules

RFC Editor Note: Please replace XXXX with the number assigned to the RFC once this draft becomes an RFC. Please replace YYYY with the RFC numbers assigned to [I-D.ietf-ccamp-layer1-types]. Please replace ZZZZ with the RFC numbers assigned to [I-D.ietf-teas-yang-te].

2. OTN Tunnel Model Description

2.1. Overview of OTN Tunnel Model

This document aims to describe the data model for OTN tunnel. The OTN tunnel model is using TE tunnel [I-D.ietf-teas-yang-te] as a basic model and augments it with OTN-specific parameters, including the bandwidth information and label information. Figure 1 shows the augmentation relationship.

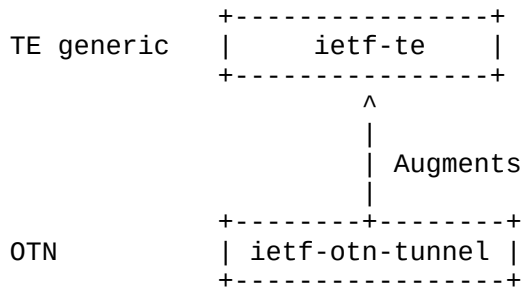

Figure 1: Relationship between OTN and TE tunnel models

It is also worth noting that the OTN tunnel provisioning is usually based on the OTN topology. Therefore the OTN tunnel model is usually used together with OTN topology model specified in [I-D.ietf-ccamp-otn-topo-yang]. The OTN tunnel model also imports a few type modules, including ietf-layer1-types, ietf-te-types and ietf-inet-types. The OTN-specific attributes in [RFC7139], including the Tributary Slot (TS) and Tributary Port Number (TPN), can be used

to represent the bandwidth and label information. These attributes have been specified in [I-D.ietf-ccamp-layer1-types] and used in this document for augmentation of the generic TE tunnel model.

More scenarios and model applications can be found in [I-D.ietf-ccamp-transport-nbi-app-statement] and [I-D.ietf-teas-actn-yang].

2.2. Bandwidth Augmentation

The model augments all the occurrences of the te-bandwidth container with the OTN technology specific attributes using the otn-link-bandwidth and otn-path-bandwidth groupings defined in [I-D.ietf-ccamp-layer1-types].

2.3. Label Augmentation

The model augments all the occurrences of the label-restriction list with OTN technology specific attributes using the otn-label-range-info grouping defined in [I-D.ietf-ccamp-layer1-types].

Moreover, the model augments all the occurrences of the te-label container with the OTN technology specific attributes using the otn-label-start-end, otn-label-hop and otn-label-step groupings defined in [I-D.ietf-ccamp-layer1-types].

