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**YANG Data Model for Layer 3 TE Topologies  
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Abstract

This document defines a YANG data model for layer 3 traffic engineering topologies.

Status of This Memo

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## [1.](#) Introduction

This document defines a YANG [[RFC7950](#)] data model for describing the relationship between a layer 3 unicast topology [[RFC8346](#)] and a Traffic Engineering (TE) topology [[RFC8795](#)].

When traffic engineering is enabled on a layer 3 unicast topology, there will be a corresponding TE topology. The TE topology may or may not be congruent with the layer 3 unicast topology. When such a congruent TE topology exists, there will be a one-to-one association between the one modeling element in the layer 3 unicast topology and another element in the TE topology. When such a congruent TE topology does not exist, the association will not be one-to-one. This YANG data model supports both cases.

### [1.1.](#) Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [BCP 14](#), [[RFC2119](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

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

- o augment
- o data model
- o data node

### [1.2.](#) Tree Diagrams

Tree diagrams used in this document follow the notation defined in [[RFC8340](#)].



## 2. Modeling Considerations for L3 TE Topologies

A layer 3 TE topology is a layer 3 unicast topology with additional TE capabilities enabled. [RFC8346] defines a YANG data model for layer 3 unicast topologies, consisting of two modules: `ietf-l3-unicast-topology` and `ietf-l3-unicast-topology-state`. The YANG data model defined in this document augments the YANG data model defined in [RFC8346]. This document specifies two YANG modules `ietf-l3-te-topology` and `ietf-l3-te-topology-state`, augmenting `ietf-l3-unicast-topology` and `ietf-l3-unicast-topology-state` respectively, to add additional TE capabilities. Such an augmentation relationship is shown in Figure 1 below.

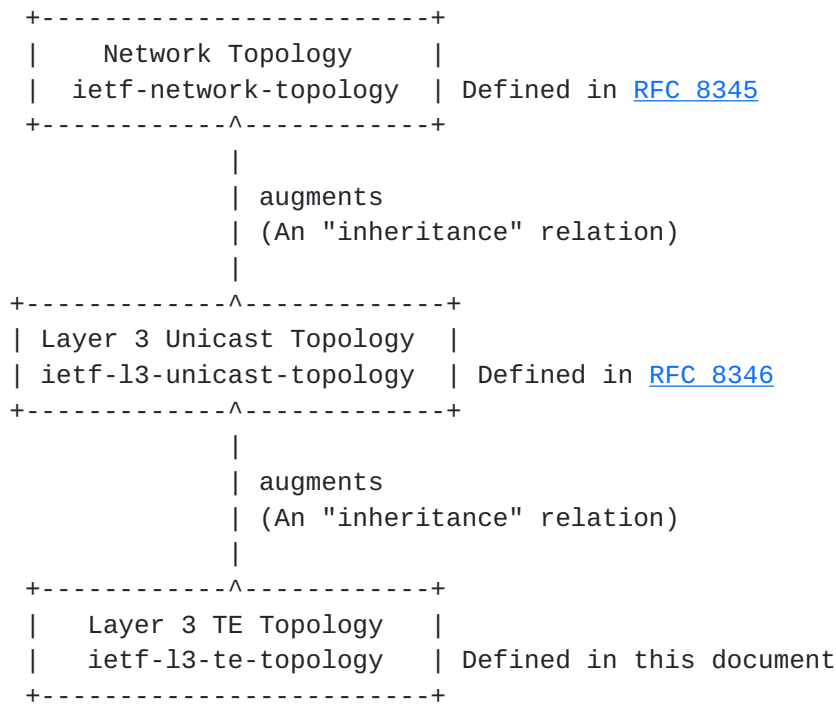


Figure 1: L3 TE Model Augmentation

Additionally, this document specifies two more YANG modules `ietf-te-topology-packet` and `ietf-te-topology-packet-state`, augmenting `ietf-te-topology` and `ietf-te-topology-state` respectively, to add additional attributes for TE packet data networks, as shown in Figure 2. Section 3 of this document describes these additional attributes in further details.



