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A YANG Data Model for MPLS-TE Topology
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Abstract

This document describes a YANG data model for Multi-Protocol Label Switching (MPLS) with Traffic Engineering (MPLS-TE) networks.

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[1. Introduction](#)

This document describes a YANG data model for Multi-Protocol Label Switching (MPLS) with Traffic Engineering (MPLS-TE) networks.

This document also defines a collection of common data types and groupings in YANG data modeling language for MPLS-TE networks. These derived common types and groupings are intended to be imported by the MPLS-TE topology model, defined in this document, as well as by the MPLS-TE tunnel model, defined in [[TE-MPLS](#)].

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Multi-Protocol Label Switching - Transport Profile (MPLS-TP) is a profile of the MPLS protocol that is used in packet switched transport networks and operated in a similar manner to other existing transport technologies (e.g., OTN), as described in [RFC5921](#). The YANG model defined in this document can also be for MPLS-TP networks.

[1.1. Tree Diagram](#)

A simplified graphical representation of the data model is used in [section 5.1](#) of this document. The meaning of the symbols in these diagrams is 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.

| Prefix | YANG module | Reference |
|-----------|-------------------------|------------------------------------|
| rt-types | ietf-routing-types | [RFC8294] |
| tet | ietf-te-topology | [TE-Topology] |
| tet-pkt | ietf-te-topology-packet | [L3-TE-Topology] |
| mte-types | ietf-mpls-te-types | This document |
| tet-mpls | ietf-te-mpls-topology | This document |

Table 1: Prefixes and corresponding YANG modules

[2. MPLS-TE Types Overview](#)

The module `ietf-mpls-te-types` contains the following YANG reusable types and groupings:

`bandwidth-profile-type`:

This identity defines various bandwidth profiles specified by IETF and other organizations that may be used to limit bandwidth utilization of MPLS-TE LSPs.

`load-balancing-type`

This identify defines the types of load-balancing algorithms used on bundled MPLS-TE link.

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te-packet-path-bandwidth

This grouping defines the path bandwidth information and could be used in MPLS-TE topology model for the representation of MPLS-TE LSP bandwidth. All the path and LSP bandwidth related sections in generic module, [[RFC8776](#)], need to be augmented with this grouping for the usage of MPLS-TE. This grouping is also applicable to set up the MPLS-TE tunnel.

te-packet-link-bandwidth

This grouping defines the link bandwidth information and could be used in MPLS-TE topology model for link bandwidth representation. All the link bandwidth related sections in generic module, [[RFC8776](#)], need to be augmented with this grouping for the usage of MPLS_TE.

te-mpls-label-hop

This grouping is used for the augmentation of TE label for MPLS_TE path.

3. MPLS-TE Topology Model Overview

The MPLS-TE technology specific topology model augments the ietf-te-topology-packet YANG module, defined in [[L3-TE-Topology](#)], which in turns augment the generic ietf-te-topology YANG module, defined in [[TE-Topology](#)].

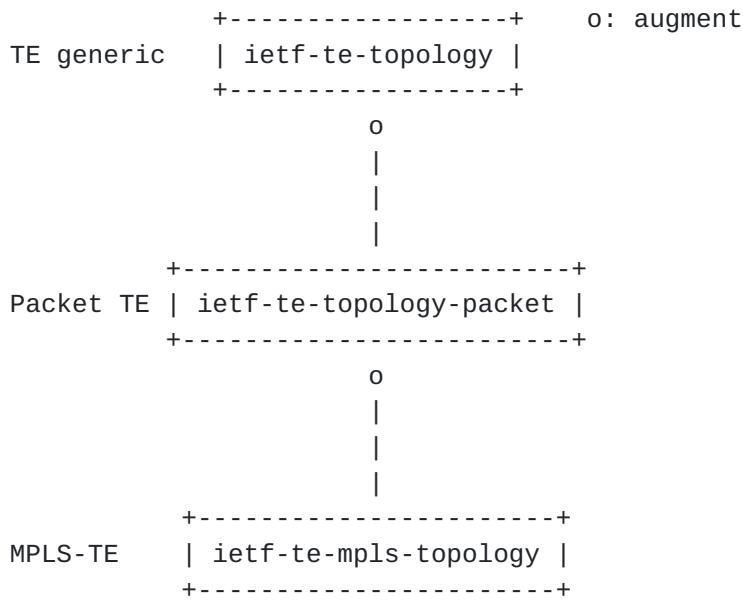


Figure 1 - Relationship between MPLS-TE, Packet-TE and TE topology models

Given the guidance for augmentation in [[TE-Topology](#)], the following technology-specific augmentations need to be provided:

- A network-type to indicate that the TE topology is an MPLS-TE Topology, as follow:

```
augment /nw:networks/nw:network/nw:network-types/tet:te-topology
    /tet-pkt:packet:
    +-rw mpls-topology!
```

- TE Bandwidth Augmentations for paths and LSPs:

```
+--:(packet)
    +-rw bandwidth-profile-name?    string
    +-rw bandwidth-profile-type?   identityref
    +-rw CIR?                   uint64
    +-rw EIR?                   uint64
    +-rw CBS?                   uint64
    +-rw EBS?                   uint64
```

- TE Bandwidth Augmentations for links:

```
+--:(packet)
    +-rw packet-bandwidth?   bandwidth-kbps
```

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- TE Label Augmentations as described in [section 3.2](#);

[3.1.](#) TE Label Augmentations

In MPLS-TE, the label allocation is done by NE, information about label values availability is not necessary to be provided to the controller. Moreover, MPLS-TE tunnels are currently established within a single domain.

Therefore this document does not define any MPLS-TE technology-specific augmentations, of the TE Topology model, for the TE label since no TE label related attributes should be instantiated for MPLS-TE Topologies.

Open issue: shall this module allows the setup of MPLS-TE multi-domain tunnels?

[3.2.](#) MPLS-TP Topology

Multi-Protocol Label Switching - Transport Profile (MPLS-TP) is a profile of the MPLS protocol that is used in packet switched transport networks and operated in a similar manner to other existing transport technologies (e.g., OTN), as described in [[RFC5921](#)].

Therefore YANG model defined in this document can also be applicable for MPLS-TP networks.

However, as described in [[RFC5921](#)], MPLS-TP networks support bidirectional LSPs and require no ECMP and no PHP. When reporting the topology for an MPLS-TP network, additional information is required to indicate whether the network support these MPLS-TP characteristics.

It is worth noting that [[TE-Topology](#)] is already capable to model TE topologies supporting either unidirectional or bidirectional LSPs: all bidirectional TE links can support bidirectional LSPs and all the links can support unidirectional LSPs and it is always possible to associate unidirectional LSPs as long as they belong to the same tunnel.

When setting up bidirectional LSPs (e.g., MPLS-TP LSPs) only bidirectional TE Links are selected by path computation.

In order to allow reporting that ECMP is not affecting forwarding the packets of a given LSP, the load-balancing-type attribute reports

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whether a LAG or TE Bundled Link performs load-balancing on a per-flow or per-top-label:

```
augment /nw:networks/nw:network/nt:link/tet:te:  
  +-rw load-balancing-type?    mte-types:load-balancing-type
```

When setting up LSPs which do not require ECMP (e.g., MPLS-TP LSPs) only Links that are not part of a LAG or TE Bundle or that performs per-top-label load balancing are selected by path computation.

It is assumed that almost all the MPLS-TE nodes are capable to support Ultimate Hop Popping (UHP). However, if some interfaces are not able to support UHP, they can report it in the MPLS-TE topology:

```
augment /nw:networks/nw:network/nw:node/nt:termination-point  
  /tet:te:  
  +-ro uhp-incapable?    empty
```

When setting up LSPs which do not require PHP (e.g., MPLS-TP LSPs) only the interfaces (LTPs) which are capable to support UHP in the destination node are selected by path computation.

4. YANG model for common MPLS-TE Types

```
<CODE BEGINS>file "ietf-mpls-te-types@2020-07-13.yang"  
module ietf-mpls-te-types {  
  yang-version 1.1;  
  namespace "urn:ietf:params:xml:ns:yang:ietf-mpls-te-types";  
  
  prefix "mte-types";  
  
  import ietf-routing-types {  
    prefix "rt-types";  
  
  }  
  
  import ietf-te-packet-types {  
    prefix "te-packet-types";  
    reference  
      "RFC 8776: Common YANG Data Types for Traffic Engineering";  
  }  
  
  organization  
    "Internet Engineering Task Force (IETF) TEAS WG";
```

```
contact
  "WG Web:  <https://datatracker.ietf.org/wg/teas/>
   WG List: <mailto:teas@ietf.org>
```