3. OTN Tunnel YANG Tree

module: ietf-otn-tunnel

```
  augment /te:te/te:globals/te:named-path-constraints
            /te:named-path-constraint/te:te-bandwidth/te:technology:
    +--:(otn)
       +--rw otn-bandwidth
          +--rw odu-type?                    identityref
          +--rw (oduflex-type)?
             +--:(generic)
             |  +--rw nominal-bit-rate       union
             +--:(cbr)
             |  +--rw client-type            identityref
             +--:(gfp-n-k)
             |  +--rw gfp-n                  uint8
             |  +--rw gfp-k?                 gfp-k
             +--:(flexe-client)
             |  +--rw flexe-client           flexe-client-rate
             +--:(flexe-aware)
             |  +--rw flexe-aware-n          uint16
             +--:(packet)
```

```
               +--rw opuflex-payload-rate    union
     augment /te:te/te:tunnels/te:tunnel/te:te-bandwidth/te:technology:
       +--:(otn)
          +--rw otn-bandwidth
             +--rw odu-type?                    identityref
             +--rw (oduflex-type)?
                +--:(generic)
                |  +--rw nominal-bit-rate        union
                +--:(cbr)
                |  +--rw client-type             identityref
                +--:(gfp-n-k)
                |  +--rw gfp-n                   uint8
                |  +--rw gfp-k?                  gfp-k
                +--:(flexe-client)
                |  +--rw flexe-client            flexe-client-rate
                +--:(flexe-aware)
                |  +--rw flexe-aware-n           uint16
                +--:(packet)
                   +--rw opuflex-payload-rate    union
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:te-bandwidth/te:technology:
       +--:(otn)
          +--rw otn-bandwidth
             +--rw odu-type?                    identityref
             +--rw (oduflex-type)?
                +--:(generic)
                |  +--rw nominal-bit-rate        union
                +--:(cbr)
                |  +--rw client-type             identityref
                +--:(gfp-n-k)
                |  +--rw gfp-n                   uint8
                |  +--rw gfp-k?                  gfp-k
                +--:(flexe-client)
                |  +--rw flexe-client            flexe-client-rate
                +--:(flexe-aware)
                |  +--rw flexe-aware-n           uint16
                +--:(packet)
                   +--rw opuflex-payload-rate    union
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:computed-paths-properties
               /te:computed-path-properties/te:path-properties
               /te:te-bandwidth/te:technology:
       +--:(otn)
          +--ro otn-bandwidth
             +--ro odu-type?                    identityref
             +--ro (oduflex-type)?
                +--:(generic)
                |  +--ro nominal-bit-rate        union
```

```
               +--:(cbr)
               |  +--ro client-type             identityref
               +--:(gfp-n-k)
               |  +--ro gfp-n                   uint8
               |  +--ro gfp-k?                  gfp-k
               +--:(flexe-client)
               |  +--ro flexe-client            flexe-client-rate
               +--:(flexe-aware)
               |  +--ro flexe-aware-n           uint16
               +--:(packet)
                  +--ro opuflex-payload-rate    union
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path/te:te-bandwidth
               /te:technology:
       +--:(otn)
          +--rw otn-bandwidth
             +--rw odu-type?                    identityref
             +--rw (oduflex-type)?
                +--:(generic)
                |  +--rw nominal-bit-rate       union
                +--:(cbr)
                |  +--rw client-type            identityref
                +--:(gfp-n-k)
                |  +--rw gfp-n                  uint8
                |  +--rw gfp-k?                 gfp-k
                +--:(flexe-client)
                |  +--rw flexe-client           flexe-client-rate
                +--:(flexe-aware)
                |  +--rw flexe-aware-n          uint16
                +--:(packet)
                   +--rw opuflex-payload-rate   union
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:computed-paths-properties/te:computed-path-properties
               /te:path-properties/te:te-bandwidth/te:technology:
       +--:(otn)
          +--ro otn-bandwidth
             +--ro odu-type?                    identityref
             +--ro (oduflex-type)?
                +--:(generic)
                |  +--ro nominal-bit-rate       union
                +--:(cbr)
                |  +--ro client-type            identityref
                +--:(gfp-n-k)
                |  +--ro gfp-n                  uint8
                |  +--ro gfp-k?                 gfp-k
                +--:(flexe-client)
                |  +--ro flexe-client           flexe-client-rate
```

```
               +--:(flexe-aware)
               |  +--ro flexe-aware-n           uint16
               +--:(packet)
                  +--ro opuflex-payload-rate    union
     augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
               /te:secondary-path/te:te-bandwidth/te:technology:
       +--:(otn)
          +--rw otn-bandwidth
             +--rw odu-type?                    identityref
             +--rw (oduflex-type)?
                +--:(generic)
                |  +--rw nominal-bit-rate       union
                +--:(cbr)
                |  +--rw client-type            identityref
                +--:(gfp-n-k)
                |  +--rw gfp-n                  uint8
                |  +--rw gfp-k?                 gfp-k
                +--:(flexe-client)
                |  +--rw flexe-client           flexe-client-rate
                +--:(flexe-aware)
                |  +--rw flexe-aware-n          uint16
                +--:(packet)
                   +--rw opuflex-payload-rate   union
     augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
               /te:secondary-path/te:computed-paths-properties
               /te:computed-path-properties/te:path-properties
               /te:te-bandwidth/te:technology:
       +--:(otn)
          +--ro otn-bandwidth
             +--ro odu-type?                    identityref
             +--ro (oduflex-type)?
                +--:(generic)
                |  +--ro nominal-bit-rate       union
                +--:(cbr)
                |  +--ro client-type            identityref
                +--:(gfp-n-k)
                |  +--ro gfp-n                  uint8
                |  +--ro gfp-k?                 gfp-k
                +--:(flexe-client)
                |  +--ro flexe-client           flexe-client-rate
                +--:(flexe-aware)
                |  +--ro flexe-aware-n          uint16
                +--:(packet)
                   +--ro opuflex-payload-rate   union
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:te-bandwidth/te:technology:
       +--:(otn)
          +--rw otn-bandwidth
```

```
            +--rw odu-type?                      identityref
            +--rw (oduflex-type)?
               +--:(generic)
               |  +--rw nominal-bit-rate        union
               +--:(cbr)
               |  +--rw client-type             identityref
               +--:(gfp-n-k)
               |  +--rw gfp-n                   uint8
               |  +--rw gfp-k?                  gfp-k
               +--:(flexe-client)
               |  +--rw flexe-client            flexe-client-rate
               +--:(flexe-aware)
               |  +--rw flexe-aware-n           uint16
               +--:(packet)
                  +--rw opuflex-payload-rate    union
    augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
              /te:secondary-reverse-path/te:computed-paths-properties
              /te:computed-path-properties/te:path-properties
              /te:te-bandwidth/te:technology:
      +--:(otn)
         +--ro otn-bandwidth
            +--ro odu-type?                      identityref
            +--ro (oduflex-type)?
               +--:(generic)
               |  +--ro nominal-bit-rate        union
               +--:(cbr)
               |  +--ro client-type             identityref
               +--:(gfp-n-k)
               |  +--ro gfp-n                   uint8
               |  +--ro gfp-k?                  gfp-k
               +--:(flexe-client)
               |  +--ro flexe-client            flexe-client-rate
               +--:(flexe-aware)
               |  +--ro flexe-aware-n           uint16
               +--:(packet)
                  +--ro opuflex-payload-rate    union