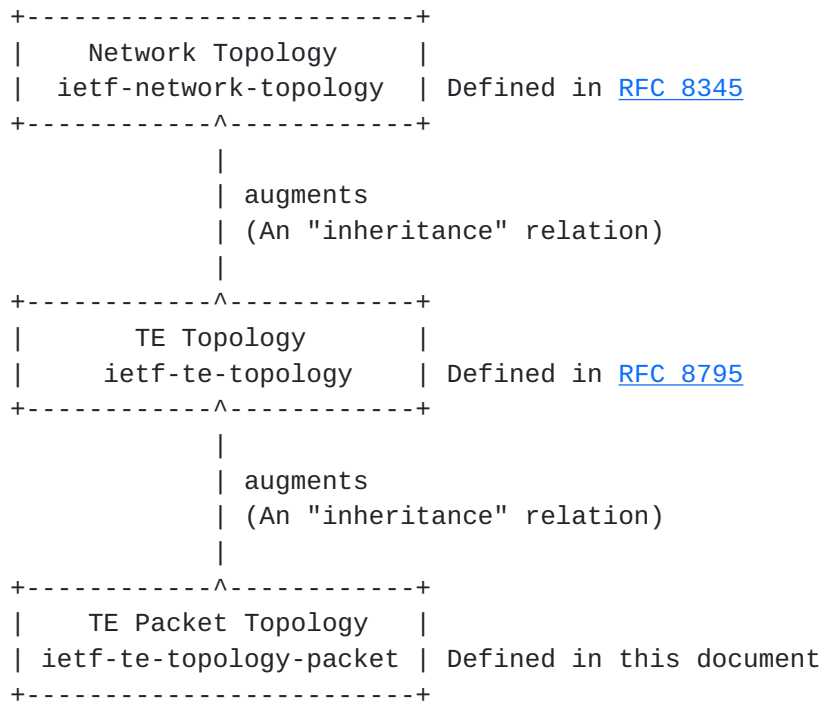


Figure 2: TE Packet Model Augmentation

**2.1. Relationship Between Layer 3 Unicast Topology and TE topology**

In general, the layer 3 unicast topology model specified in [[RFC8346](#)] and the TE topology model specified in [[RFC8795](#)] can be used independently. This document provides a method to use both together.

When traffic engineering is enabled on a layer 3 unicast topology, there will be a resulting layer 3 TE topology, which is modeled by the YANG modules defined in this document. A layer 3 TE topology augments a layer 3 unicast topology, so it inherits all the objects and properties of the base layer 3 unicast topology. In addition, in such a layer 3 TE topology, the objects that are inherited from the base layer 3 unicast topology to this layer 3 TE topology may be associated with the objects in one corresponding TE topology. Such associations are supported by the module `ietf-l3-te-topology` defined in this document.





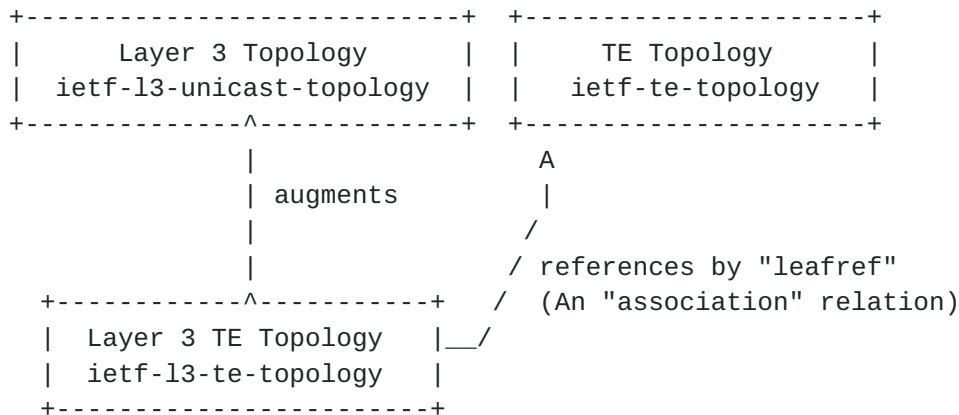


Figure 3: Model References

The properties of the relations between the objects in a layer 3 TE topology and the objects in the corresponding TE topology are:

- o The associations are between objects of the same class, i.e. node to node or link to link.
- o The multiplicity of such an association is: 0..1 to 0..1. An object in a layer 3 TE topology modeled by `ietf-l3-te-topology` may be associated with zero or one object in the corresponding TE topology.

## 2.2. Relationship Modeling

YANG data type `leafref` is used to model the association relationship between a layer 3 TE topology and a TE topology. YANG "must" statements are used to enforce that the referenced objects are in a topology of the proper type.