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

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

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

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

```
description
  "This module defines technology-specific MPLS-TE types
   data model.
```

```
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```

```
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(http://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 2020-07-13 {
  description
    "Initial Version";
  reference
    "draft-busizheng-teas-yang-te-mpls-topology";
}
```

```
/*
```

```
* Identities (to be moved to te-packet-types?)  
*/  
  
identity bandwidth-profile-type {  
    description  
        "Bandwidth Profile Types";  
}  
  
identity mef-10-bwp {  
    base bandwidth-profile-type;  
    description  
        "MEF 10 Bandwidth Profile";  
}  
  
identity rfc-2697-bwp {  
    base bandwidth-profile-type;  
    description  
        "RFC 2697 Bandwidth Profile";  
}  
  
identity rfc-2698-bwp {  
    base bandwidth-profile-type;  
    description  
        "RFC 2698 Bandwidth Profile";  
}  
  
identity rfc-4115-bwp {  
    base bandwidth-profile-type;  
    description  
        "RFC 4115 Bandwidth Profile";  
}  
  
/*  
 * Type Definitions (MPLS-TE)  
 */  
  
typedef load-balancing-type {  
    type enumeration {  
        enum per-flow {  
            description  
                "The load-balancing algorithm ensures that packets
```

```
characterized as the same flow (e.g. based on IP 5-tuple)
that egress on a LAG or a bundled TE link are forwarded
on the same component link.

Packets for different flows within the same LSP can be
forwarded on different component links.";
```

```
}
```

```
enum per-top-label {
    description
        "The load-balancing algorithm ensures incoming MPLS
         packets with the same top MPLS label and that egress on
         a on a LAG or bundled TE link are forwarded on the same
         component link.
```



```
Packets for different flows within the same LSP are
forwarded on the same component link.";
```

```
}
```

```
}
```

```
description
    "The type of load balancing used on bundled links.";
```

```
} // typedef load-balancing-type
```



```
/*
 * Groupings (to be moved to te-packet-types?)
 */
```



```
grouping te-packet-path-bandwidth {
    description
        "Path bandwidth for Packet. ";
    leaf bandwidth-profile-name{
        type string;
        description "Name of Bandwidth Profile.";
    }
    leaf bandwidth-profile-type {
        type identityref {
            base bandwidth-profile-type;
        }
        description "Type of Bandwidth Profile.";
    }
}
```

```
leaf CIR {
    type uint64;
    description
        "Committed Information Rate in Kbps";
}

leaf EIR {
    type uint64;
    /*
     Need to indicate that EIR is not supported by RFC 2697
     must
        '.../bw-profile-type = "etht-types:mef-10-bwp" or ' +
        '.../bw-profile-type = "etht-types:rfc-2698-bwp" or ' +
        '.../bw-profile-type = "etht-types:rfc-4115-bwp"'
     must
        '.../bw-profile-type != "etht-types:rfc-2697-bwp"'
    */
    description
        "Excess Information Rate in Kbps
         In case of RFC 2698, PIR = CIR + EIR";
}

leaf CBS {
    type uint64;
    description
        "Committed Burst Size in KBytes";
}

leaf EBS {
    type uint64;
    description
        "Excess Burst Size in KBytes.
         In case of RFC 2698, PBS = CBS + EBS";
}

grouping te-packet-link-bandwidth {
    description
```

```

"Link Bandwidth for Packet. ";
leaf packet-bandwidth {
    type te-packet-types:bandwidth-kbps;
    description
        "Available bandwidth value expressed in kilobits per
         second";
}
}

/*
 * Groupings (MPLS-TE)
 */

grouping te-mpls-label-hop {
    description
        "MPLS-TE Label Hop. ";

    leaf mpls-label {
        type rt-types:mpls-label;
        description
            "MPLS Label.";
    }
} // grouping te-mpls-label-hop
}

<CODE ENDS>

```

Figure 2 - MPLS-TE types YANG module

[5. YANG model for MPLS-TE Topology](#)

[5.1. YANG Tree](#)

Figure 3 below shows the tree diagram of the YANG model defined in module `ietf-te-mpls-topology.yang`.