    augment /te:te/te:globals/te:named-path-constraints
              /te:named-path-constraint/te:path-in-segment
              /te:label-restrictions/te:label-restriction:
      +--rw otn-label-range
         +--rw range-type?      otn-label-range-type
         +--rw tsg?             identityref
         +--rw odu-type-list*   identityref
         +--rw priority?        uint8
    augment /te:te/te:globals/te:named-path-constraints
              /te:named-path-constraint/te:path-out-segment
              /te:label-restrictions/te:label-restriction:
      +--rw otn-label-range
```

```
        +--rw range-type?      otn-label-range-type
        +--rw tsg?             identityref
        +--rw odu-type-list*   identityref
        +--rw priority?        uint8
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:path-in-segment/te:label-restrictions
              /te:label-restriction:
      +--rw otn-label-range
        +--rw range-type?      otn-label-range-type
        +--rw tsg?             identityref
        +--rw odu-type-list*   identityref
        +--rw priority?        uint8
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:path-out-segment
              /te:label-restrictions/te:label-restriction:
      +--rw otn-label-range
        +--rw range-type?      otn-label-range-type
        +--rw tsg?             identityref
        +--rw odu-type-list*   identityref
        +--rw priority?        uint8
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:primary-reverse-path
              /te:path-in-segment/te:label-restrictions
              /te:label-restriction:
      +--rw otn-label-range
        +--rw range-type?      otn-label-range-type
        +--rw tsg?             identityref
        +--rw odu-type-list*   identityref
        +--rw priority?        uint8
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:primary-reverse-path
              /te:path-out-segment/te:label-restrictions
              /te:label-restriction:
      +--rw otn-label-range
        +--rw range-type?      otn-label-range-type
        +--rw tsg?             identityref
        +--rw odu-type-list*   identityref
        +--rw priority?        uint8
    augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
              /te:secondary-path/te:path-in-segment
              /te:label-restrictions/te:label-restriction:
      +--rw otn-label-range
        +--rw range-type?      otn-label-range-type
        +--rw tsg?             identityref
        +--rw odu-type-list*   identityref
        +--rw priority?        uint8
    augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
              /te:secondary-path/te:path-out-segment
```

```
            /te:label-restrictions/te:label-restriction:
      +--rw otn-label-range
         +--rw range-type?      otn-label-range-type
         +--rw tsg?             identityref
         +--rw odu-type-list*   identityref
         +--rw priority?        uint8
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
            /te:secondary-reverse-path/te:path-in-segment
            /te:label-restrictions/te:label-restriction:
      +--rw otn-label-range
         +--rw range-type?      otn-label-range-type
         +--rw tsg?             identityref
         +--rw odu-type-list*   identityref
         +--rw priority?        uint8
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
            /te:secondary-reverse-path/te:path-out-segment
            /te:label-restrictions/te:label-restriction:
      +--rw otn-label-range
         +--rw range-type?      otn-label-range-type
         +--rw tsg?             identityref
         +--rw odu-type-list*   identityref
         +--rw priority?        uint8
     augment /te:te/te:globals/te:named-path-constraints
            /te:named-path-constraint/te:explicit-route-objects
            /te:route-object-exclude-always/te:type/te:label
            /te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?       otn-tpn
            +--rw tsg?       identityref
            +--rw ts-list?   string
     augment /te:te/te:globals/te:named-path-constraints
            /te:named-path-constraint/te:explicit-route-objects
            /te:route-object-include-exclude/te:type/te:label
            /te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?       otn-tpn
            +--rw tsg?       identityref
            +--rw ts-list?   string
     augment /te:te/te:globals/te:named-path-constraints
            /te:named-path-constraint/te:path-in-segment
            /te:label-restrictions/te:label-restriction
            /te:label-start/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
```

```
augment /te:te/te:globals/te:named-path-constraints
          /te:named-path-constraint/te:path-in-segment
          /te:label-restrictions/te:label-restriction/te:label-end
          /te:te-label/te:technology:
  +--:(otn)
     +--rw otn-label
        +--rw tpn?   otn-tpn
        +--rw ts?    otn-ts
augment /te:te/te:globals/te:named-path-constraints
          /te:named-path-constraint/te:path-in-segment
          /te:label-restrictions/te:label-restriction/te:label-step
          /te:technology:
  +--:(otn)
     +--rw otn-label-step
        +--rw tpn?   otn-tpn
        +--rw ts?    otn-ts
augment /te:te/te:globals/te:named-path-constraints
          /te:named-path-constraint/te:path-out-segment
          /te:label-restrictions/te:label-restriction
          /te:label-start/te:te-label/te:technology:
  +--:(otn)
     +--rw otn-label
        +--rw tpn?   otn-tpn
        +--rw ts?    otn-ts
augment /te:te/te:globals/te:named-path-constraints
          /te:named-path-constraint/te:path-out-segment
          /te:label-restrictions/te:label-restriction/te:label-end
          /te:te-label/te:technology:
  +--:(otn)
     +--rw otn-label
        +--rw tpn?   otn-tpn
        +--rw ts?    otn-ts
augment /te:te/te:globals/te:named-path-constraints
          /te:named-path-constraint/te:path-out-segment
          /te:label-restrictions/te:label-restriction/te:label-step
          /te:technology:
  +--:(otn)
     +--rw otn-label-step
        +--rw tpn?   otn-tpn
        +--rw ts?    otn-ts
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
          /te:primary-path/te:optimizations/te:algorithm/te:metric
          /te:optimization-metric/te:explicit-route-exclude-objects
          /te:route-object-exclude-object/te:type/te:label
          /te:label-hop/te:te-label/te:technology:
  +--:(otn)
     +--rw otn-label
        +--rw tpn?       otn-tpn
```

```
          +--rw tsg?       identityref
          +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:optimizations/te:algorithm/te:metric
               /te:optimization-metric/te:explicit-route-include-objects
               /te:route-object-include-object/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:explicit-route-objects
               /te:route-object-exclude-always/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:explicit-route-objects
               /te:route-object-include-exclude/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:path-in-segment/te:label-restrictions
               /te:label-restriction/te:label-start/te:te-label
               /te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:path-in-segment/te:label-restrictions
               /te:label-restriction/te:label-end/te:te-label
               /te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:path-in-segment/te:label-restrictions
```

```
            /te:label-restriction/te:label-step/te:technology:
      +--:(otn)
         +--rw otn-label-step
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:path-out-segment
              /te:label-restrictions/te:label-restriction
              /te:label-start/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:path-out-segment
              /te:label-restrictions/te:label-restriction/te:label-end
              /te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:path-out-segment
              /te:label-restrictions/te:label-restriction/te:label-step
              /te:technology:
      +--:(otn)
         +--rw otn-label-step
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:computed-paths-properties
              /te:computed-path-properties/te:path-properties
              /te:path-route-objects/te:path-route-object/te:type
              /te:label/te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--ro otn-label
            +--ro tpn?       otn-tpn
            +--ro tsg?       identityref
            +--ro ts-list?   string
    augment /te:te/te:tunnels/te:tunnel/te:primary-paths
              /te:primary-path/te:primary-reverse-path/te:optimizations
              /te:algorithm/te:metric/te:optimization-metric