### 2.2.1. Topology Referencing

When TE is enabled on a layer 3 unicast topology, if the TE topology is not congruent with the layer 3 unicast topology, the layer 3 TE topology will have a reference to the corresponding TE topology. Such a reference is modeled as follows:

```

augment /nw:networks/nw:network/l3t:l3-topology-attributes:
  +-rw l3-te-topology-attributes
    +-rw network-ref? -> /nw:networks/network/network-id
  
```

The above `network-ref` is a YANG data node of type `leafref`, used to indicate the `network-id` of the corresponding TE topology. The



leafref relationship is illustrated by the simplified data instances in the following diagram.

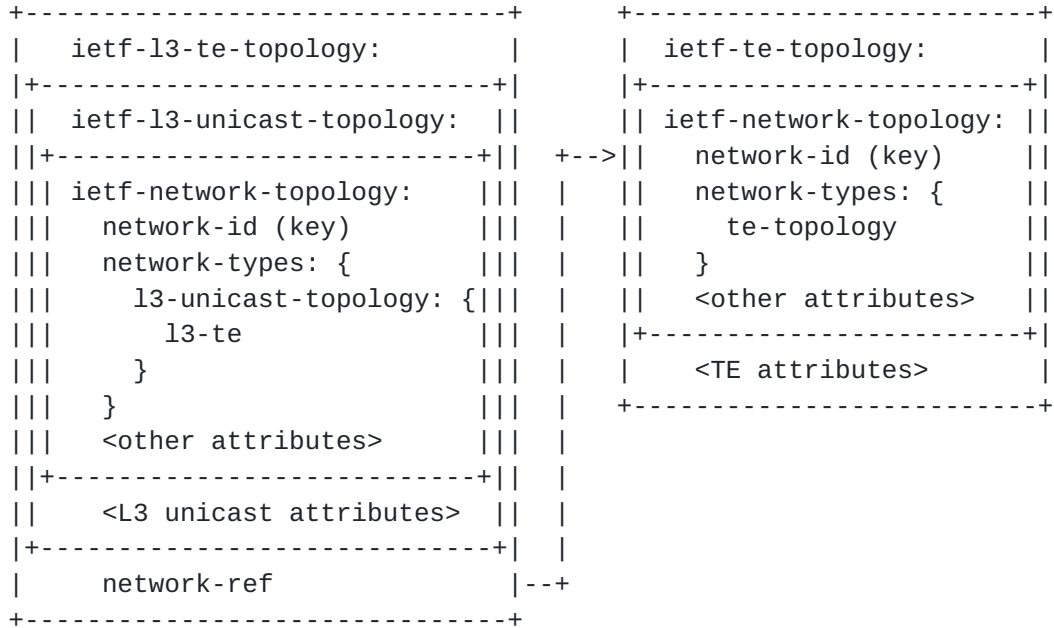


Figure 4: Topology Referencing

network-id defined in in [\[RFC8345\]](#) uniquely identifies a network topology instance of any type. As shown in the above diagram, the value of network-ref in the ietf-l3-te-topology instance matches the value of network-id in the ietf-te-topology instance. To ensure that the topology instance identified by this network-id is of type "te-topology", a "must" statement is defined in module ietf-l3-te-topology. Such "must" statements are also used in all the following leafref nodes in this section.

If the TE topology is congruent with the layer 3 unicast topology, the above reference can still be used to specified TE parameters defined in the TE topology model.

**2.2.2. Node Referencing**

When TE is enabled on a layer 3 unicast topology, if the TE topology is not congruent with the layer 3 unicast topology, a node in the layer 3 TE topology may have a reference to the corresponding node in the TE Topology. Such a reference is modeled as follows:



```
augment /nw:networks/nw:network/nw:node/l3t:l3-node-attributes:
  +--rw l3-te-node-attributes
    +--rw node-ref?      leafref
    +--rw network-ref?   -> /nw:networks/network/network-id
```

### **2.2.3. Link Termination Point Referencing**

When TE is enabled on a layer 3 unicast topology, if the TE topology is not congruent with the layer 3 unicast topology, a link termination point in the layer 3 TE topology may have a reference to the corresponding link termination point in the TE Topology. Such a reference is modeled as follows:

```
augment /nw:networks/nw:network/nw:node/nt:termination-point
  /l3t:l3-termination-point-attributes:
  +--rw l3-te-tp-attributes
    +--rw tp-ref?      leafref
    +--rw node-ref?   leafref
    +--rw network-ref? -> /nw:networks/network/network-id
```