```

module: ietf-te-mpls-topology
augment /nw:networks/nw:network/nw:node/nt:termination-point/tet:te
        /tet:interface-switching-capability/tet:max-lsp-bandwidth
        /tet:te-bandwidth/tet:technology:
        +-:(packet)
        +-rw bandwidth-profile-name?      string

```

```
    +-rw bandwidth-profile-type? identityref
    +-rw CIR?          uint64
    +-rw EIR?          uint64
    +-rw CBS?          uint64
    +-rw EBS?          uint64
augment /nw:networks/nw:network/nw:node/tet:te
    /tet:te-node-attributes/tet:connectivity-matrices
    /tet:path-constraints/tet:te-bandwidth/tet:technology:
+--:(packet)
    +-rw packet-bandwidth? te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nw:node/tet:te
    /tet:te-node-attributes/tet:connectivity-matrices
    /tet:connectivity-matrix/tet:path-constraints
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-rw packet-bandwidth? te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nw:node/tet:te
    /tet:information-source-entry/tet:connectivity-matrices
    /tet:path-constraints/tet:te-bandwidth/tet:technology:
+--:(packet)
    +-ro packet-bandwidth? te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nw:node/tet:te
    /tet:information-source-entry/tet:connectivity-matrices
    /tet:connectivity-matrix/tet:path-constraints
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-ro packet-bandwidth? te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nw:node/tet:te
    /tet:tunnel-termination-point/tet:client-layer-adaptation
    /tet:switching-capability/tet:te-bandwidth
    /tet:technology:
+--:(packet)
    +-rw packet-bandwidth? te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nw:node/tet:te
    /tet:tunnel-termination-point
    /tet:local-link-connectivities/tet:path-constraints
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-rw packet-bandwidth? te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nw:node/tet:te
    /tet:tunnel-termination-point
```

```
    /tet:local-link-connectivities
    /tet:local-link-connectivity/tet:path-constraints
    /tet:te-bandwidth/tet:technology:
    +--:(packet)
        +-rw packet-bandwidth?    te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nt:link/tet:te
    /tet:te-link-attributes
    /tet:interface-switching-capability/tet:max-lsp-bandwidth
    /tet:te-bandwidth/tet:technology:
    +--:(packet)
        +-rw bandwidth-profile-name?    string
        +-rw bandwidth-profile-type?    identityref
        +-rw CIR?                    uint64
        +-rw EIR?                    uint64
        +-rw CBS?                    uint64
        +-rw EBS?                    uint64
augment /nw:networks/nw:network/nt:link/tet:te
    /tet:te-link-attributes/tet:max-link-bandwidth
    /tet:te-bandwidth/tet:technology:
    +--:(packet)
        +-rw packet-bandwidth?    te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nt:link/tet:te
    /tet:te-link-attributes/tet:max-resv-link-bandwidth
    /tet:te-bandwidth/tet:technology:
    +--:(packet)
        +-rw packet-bandwidth?    te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nt:link/tet:te
    /tet:te-link-attributes/tet:unreserved-bandwidth
    /tet:te-bandwidth/tet:technology:
    +--:(packet)
        +-rw packet-bandwidth?    te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nt:link/tet:te
    /tet:information-source-entry
    /tet:interface-switching-capability/tet:max-lsp-bandwidth
    /tet:te-bandwidth/tet:technology:
    +--:(packet)
        +-ro bandwidth-profile-name?    string
        +-ro bandwidth-profile-type?    identityref
        +-ro CIR?                    uint64
        +-ro EIR?                    uint64
        +-ro CBS?                    uint64
```

```
    +-+ro EBS?                      uint64
augment /nw:networks/nw:network/nt:link/tet:te
    /tet:information-source-entry/tet:max-link-bandwidth
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-+ro packet-bandwidth?  te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nt:link/tet:te
    /tet:information-source-entry/tet:max-resv-link-bandwidth
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-+ro packet-bandwidth?  te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nt:link/tet:te
    /tet:information-source-entry/tet:unreserved-bandwidth
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-+ro packet-bandwidth?  te-packet-types:bandwidth-kbps
augment /nw:networks/tet:te/tet:templates/tet:link-template
    /tet:te-link-attributes
    /tet:interface-switching-capability/tet:max-lsp-bandwidth
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-+rw bandwidth-profile-name?  string
    +-+rw bandwidth-profile-type?  identityref
    +-+rw CIR?                  uint64
    +-+rw EIR?                  uint64
    +-+rw CBS?                  uint64
    +-+rw EBS?                  uint64
augment /nw:networks/tet:te/tet:templates/tet:link-template
    /tet:te-link-attributes/tet:max-link-bandwidth
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-+rw packet-bandwidth?  te-packet-types:bandwidth-kbps
augment /nw:networks/tet:te/tet:templates/tet:link-template
    /tet:te-link-attributes/tet:max-resv-link-bandwidth
    /tet:te-bandwidth/tet:technology:
+--:(packet)
    +-+rw packet-bandwidth?  te-packet-types:bandwidth-kbps
augment /nw:networks/tet:te/tet:templates/tet:link-template
    /tet:te-link-attributes/tet:unreserved-bandwidth
    /tet:te-bandwidth/tet:technology:
+--:(packet)
```