              /te:explicit-route-exclude-objects
              /te:route-object-exclude-object/te:type/te:label
              /te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?       otn-tpn
```

```
          +--rw tsg?       identityref
          +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path/te:optimizations
               /te:algorithm/te:metric/te:optimization-metric
               /te:explicit-route-include-objects
               /te:route-object-include-object/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:explicit-route-objects/te:route-object-exclude-always
               /te:type/te:label/te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:explicit-route-objects
               /te:route-object-include-exclude/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:path-in-segment/te:label-restrictions
               /te:label-restriction/te:label-start/te:te-label
               /te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:path-in-segment/te:label-restrictions
               /te:label-restriction/te:label-end/te:te-label
               /te:technology:
       +--:(otn)
          +--rw otn-label
```

```
          +--rw tpn?   otn-tpn
          +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:path-in-segment/te:label-restrictions
               /te:label-restriction/te:label-step/te:technology:
       +--:(otn)
          +--rw otn-label-step
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:path-out-segment/te:label-restrictions
               /te:label-restriction/te:label-start/te:te-label
               /te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:path-out-segment/te:label-restrictions
               /te:label-restriction/te:label-end/te:te-label
               /te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:path-out-segment/te:label-restrictions
               /te:label-restriction/te:label-step/te:technology:
       +--:(otn)
          +--rw otn-label-step
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:primary-paths
               /te:primary-path/te:primary-reverse-path
               /te:computed-paths-properties/te:computed-path-properties
               /te:path-properties/te:path-route-objects
               /te:path-route-object/te:type/te:label/te:label-hop
               /te:te-label/te:technology:
       +--:(otn)
          +--ro otn-label
             +--ro tpn?       otn-tpn
             +--ro tsg?       identityref
             +--ro ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
```

```
            /te:secondary-path/te:optimizations/te:algorithm
            /te:metric/te:optimization-metric
            /te:explicit-route-exclude-objects
            /te:route-object-exclude-object/te:type/te:label
            /te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?       otn-tpn
            +--rw tsg?       identityref
            +--rw ts-list?   string
   augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:optimizations/te:algorithm
            /te:metric/te:optimization-metric
            /te:explicit-route-include-objects
            /te:route-object-include-object/te:type/te:label
            /te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?       otn-tpn
            +--rw tsg?       identityref
            +--rw ts-list?   string
   augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:explicit-route-objects
            /te:route-object-exclude-always/te:type/te:label
            /te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?       otn-tpn
            +--rw tsg?       identityref
            +--rw ts-list?   string
   augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:explicit-route-objects
            /te:route-object-include-exclude/te:type/te:label
            /te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?       otn-tpn
            +--rw tsg?       identityref
            +--rw ts-list?   string
   augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:path-in-segment
            /te:label-restrictions/te:label-restriction
            /te:label-start/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
   augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
```

```
            /te:secondary-path/te:path-in-segment
            /te:label-restrictions/te:label-restriction/te:label-end
            /te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:path-in-segment
            /te:label-restrictions/te:label-restriction/te:label-step
            /te:technology:
      +--:(otn)
         +--rw otn-label-step
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:path-out-segment
            /te:label-restrictions/te:label-restriction
            /te:label-start/te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:path-out-segment
            /te:label-restrictions/te:label-restriction/te:label-end
            /te:te-label/te:technology:
      +--:(otn)
         +--rw otn-label
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:path-out-segment
            /te:label-restrictions/te:label-restriction/te:label-step
            /te:technology:
      +--:(otn)
         +--rw otn-label-step
            +--rw tpn?   otn-tpn
            +--rw ts?    otn-ts
    augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
            /te:secondary-path/te:computed-paths-properties
            /te:computed-path-properties/te:path-properties
            /te:path-route-objects/te:path-route-object/te:type
            /te:label/te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--ro otn-label
            +--ro tpn?       otn-tpn
            +--ro tsg?       identityref
```

```
          +--ro ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:optimizations/te:algorithm
               /te:metric/te:optimization-metric
               /te:explicit-route-exclude-objects
               /te:route-object-exclude-object/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:optimizations/te:algorithm
               /te:metric/te:optimization-metric
               /te:explicit-route-include-objects
               /te:route-object-include-object/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:explicit-route-objects
               /te:route-object-exclude-always/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:explicit-route-objects
               /te:route-object-include-exclude/te:type/te:label
               /te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?       otn-tpn
             +--rw tsg?       identityref
             +--rw ts-list?   string
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:path-in-segment
               /te:label-restrictions/te:label-restriction
               /te:label-start/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
```

```
          +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:path-in-segment
               /te:label-restrictions/te:label-restriction/te:label-end
               /te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:path-in-segment
               /te:label-restrictions/te:label-restriction/te:label-step
               /te:technology:
       +--:(otn)
          +--rw otn-label-step
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:path-out-segment
               /te:label-restrictions/te:label-restriction
               /te:label-start/te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:path-out-segment
               /te:label-restrictions/te:label-restriction/te:label-end
               /te:te-label/te:technology:
       +--:(otn)
          +--rw otn-label
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:path-out-segment
               /te:label-restrictions/te:label-restriction/te:label-step
               /te:technology:
       +--:(otn)
          +--rw otn-label-step
             +--rw tpn?   otn-tpn
             +--rw ts?    otn-ts
     augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
               /te:secondary-reverse-path/te:computed-paths-properties
               /te:computed-path-properties/te:path-properties
               /te:path-route-objects/te:path-route-object/te:type
               /te:label/te:label-hop/te:te-label/te:technology:
       +--:(otn)
          +--ro otn-label
```

```
            +--ro tpn?       otn-tpn
            +--ro tsg?       identityref
            +--ro ts-list?   string
    augment /te:te/te:lsps/te:lsp/te:lsp-actual-route-information
              /te:lsp-actual-route-information/te:type/te:label
              /te:label-hop/te:te-label/te:technology:
      +--:(otn)
         +--ro otn-label
            +--ro tpn?       otn-tpn
            +--ro tsg?       identityref
            +--ro ts-list?   string
```