### **2.2.4. Link Referencing**

When TE is enabled on a layer 3 unicast topology, if the TE topology is not congruent with the layer 3 unicast topology, a link in the layer 3 topology may have a reference to the corresponding link in the TE Topology. Such a reference is modeled as follows:

```
augment /nw:networks/nw:network/nt:link/l3t:l3-link-attributes:
  +--rw l3-te-link-attributes
    +--rw link-ref?      leafref
    +--rw network-ref?   -> /nw:networks/network/network-id
```

## **2.3. Topology Type Modeling**

A new topology type is defined in this document, to indicate a topology that is a layer 3 TE topology, which both inherits l3 unicast topology properties and is capable of TE.

```
augment /nw:networks/nw:network/nw:network-types
  /l3t:l3-unicast-topology:
  +--rw l3-te!
```

## **3. Packet TE YANG Types**

This document updates [[RFC8776](#)] with a new revision of the module `ietf-te-packet-types`.



The module `ietf-te-packet-types` has been updated to add the following YANG identities, types and groupings which can be reused by MPLS-TE and other packet technologies YANG models:

`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.

`bandwidth-scientific-notation` This types represents the bandwidth in bit-per-second, using the scientific notation (e.g., `10e3`).

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

The Packet TE path bandwidth can be represented by a bandwidth profile as follow:

```
+--:(packet)
  +--rw bandwidth-profile-name?  string
  +--rw bandwidth-profile-type?  identityref
  +--rw cir?                      uint64
  +--rw eir?                      uint64
  +--rw cbs?                      uint64
  +--rw ebs?                      uint64
```

Other formats for the MPLS-TE path bandwidth are defined in [\[I-D.ietf-teas-yang-te-mpls\]](#) and they could be added in a future update of this document.

`te-packet-link-bandwidth` This grouping defines the link bandwidth information and could be used in any Packet TE topology model (e.g., MPLS-TE) 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 Packet TE technologies.

The Packet TE link bandwidth can be represented by a bandwidth expressed in scientific notation as follow:

```
+--:(packet)
  +--rw packet-bandwidth?  bandwidth-scientific-notation
```





#### 4. Packet Switching Technology Extensions to TE Topologies

The technology agnostic TE Topology model is defined in [RFC8795], which is extended by this document to cover the Packet Switch Capable (PSC) technology [RFC3471] [RFC7074].

##### 4.1. Technology Specific Link Attributes

The technology agnostic TE Topology model is augmented with packet switching specific link attributes:

```
augment /nw:networks/tet:te/tet:templates/tet:link-template
  /tet:te-link-attributes
  /tet:interface-switching-capability:
  +-rw packet-switch-capable
    +-rw minimum-lsp-bandwidth?  rt-types:bandwidth-ieee-float32
    +-rw interface-mtu?          uint16
augment /nw:networks/nw:network/nt:link/tet:te
  /tet:te-link-attributes
  /tet:interface-switching-capability:
  +-rw packet-switch-capable
    +-rw minimum-lsp-bandwidth?  rt-types:bandwidth-ieee-float32
    +-rw interface-mtu?          uint16
augment /nw:networks/nw:network/nt:link/tet:te
  /tet:information-source-entry
  /tet:interface-switching-capability:
  +-ro packet-switch-capable
    +-ro minimum-lsp-bandwidth?  rt-types:bandwidth-ieee-float32
    +-ro interface-mtu?          uint16
```

##### 4.2. Performance Metric

[RFC7471], [RFC8570] and [RFC7823] specify TE performance metric parameters and their usage. The packet switching augmentations specified in this document support such a capability, which can be conditional enabled by a YANG feature "te-performance-metric".

```
augment /nw:networks/nw:network/nw:node/tet:te
  /tet:te-node-attributes/tet:connectivity-matrices:
  +-rw performance-metric
    +-rw measurement
      | .....
  +-rw normality
      | .....
  +-rw throttle
      | .....
  +-rw .....
```

Such an augmentation has been applied to:



- o Connectivity matrices container
- o Connectivity matrix entry
- o Local link connectivities container
- o Local link connectivity entry
- o TE link attributes container in a TE link template
- o TE link attributes container in a TE link
- o Information source entry in a TE link