```
    +-rw packet-bandwidth?  te-packet-types:bandwidth-kbps
augment /nw:networks/nw:network/nw:network-types/tet:te-topology
    /tet-pkt:packet:
    +-rw mpls-topology!
augment /nw:networks/nw:network/nt:link/tet:te:
    +-rw load-balancing-type?  mte-types:load-balancing-type
augment /nw:networks/nw:network/nw:node/nt:termination-point
    /tet:te:
    +-ro uhp-incapable?  empty
```

Figure 3 - MPLS-TE topology YANG tree

5.2. YANG Code

```
<CODE BEGINS>file "ietf-te-mpls-topology@2020-07-13.yang"
module ietf-te-mpls-topology {
    yang-version 1.1;
    namespace "urn:ietf:params:xml:ns:yang:ietf-te-mpls-topology";

    prefix "tet-mpls";

    import ietf-network {
        prefix "nw";
    }

    import ietf-network-topology {
        prefix "nt";
    }

    import ietf-te-topology {
        prefix "tet";
    }

    import ietf-te-topology-packet {
        prefix "tet-pkt";
    }

    import ietf-mpls-te-types {
        prefix "mte-types";
    }
```

```
organization
  "Internet Engineering Task Force (IETF) TEAS WG";
contact
  "WG Web: <https://datatracker.ietf.org/wg/teas/>
WG List: <mailto:teas@ietf.org>

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

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

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

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

description
"This module defines technology-specific MPLS-TE topology
data model.

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

revision 2020-07-13 {
  description
    "Initial Version";
  reference
    "draft-busizheng-teas-yang-te-mpls-topology";
}
```

```
/*
 * Augment TE bandwidth (to be moved to te-topology-packet?)
 */

augment "/nw:networks/nw:network/nw:node/nt:termination-point/"
    + "tet:te/"
    + "tet:interface-switching-capability/tet:max-lsp-bandwidth/"
    + "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../.../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
description
    "Augmentation parameters apply only for networks with
    Packet TE topology type.";
}
description
    "Augment maximum LSP TE bandwidth for the link termination
    point (LTP).";
case packet {
    uses mte-types:te-packet-path-bandwidth;
}
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
    + "tet:te-node-attributes/tet:connectivity-matrices/"
    + "tet:path-constraints/tet:te-bandwidth/tet:technology" {
when ".../.../.../.../.../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
description
    "Augmentation parameters apply only for networks with
    Packet TE topology type.";
}
description
    "Augment TE bandwidth path constraints of the TE node
    connectivity matrices.";
case packet {
    uses mte-types:te-packet-link-bandwidth;
}
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
```

```
+ "tet:te-node-attributes/tet:connectivity-matrices/"
+ "tet:connectivity-matrix/"
+ "tet:path-constraints/tet:te-bandwidth/tet:technology" {
when ".../.../.../.../.../nw:network-types/tet:te-topology/"
+ "tet-pkt:packet" {
description
    "Augmentation parameters apply only for networks with
    Packet TE topology type.";
}
description
    "Augment TE bandwidth path constraints of the
    connectivity matrix entry.";
case packet {
    uses mte-types:te-packet-link-bandwidth;
}
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
+ "tet:information-source-entry/tet:connectivity-matrices/"
+ "tet:path-constraints/tet:te-bandwidth/tet:technology" {
when ".../.../.../.../.../nw:network-types/tet:te-topology/"
+ "tet-pkt:packet" {
description
    "Augmentation parameters apply only for networks with
    Packet TE topology type.";
}
description
    "Augment TE bandwidth path constraints of the TE node
    connectivity matrices information source.";
case packet {
    uses mte-types:te-packet-link-bandwidth;
}
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
+ "tet:information-source-entry/tet:connectivity-matrices/"
+ "tet:connectivity-matrix/"
+ "tet:path-constraints/tet:te-bandwidth/tet:technology" {
when ".../.../.../.../.../nw:network-types/tet:te-topology/"
+ "tet-pkt:packet" {
description
```