Figure 2

4. OTN Tunnel YANG Code

```
<CODE BEGINS> file "ietf-otn-tunnel@2024-03-21.yang"
module ietf-otn-tunnel {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-otn-tunnel";
  prefix "otn-tnl";

  import ietf-te {
    prefix "te";
    reference
      "RFC ZZZZ: A YANG Data Model for Traffic Engineering Tunnels
      and Interfaces.";
  }
  /* Note: The RFC Editor will replace ZZZZ with the number assigned
     to the RFC once draft-ietf-teas-yang-te becomes an RFC.*/

  import ietf-layer1-types {
    prefix "l1-types";
    reference
      "RFC YYYY: Common YANG Data Types for Layer 1 Networks.";
  }
  /* Note: The RFC Editor will replace YYYY with the number assigned
     to the RFC once draft-ietf-ccamp-layer1-types becomes an RFC.*/

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

     Editor:   Haomian Zheng
               <mailto:zhenghaomian@huawei.com>
```

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

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

        Editor:   Victor Lopez
                  <mailto:victor.lopez@nokia.com>

        Editor:   Yunbin Xu
                  <mailto:xuyunbin@caict.ac.cn>";

     description
       "This module defines a model for OTN Tunnel Services.

       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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       without modification, is permitted pursuant to, and subject
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       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 "2024-03-21" {
       description
         "Initial version";
       reference
         "RFC XXXX: A YANG Data Model for Optical Transport Network
         (OTN) Tunnels and Label Switched Paths";
       // RFC Ed.: replace XXXX with actual RFC number, update date
       // information and remove this note
     }

    /*
     * Data nodes
     */

     /*
      * Augment TE bandwidth
      */
```

```
    augment "/te:te/te:globals/te:named-path-constraints/"
          + "te:named-path-constraint/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the named path constraint.";
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the tunnel.";
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the primary path.";
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:computed-paths-properties/"
          + "te:computed-path-properties/te:path-properties/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of primary path's computed path
        properties.";
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the primary reverse path.";
```

```
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
          + "te:computed-paths-properties/"
          + "te:computed-path-properties/te:path-properties/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the primary reverse path's computed
        path properties.";
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the secondary path.";
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:computed-paths-properties/"
          + "te:computed-path-properties/te:path-properties/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the secondary path's computed path
        properties.";
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/"
          + "te:secondary-reverse-path/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the secondary reverse path.";
```

```
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/"
          + "te:secondary-reverse-path/"
          + "te:computed-paths-properties/"
          + "te:computed-path-properties/te:path-properties/"
          + "te:te-bandwidth/te:technology" {
      description
        "Augment TE bandwidth of the secondary reverse path's computed
        path properties.";
      case otn {
        uses l1-types:otn-path-bandwidth;
      }
    }

    /*
     * Augment TE label range information
     */

    augment "/te:te/te:globals/te:named-path-constraints/"
          + "te:named-path-constraint/te:path-in-segment/"
          + "te:label-restrictions/te:label-restriction" {
      description
        "Augment TE label range information for the ingress segment
        of the named path constraint.";
      uses l1-types:otn-label-range-info;
    }

    augment "/te:te/te:globals/te:named-path-constraints/"
          + "te:named-path-constraint/te:path-out-segment/"
          + "te:label-restrictions/"
          + "te:label-restriction" {
      description
        "Augment TE label range information for the egress segment
        of the named path constraint.";
      uses l1-types:otn-label-range-info;
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction" {
      description
        "Augment TE label range information for the ingress segment
```

```
        of the primay path.";
      uses l1-types:otn-label-range-info;
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction" {
      description
        "Augment TE label range information for the egress segment
        of the primay path.";
      uses l1-types:otn-label-range-info;
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction" {
      description
        "Augment TE label range information for the ingress segment
        of the primay reverse path.";
      uses l1-types:otn-label-range-info;
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction" {
      description
        "Augment TE label range information for the egress segment
        of the primay reverse path.";
      uses l1-types:otn-label-range-info;
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction" {
      description
        "Augment TE label range information for the ingress segment
        of the secondary path.";
      uses l1-types:otn-label-range-info;
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
```

```
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction" {
        description
          "Augment TE label range information for the egress segment
          of the secondary path.";
        uses l1-types:otn-label-range-info;
      }

      augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction" {
        description
          "Augment TE label range information for the ingress segment
          of the secondary reverse path.";
        uses l1-types:otn-label-range-info;
      }

      augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction" {
        description
          "Augment TE label range information for the egress segment
          of the secondary reverse path.";
        uses l1-types:otn-label-range-info;
      }

      /*
       * Augment TE label.
       */

      augment "/te:te/te:globals/te:named-path-constraints/"
          + "te:named-path-constraint/"
          + "te:explicit-route-objects/"
          + "te:route-object-exclude-always/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
        description
          "Augment TE label hop for the explicit route objects always
          excluded by the path computation with the named path
          constraint.";
        case otn {
          uses l1-types:otn-label-hop;
        }
      }

      augment "/te:te/te:globals/te:named-path-constraints/"
          + "te:named-path-constraint/"
```

```
          + "te:explicit-route-objects/"
          + "te:route-object-include-exclude/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
        description
          "Augment TE label hop for the explicit route objects included
          or excluded by the path computation with the named path
          constraint.";
        case otn {
          uses l1-types:otn-label-hop;
        }
      }

      augment "/te:te/te:globals/te:named-path-constraints/"
            + "te:named-path-constraint/te:path-in-segment/"
            + "te:label-restrictions/"
            + "te:label-restriction/te:label-start/"
            + "te:te-label/te:technology" {
        description
          "Augment TE label range start for the ingress segment
          of the named path constraint.";
        case otn {
          uses l1-types:otn-label-start-end;
        }
      }

      augment "/te:te/te:globals/te:named-path-constraints/"
            + "te:named-path-constraint/te:path-in-segment/"
            + "te:label-restrictions/"
            + "te:label-restriction/te:label-end/"
            + "te:te-label/te:technology" {
        description
          "Augment TE label range end for the ingress segment
          of the named path constraint.";
        case otn {
          uses l1-types:otn-label-start-end;
        }
      }

      augment "/te:te/te:globals/te:named-path-constraints/"
            + "te:named-path-constraint/te:path-in-segment/"
            + "te:label-restrictions/te:label-restriction/"
            + "te:label-step/te:technology" {
        description
          "Augment TE label range step for the ingress segment
          of the named path constraint.";
        case otn {
          uses l1-types:otn-label-step;
        }
```