## 5. Complete Model Tree Structure

### 5.1. Layer 3 TE Topology Module

The model tree structure of the layer 3 TE topology module is as shown below:

```
module: ietf-l3-te-topology
  augment /nw:networks/nw:network/nw:network-types
    /l3t:l3-unicast-topology:
      +--rw l3-te!
  augment /nw:networks/nw:network/l3t:l3-topology-attributes:
    +--rw l3-te-topology-attributes
      +--rw network-ref? -> /nw:networks/network/network-id
  augment /nw:networks/nw:network/nw:node/l3t:l3-node-attributes:
    +--rw l3-te-node-attributes
      +--rw node-ref? leafref
      +--rw network-ref? -> /nw:networks/network/network-id
  augment /nw:networks/nw:network/nw:node/nt:termination-point
    /l3t:l3-termination-point-attributes:
      +--rw l3-te-tp-attributes
        +--rw tp-ref? leafref
        +--rw node-ref? leafref
        +--rw network-ref? -> /nw:networks/network/network-id
  augment /nw:networks/nw:network/nt:link/l3t:l3-link-attributes:
    +--rw l3-te-link-attributes
      +--rw link-ref? leafref
      +--rw network-ref? -> /nw:networks/network/network-id
```



## 5.2. Packet Switching TE Topology Module

This is an augmentation to base TE topology model.

### 5.2.1. Network Types

This augments the network types with a new network type for TE packet topologies.

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

### 5.2.2. Node Connectivity Matrix Attributes

This augments the node connectivity matrix attributes with configuration and states for performance metrics when the network type is packet.

```
augment /nw:networks/nw:network/nw:node/tet:te
  /tet:te-node-attributes/tet:connectivity-matrices:
  +-ro performance-metrics-one-way {te-performance-metric}?
  | +-ro one-way-delay?                               uint32
  | +-ro one-way-delay-normality?
  | |         te-types:performance-metrics-normality
  | +-ro one-way-residual-bandwidth?
  | |         rt-types:bandwidth-ieee-float32
  | +-ro one-way-residual-bandwidth-normality?
  | |         te-types:performance-metrics-normality
  | +-ro one-way-available-bandwidth?
  | |         rt-types:bandwidth-ieee-float32
  | +-ro one-way-available-bandwidth-normality?
  | |         te-types:performance-metrics-normality
  | +-ro one-way-utilized-bandwidth?
  | |         rt-types:bandwidth-ieee-float32
  | +-ro one-way-utilized-bandwidth-normality?
  | |         te-types:performance-metrics-normality
  | +-ro one-way-min-delay?                           uint32
  | +-ro one-way-min-delay-normality?
  | |         te-types:performance-metrics-normality
  | +-ro one-way-max-delay?                           uint32
  | +-ro one-way-max-delay-normality?
  | |         te-types:performance-metrics-normality
  | +-ro one-way-delay-variation?                     uint32
```



```

| +--ro one-way-delay-variation-normality?
| |       te-types:performance-metrics-normality
| +--ro one-way-packet-loss?                decimal64
| +--ro one-way-packet-loss-normality?
|       te-types:performance-metrics-normality
+--ro performance-metrics-two-way {te-performance-metric}?
| +--ro two-way-delay?                      uint32
| +--ro two-way-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro two-way-min-delay?                  uint32
| +--ro two-way-min-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro two-way-max-delay?                  uint32
| +--ro two-way-max-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro two-way-delay-variation?            uint32
| +--ro two-way-delay-variation-normality?
| |       te-types:performance-metrics-normality
| +--ro two-way-packet-loss?                decimal64
| +--ro two-way-packet-loss-normality?
|       te-types:performance-metrics-normality
+--rw throttle {te-performance-metric}?
  +--rw one-way-delay-offset?                uint32
  +--rw measure-interval?                    uint32
  +--rw advertisement-interval?              uint32
  +--rw suppression-interval?                uint32
  +--rw threshold-out
  | +--rw one-way-delay?                      uint32
  | +--rw one-way-residual-bandwidth?
  | |       rt-types:bandwidth-ieee-float32
  | +--rw one-way-available-bandwidth?
  | |       rt-types:bandwidth-ieee-float32
  | +--rw one-way-utilized-bandwidth?
  | |       rt-types:bandwidth-ieee-float32
  | +--rw two-way-delay?                      uint32
  | +--rw one-way-min-delay?                  uint32
  | +--rw one-way-max-delay?                  uint32
  | +--rw one-way-delay-variation?            uint32
  | +--rw one-way-packet-loss?                decimal64
  | +--rw two-way-min-delay?                  uint32
  | +--rw two-way-max-delay?                  uint32
  | +--rw two-way-delay-variation?            uint32
  | +--rw two-way-packet-loss?                decimal64
+--rw threshold-in
  | +--rw one-way-delay?                      uint32
  | +--rw one-way-residual-bandwidth?
  | |       rt-types:bandwidth-ieee-float32
  | +--rw one-way-available-bandwidth?