```
        "Augmentation parameters apply only for networks with
        Packet TE topology type.";
    }
    description
        "Augment TE bandwidth path constraints of the
         connectivity matrix entry information source";
    case packet {
        uses mte-types:te-packet-link-bandwidth;
    }
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
    + "tet:tunnel-termination-point/"
    + "tet:client-layer-adaptation/tet:switching-capability/"
    + "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../.../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
    description
        "Augmentation parameters apply only for networks with
        Packet TE topology type.";
    }
    description
        "Augment client TE bandwidth of the tunnel termination point
         (TTP)";
    case packet {
        uses mte-types:te-packet-link-bandwidth;
    }
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
    + "tet:tunnel-termination-point/"
    + "tet:local-link-connectivities/tet:path-constraints/"
    + "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../.../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
    description
        "Augmentation parameters apply only for networks with
        Packet TE topology type.";
    }
    description
        "Augment TE bandwidth path constraints for the TTP
```

```
    Local Link Connectivities.";  
  case packet {  
    uses mte-types:te-packet-link-bandwidth;  
  }  
}  
  
augment "/nw:networks/nw:network/nw:node/tet:te/"  
  + "tet:tunnel-termination-point/"  
  + "tet:local-link-connectivities/"  
  + "tet:local-link-connectivity/tet:path-constraints/"  
  + "tet:te-bandwidth/tet:technology" {  
when ".../.../.../.../.../nw:network-types/tet:te-topology/"  
  + "tet-pkt:packet" {  
  description  
    "Augmentation parameters apply only for networks with  
    Packet TE topology type.;"  
}  
  description  
    "Augment TE bandwidth path constraints for the TTP  
    Local Link Connectivity entry.";  
  case packet {  
    uses mte-types:te-packet-link-bandwidth;  
  }  
}  
  
augment "/nw:networks/nw:network/nt:link/tet:te/"  
  + "tet:te-link-attributes/"  
  + "tet:interface-switching-capability/tet:max-lsp-bandwidth/"  
  + "tet:te-bandwidth/tet:technology" {  
when ".../.../.../.../nw:network-types/tet:te-topology/"  
  + "tet-pkt:packet" {  
  description  
    "Augmentation parameters apply only for networks with  
    Packet TE topology type.;"  
}  
  description  
    "Augment maximum LSP TE bandwidth for the TE link.";  
  case packet {  
    uses mte-types:te-packet-path-bandwidth;  
  }  
}
```

```
augment "/nw:networks/nw:network/nt:link/tet:te/"
    + "tet:te-link-attributes/"
    + "tet:max-link-bandwidth/"
    + "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
        description
            "Augmentation parameters apply only for networks with
            Packet TE topology type.";
    }
    description
        "Augment maximum TE bandwidth for the TE link";
    case packet {
        uses mte-types:te-packet-link-bandwidth;
    }
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
    + "tet:te-link-attributes/"
    + "tet:max-resv-link-bandwidth/"
    + "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
        description
            "Augmentation parameters apply only for networks with
            Packet TE topology type.";
    }
    description
        "Augment maximum reservable TE bandwidth for the TE link";
    case packet {
        uses mte-types:te-packet-link-bandwidth;
    }
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
    + "tet:te-link-attributes/"
    + "tet:unreserved-bandwidth/"
    + "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
```

```
description
  "Augmentation parameters apply only for networks with
   Packet TE topology type.";
}
description
  "Augment unreserved TE bandwidth for the TE Link";
case packet {
  uses mte-types:te-packet-link-bandwidth;
}
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
  + "tet:information-source-entry/"
  + "tet:interface-switching-capability/"
  + "tet:max-lsp-bandwidth/"
  + "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../.../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet" {
  description
    "Augmentation parameters apply only for networks with
     Packet TE topology type.";
}
  description
    "Augment maximum LSP TE bandwidth for the TE link
     information source";
  case packet {
    uses mte-types:te-packet-path-bandwidth;
  }
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
  + "tet:information-source-entry/"
  + "tet:max-link-bandwidth/"
  + "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet" {
  description
    "Augmentation parameters apply only for networks with
     Packet TE topology type.";
}
  description
```