```
    }

    augment "/te:te/te:globals/te:named-path-constraints/"
          + "te:named-path-constraint/te:path-out-segment/"
          + "te:label-restrictions/"
          + "te:label-restriction/te:label-start/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range start for the egress segment
        of the named path constraint.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:globals/te:named-path-constraints/"
          + "te:named-path-constraint/te:path-out-segment/"
          + "te:label-restrictions/"
          + "te:label-restriction/te:label-end/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range end for the egress segment
        of the named path constraint.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:globals/te:named-path-constraints/"
          + "te:named-path-constraint/te:path-out-segment/"
          + "te:label-restrictions/te:label-restriction/"
          + "te:label-step/te:technology" {
      description
        "Augment TE label range step for the egress segment
        of the named path constraint.";
      case otn {
        uses l1-types:otn-label-step;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:optimizations/te:algorithm/te:metric/"
          + "te:optimization-metric/te:explicit-route-exclude-objects/"
          + "te:route-object-exclude-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the optimization of the explicit
```

```
        route objects excluded by the path computation of the primary
        path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:optimizations/te:algorithm/te:metric/"
          + "te:optimization-metric/te:explicit-route-include-objects/"
          + "te:route-object-include-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the optimization of the explicit
        route objects included by the path computation of the primary
        path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:explicit-route-objects/"
          + "te:route-object-exclude-always/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the explicit route objects always
        excluded by the path computation of the primary path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:explicit-route-objects/"
          + "te:route-object-include-exclude/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the explicit route objects included
        or excluded by the path computation of the primary path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }
```

```
    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-start/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range start for the ingress segment
        of the primay path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-end/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range end for the ingress segment
        of the primay path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-step/te:technology" {
      description
        "Augment TE label range step for the ingress segment
        of the primay path.";
      case otn {
        uses l1-types:otn-label-step;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-start/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range start for the egress segment
        of the primay path.";
      case otn {
        uses l1-types:otn-label-start-end;
```

```
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-end/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range end for the egress segment
        of the primay path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-step/te:technology" {
      description
        "Augment TE label range end for the egress segment
        of the primay path.";
      case otn {
        uses l1-types:otn-label-step;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:computed-paths-properties/"
          + "te:computed-path-properties/te:path-properties/"
          + "te:path-route-objects/te:path-route-object/"
          + "te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the route object of the computed
        primary path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
          + "te:optimizations/te:algorithm/te:metric/"
          + "te:optimization-metric/te:explicit-route-exclude-objects/"
```

```
          + "te:route-object-exclude-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
        description
          "Augment TE label hop for the optimization of the explicit
          route objects excluded by the path computation of the primary
          reverse path.";
        case otn {
          uses l1-types:otn-label-hop;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:primary-paths/te:primary-path/"
            + "te:primary-reverse-path/"
            + "te:optimizations/te:algorithm/te:metric/"
            + "te:optimization-metric/te:explicit-route-include-objects/"
            + "te:route-object-include-object/te:type/te:label/"
            + "te:label-hop/te:te-label/te:technology" {
        description
          "Augment TE label hop for the optimization of the explicit
          route objects included by the path computation of the primary
          reverse path.";
        case otn {
          uses l1-types:otn-label-hop;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:primary-paths/te:primary-path/"
            + "te:primary-reverse-path/"
            + "te:explicit-route-objects/"
            + "te:route-object-exclude-always/"
            + "te:type/te:label/"
            + "te:label-hop/te:te-label/te:technology" {
        description
          "Augment TE label hop for the explicit route objects always
          excluded by the path computation of the primary reverse
          path.";
        case otn {
          uses l1-types:otn-label-hop;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:primary-paths/te:primary-path/"
            + "te:primary-reverse-path/"
            + "te:explicit-route-objects/"
            + "te:route-object-include-exclude/"
```

```
          + "te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
        description
          "Augment TE label hop for the explicit route objects included
          or excluded by the path computation of the primary reverse
          path.";
        case otn {
          uses l1-types:otn-label-hop;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:primary-paths/te:primary-path/"
            + "te:primary-reverse-path/"
            + "te:path-in-segment/te:label-restrictions/"
            + "te:label-restriction/te:label-start/"
            + "te:te-label/te:technology" {
        description
          "Augment TE label range start for the ingress segment
          of the primay reverse path.";
        case otn {
          uses l1-types:otn-label-start-end;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:primary-paths/te:primary-path/"
            + "te:primary-reverse-path/"
            + "te:path-in-segment/te:label-restrictions/"
            + "te:label-restriction/te:label-end/"
            + "te:te-label/te:technology" {
        description
          "Augment TE label range end for the ingress segment
          of the primay reverse path.";
        case otn {
          uses l1-types:otn-label-start-end;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:primary-paths/te:primary-path/"
            + "te:primary-reverse-path/"
            + "te:path-in-segment/te:label-restrictions/"
            + "te:label-restriction/te:label-step/te:technology" {
        description
          "Augment TE label range step for the ingress segment
          of the primay reverse path.";
        case otn {
```

```
        uses l1-types:otn-label-step;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-start/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range start for the egress segment
        of the primay reverse path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-end/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range end for the egress segment
        of the primay reverse path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-step/te:technology" {
      description
        "Augment TE label range step for the egress segment
        of the primay reverse path.";
      case otn {
        uses l1-types:otn-label-step;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:primary-paths/te:primary-path/"
          + "te:primary-reverse-path/"
```