```
"Augment maximum TE bandwidth for the TE link
information source";
case packet {
    uses mte-types:te-packet-link-bandwidth;
}
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
+ "tet:information-source-entry/"
+ "tet:max-resv-link-bandwidth/"
+ "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../nw:network-types/tet:te-topology/"
+ "tet-pkt:packet" {
description
    "Augmentation parameters apply only for networks with
    Packet TE topology type.";
}
description
    "Augment maximum reservable TE bandwidth for the TE link
    information-source";
case packet {
    uses mte-types:te-packet-link-bandwidth;
}
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
+ "tet:information-source-entry/"
+ "tet:unreserved-bandwidth/"
+ "tet:te-bandwidth/tet:technology" {
when ".../.../.../.../nw:network-types/tet:te-topology/"
+ "tet-pkt:packet" {
description
    "Augmentation parameters apply only for networks with
    Packet TE topology type.";
}
description
    "Augment unreserved TE bandwidth of the TE link
    information source";
case packet {
    uses mte-types:te-packet-link-bandwidth;
}
```

```
}

augment "/nw:networks/tet:te/tet:templates/"
    + "tet:link-template/tet:te-link-attributes/"
    + "tet:interface-switching-capability/"
    + "tet:max-lsp-bandwidth/"
    + "tet:te-bandwidth/tet:technology" {
description
    "Augment maximum LSP TE bandwidth of the TE link
     template";
case packet {
    uses mte-types:te-packet-path-bandwidth;
}
}

augment "/nw:networks/tet:te/tet:templates/"
    + "tet:link-template/tet:te-link-attributes/"
    + "tet:max-link-bandwidth/"
    + "tet:te-bandwidth/tet:technology" {
description
    "Augment maximum TE bandwidth the TE link template";
case packet {
    uses mte-types:te-packet-link-bandwidth;
}
}

augment "/nw:networks/tet:te/tet:templates/"
    + "tet:link-template/tet:te-link-attributes/"
    + "tet:max-resv-link-bandwidth/"
    + "tet:te-bandwidth/tet:technology" {
description
    "Augment maximum reservable TE bandwidth for the TE link
     template.";
case packet {
    uses mte-types:te-packet-link-bandwidth;
}
}

augment "/nw:networks/tet:te/tet:templates/"
    + "tet:link-template/tet:te-link-attributes/"
    + "tet:unreserved-bandwidth/"
```

```
+ "tet:te-bandwidth/tet:technology" {
description
  "Augment unreserved TE bandwidth the TE link template";
case packet {
  uses mte-types:te-packet-link-bandwidth;
}
}

/*
 * Augmentations
 */

augment "/nw:networks/nw:network/nw:network-types/"
  + "tet:te-topology/tet-pkt:packet" {
description
  "Augment network types to include MPLS-TE Topology Type";
container mpls-topology {
  presence
    "Indicates an MPLS-TE Topology Type.";
  description
    "Its presence indicates an MPLS-TE Topology";
}
}

augment "/nw:networks/nw:network/nt:link/tet:te" {
when ".../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet/tet-mpls:mpls-topology" {
  description
    "Augment MPLS-TE Topology.";
}
description
  "Augment TE Link.";

leaf load-balancing-type {
  type mte-types:load-balancing-type;
  default 'per-flow';
  description
    "Indicates the type of load-balancing (per-flow or per-LSP)
     performed by the bundled TE Link.

    This leaf is not present when the TE Link is not bundled.";
```

```
        } // leaf load-balancing-type
    }

augment "/nw:networks/nw:network/nw:node/nt:termination-point/"
    + "tet:te" {
when ".../.../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet/tet-mpls:mpls-topology" {
    description "Augment MPLS-TE Topology.";
}
description "Augment LTP.;

leaf uhp-incapable {
    type empty;
    config false;
    description
        "When present, indicates that the LTP is not capable to
         support Ultimate Hop Popping (UHP).";
} // leaf uhp-incapable
}
}

<CODE ENDS>
```

Figure 4 - MPLS-TE topology YANG module

6. Security Considerations

To be added

7. IANA Considerations

To be added

8. References

8.1. Normative References

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8.2. Informative References

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