```
          + "te:computed-paths-properties/te:computed-path-properties/"
          + "te:path-properties/te:path-route-objects/"
          + "te:path-route-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the route object of the computed
        primary reverse path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:optimizations/te:algorithm/te:metric/"
          + "te:optimization-metric/te:explicit-route-exclude-objects/"
          + "te:route-object-exclude-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the optimization of the explicit
        route objects excluded by the path computation of the
        secondary path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:optimizations/te:algorithm/te:metric/"
          + "te:optimization-metric/te:explicit-route-include-objects/"
          + "te:route-object-include-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the optimization of the explicit
        route objects included by the path computation of the
        secondary path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:explicit-route-objects/"
          + "te:route-object-exclude-always/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
```

```
        "Augment TE label hop for the explicit route objects always
        excluded by the path computation of the secondary path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:explicit-route-objects/"
          + "te:route-object-include-exclude/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the explicit route objects included
        or excluded by the path computation of the secondary path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-start/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range start for the ingress segment
        of the secondary path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-end/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range end for the ingress segment
        of the secondary path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }
    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-paths/te:secondary-path/"
          + "te:path-in-segment/te:label-restrictions/"
```

```
          + "te:label-restriction/te:label-step/te:technology" {
        description
          "Augment TE label range step for the ingress segment
          of the secondary path.";
        case otn {
          uses l1-types:otn-label-step;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:secondary-paths/te:secondary-path/"
            + "te:path-out-segment/te:label-restrictions/"
            + "te:label-restriction/te:label-start/"
            + "te:te-label/te:technology" {
        description
          "Augment TE label range start for the egress segment
          of the secondary path.";
        case otn {
          uses l1-types:otn-label-start-end;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:secondary-paths/te:secondary-path/"
            + "te:path-out-segment/te:label-restrictions/"
            + "te:label-restriction/te:label-end/"
            + "te:te-label/te:technology" {
        description
          "Augment TE label range end for the egress segment
          of the secondary path.";
        case otn {
          uses l1-types:otn-label-start-end;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:secondary-paths/te:secondary-path/"
            + "te:path-out-segment/te:label-restrictions/"
            + "te:label-restriction/te:label-step/te:technology" {
        description
          "Augment TE label range step for the egress segment
          of the secondary path.";
        case otn {
          uses l1-types:otn-label-step;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
```

```
          + "te:secondary-paths/te:secondary-path/"
          + "te:computed-paths-properties/"
          + "te:computed-path-properties/"
          + "te:path-properties/te:path-route-objects/"
          + "te:path-route-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the route object of the computed
        secondary path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:optimizations/te:algorithm/te:metric/"
          + "te:optimization-metric/te:explicit-route-exclude-objects/"
          + "te:route-object-exclude-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the optimization of the explicit
        route objects excluded by the path computation of the
        secondary reverse path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:optimizations/te:algorithm/te:metric/"
          + "te:optimization-metric/te:explicit-route-include-objects/"
          + "te:route-object-include-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the optimization of the explicit
        route objects included by the path computation of the
        secondary reverse path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:explicit-route-objects/"
          + "te:route-object-exclude-always/te:type/te:label/"
```

```
          + "te:label-hop/te:te-label/te:technology" {
        description
          "Augment TE label hop for the explicit route objects always
          excluded by the path computation of the secondary reverse
          path.";
        case otn {
          uses l1-types:otn-label-hop;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:secondary-reverse-paths/te:secondary-reverse-path/"
            + "te:explicit-route-objects/"
            + "te:route-object-include-exclude/te:type/te:label/"
            + "te:label-hop/te:te-label/te:technology" {
        description
          "Augment TE label hop for the explicit route objects included
          or excluded by the path computation of the secondary reverse
          path.";
        case otn {
          uses l1-types:otn-label-hop;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:secondary-reverse-paths/te:secondary-reverse-path/"
            + "te:path-in-segment/te:label-restrictions/"
            + "te:label-restriction/te:label-start/"
            + "te:te-label/te:technology" {
        description
          "Augment TE label range start for the ingress segment
          of the secondary reverse path.";
        case otn {
          uses l1-types:otn-label-start-end;
        }
      }

      augment "/te:te/te:tunnels/te:tunnel/"
            + "te:secondary-reverse-paths/te:secondary-reverse-path/"
            + "te:path-in-segment/te:label-restrictions/"
            + "te:label-restriction/te:label-end/"
            + "te:te-label/te:technology" {
        description
          "Augment TE label range end for the ingress segment
          of the secondary reverse path.";
        case otn {
          uses l1-types:otn-label-start-end;
        }
```

```
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:path-in-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-step/te:technology" {
      description
        "Augment TE label range step for the ingress segment
        of the secondary reverse path.";
      case otn {
        uses l1-types:otn-label-step;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-start/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range start for the egress segment
        of the secondary reverse path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-end/"
          + "te:te-label/te:technology" {
      description
        "Augment TE label range end for the egress segment
        of the secondary reverse path.";
      case otn {
        uses l1-types:otn-label-start-end;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:path-out-segment/te:label-restrictions/"
          + "te:label-restriction/te:label-step/te:technology" {
      description
        "Augment TE label range step for the egress segment
        of the secondary reverse path.";
      case otn {
```

```
        uses l1-types:otn-label-step;
      }
    }

    augment "/te:te/te:tunnels/te:tunnel/"
          + "te:secondary-reverse-paths/te:secondary-reverse-path/"
          + "te:computed-paths-properties/"
          + "te:computed-path-properties/"
          + "te:path-properties/te:path-route-objects/"
          + "te:path-route-object/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the route object of the computed
        secondary reverse path.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }

    augment "/te:te/te:lsps/"
          + "te:lsp/te:lsp-actual-route-information/"
          + "te:lsp-actual-route-information/te:type/te:label/"
          + "te:label-hop/te:te-label/te:technology" {
      description
        "Augment TE label hop for the record route of the LSP.";
      case otn {
        uses l1-types:otn-label-hop;
      }
    }
  }
  <CODE ENDS>
```

Figure 3

5. IANA Considerations

IANA is requested to register the following URI in the "ns" subregistry within the "IETF XML Registry" [RFC3688]:

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

IANA is requested to register the following YANG module in the "YANG Module Names" subregistry [RFC6020] within the "YANG Parameters" registry.

```
name:         ietf-otn-tunnel
namespace:    urn:ietf:params:xml:ns:yang:ietf-otn-tunnel
prefix:       otn-tnl
reference:    RFC XXXX
```

RFC Editor Note: Please replace XXXX with the number assigned to the RFC once this draft becomes an RFC.

6. Security Considerations

This section is modeled after the template described in Section 3.7 of [I-D.ietf-netmod-rfc8407bis].

The "ietf-te-types" and the "ietf-te-packet-types" YANG modules define data models that are designed to be accessed via YANG-based management protocols, such as NETCONF [RFC6241] and RESTCONF [RFC8040]. These protocols have to use a secure transport layer (e.g., SSH [RFC4252], TLS [RFC8446], and QUIC [RFC9000]) and have to use mutual authentication.

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 this YANG module that are writable/creatable/deletable (i.e., config true, which is the default). These data nodes can 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. Specifically, the following subtrees and data nodes have particular sensitivities/vulnerabilities:

* "otnt:otn-bandwidth"

  This subtree specifies the configurations of OTN technology-specific information under any occurrence of the tet:te-bandwidth container, as defined in [I-D.ietf-teas-yang-te] (e.g., "/te:te/te:tunnels/te:tunnel/te:te-bandwidth/te:technology/otnt:otn/otnt:otn-bandwidth"). By configuring the OTN bandwidth attributes, an attacker may create an unauthorized OTN traffic path. By removing or modifying it, a malicious attacker may cause OTN traffic to be disabled or misrouted.

* "otnt:otn-label-range"

This subtree specifies the configurations of OTN technology-specific label range information under any occurrence of the tet:label-restriction container, as defined in [I-D.ietf-teas-yang-te] (e.g., "/te:te/te:tunnels/te:tunnel/te:primary-paths/te:primary-path/te:path-in-segment/te:label-restrictions/te:label-restriction/otnt:otn-label-range"). By configuring the OTN label range attributes, an attacker may create an unauthorized OTN traffic path. By removing or modifying, a malicious attacker may cause OTN traffic to be disabled or misrouted.

* "otnt:otn-label"

  This subtree specifies the configurations of OTN technology-specific label information under any occurrence of the tet:te-label container, as defined in [I-D.ietf-teas-yang-te] (e.g., "/te:te/te:tunnels/te:tunnel/te:primary-paths/te:primary-path/te:explicit-route-objects/te:route-object-include-exclude/te:type/te:label/te:label-hop/te:te-label/te:technology/otnt:otn/otnt:otn-label"). By configuring, removing or modifying the OTN label attributes, a malicious attacker may cause OTN traffic to be disabled or misrouted.

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. Specifically, the following subtrees and data nodes have particular sensitivities/vulnerabilities:

* "otnt:otn-bandwidth"

  This subtree specifies the configurations of OTN technology-specific information under any occurrence of the tet:te-bandwidth container, as defined in [I-D.ietf-teas-yang-te] (e.g., "/te:te/te:tunnels/te:tunnel/te:te-bandwidth/te:technology/otnt:otn/otnt:otn-bandwidth"). Unauthorized access to this data node can disclose the OTN bandwidth information of OTN tunnels and LSPs.

* "otnt:otn-label-range"

This subtree specifies the configurations of OTN technology-specific label range information under any occurrence of the tet:label-restriction container, as defined in [I-D.ietf-teas-yang-te] (e.g., "/te:te/te:tunnels/te:tunnel/te:primary-paths/te:primary-path/te:path-in-segment/te:label-restrictions/te:label-restriction/otnt:otn-label-range"). Unauthorized access to this data node can disclose the state information of OTN tunnels and LSPs.

* "otnt:otn-label"

This subtree specifies the configurations of OTN technology-specific label information under any occurrence of the tet:te-label container, as defined in [I-D.ietf-teas-yang-te] (e.g., "/te:te/te:tunnels/te:tunnel/te:primary-paths/te:primary-path/te:explicit-route-objects/te:route-object-include-exclude/te:type/te:label/te:label-hop/te:te-label/te:technology/otnt:otn/otnt:otn-label"). Unauthorized access to this data node can disclose the state information of OTN tunnels and LSPs.

This YANG module does not define RPC operations.

This YANG module uses groupings from other YANG modules that define nodes that may be considered sensitive or vulnerable in network environments. Refer to the Security Considerations of [I-D.ietf-ccamp-layer1-types] for information as to which nodes may be considered sensitive or vulnerable in network environments.

Finally, the YANG module described in this document augments the "ietf-te" YANG module [I-D.ietf-teas-yang-te] by adding data nodes. The security considerations for the subtrees described in those RFCs apply equally to the new data nodes that this module adds.

7. References

7.1. Normative References

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Contributors

Aihua Guo
Futurewei
Email: aihuaguo.ietf@gmail.com

Anurag Sharma
Google
Email: ansha@google.com

Rajan Rao
Infinera
Email: rrao@infinera.com

Yunbo Li
China Mobile
Email: liyunbo@chinamobile.com

Dieter Beller
Nokia
Email: dieter.beller@nokia.com

Yanlei Zheng
China Unicom
Email: zhengyanlei@chinaunicom.cn

Xian Zhang
Huawei Technologies
Email: Huawei Technologies

Lei Wang
China Mobile

Email: wangleiyj@chinamobile.com

Oscar Gonzalez de Dios
Telefonica
Email: oscar.gonzalezdedios@telefonica.com

Authors' Addresses

Haomian Zheng
Huawei Technologies
H1, Huawei Xiliu Beipo Village, Songshan Lake
Dongguan
Guangdong, 523808
China
Email: zhenghaomian@huawei.com

Italo Busi
Huawei Technologies
Email: italo.busi@huawei.com

Sergio Belotti
Nokia
Email: sergio.belotti@nokia.com

Victor Lopez
Nokia
Email: victor.lopez@nokia.com

Yunbin Xu
CAICT
Email: xuyunbin@caict.ac.cn