```





```

| |         rt-types:bandwidth-ieee-float32
| +--rw one-way-utilized-bandwidth?
| |         rt-types:bandwidth-ieee-float32
| +--rw two-way-delay?                uint32
| +--rw one-way-min-delay?            uint32
| +--rw one-way-max-delay?            uint32
| +--rw one-way-delay-variation?      uint32
| +--rw one-way-packet-loss?          decimal64
| +--rw two-way-min-delay?            uint32
| +--rw two-way-max-delay?            uint32
| +--rw two-way-delay-variation?      uint32
| +--rw two-way-packet-loss?          decimal64
+--rw threshold-accelerated-advertisement
  +--rw one-way-delay?                uint32
  +--rw one-way-residual-bandwidth?
    |         rt-types:bandwidth-ieee-float32
  +--rw one-way-available-bandwidth?
    |         rt-types:bandwidth-ieee-float32
  +--rw one-way-utilized-bandwidth?
    |         rt-types:bandwidth-ieee-float32
  +--rw two-way-delay?                uint32
  +--rw one-way-min-delay?            uint32
  +--rw one-way-max-delay?            uint32
  +--rw one-way-delay-variation?      uint32
  +--rw one-way-packet-loss?          decimal64
  +--rw two-way-min-delay?            uint32
  +--rw two-way-max-delay?            uint32
  +--rw two-way-delay-variation?      uint32
  +--rw two-way-packet-loss?          decimal64
augment /nw:networks/nw:network/nw:node/tet:te
  /tet:te-node-attributes/tet:connectivity-matrices
  /tet:connectivity-matrix:
+--ro performance-metrics-one-way {te-performance-metric}?
| +--ro one-way-delay?                uint32
| +--ro one-way-delay-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-residual-bandwidth?
| |         rt-types:bandwidth-ieee-float32
| +--ro one-way-residual-bandwidth-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-available-bandwidth?
| |         rt-types:bandwidth-ieee-float32
| +--ro one-way-available-bandwidth-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-utilized-bandwidth?
| |         rt-types:bandwidth-ieee-float32
| +--ro one-way-utilized-bandwidth-normality?
| |         te-types:performance-metrics-normality

```



```

| +--ro one-way-min-delay?                               uint32
| +--ro one-way-min-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-max-delay?                               uint32
| +--ro one-way-max-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-delay-variation?                         uint32
| +--ro one-way-delay-variation-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-packet-loss?                             decimal64
| +--ro one-way-packet-loss-normality?
| |   te-types:performance-metrics-normality
+--ro performance-metrics-two-way {te-performance-metric}?
| +--ro two-way-delay?                                   uint32
| +--ro two-way-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro two-way-min-delay?                               uint32
| +--ro two-way-min-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro two-way-max-delay?                               uint32
| +--ro two-way-max-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro two-way-delay-variation?                         uint32
| +--ro two-way-delay-variation-normality?
| |   te-types:performance-metrics-normality
| +--ro two-way-packet-loss?                             decimal64
| +--ro two-way-packet-loss-normality?
| |   te-types:performance-metrics-normality
+--rw throttle {te-performance-metric}?
  +--rw one-way-delay-offset?                             uint32
  +--rw measure-interval?                                uint32
  +--rw advertisement-interval?                          uint32
  +--rw suppression-interval?                            uint32
  +--rw threshold-out
    | +--rw one-way-delay?                                uint32
    | +--rw one-way-residual-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--rw one-way-available-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--rw one-way-utilized-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--rw two-way-delay?                                uint32
    | +--rw one-way-min-delay?                            uint32
    | +--rw one-way-max-delay?                            uint32
    | +--rw one-way-delay-variation?                     uint32
    | +--rw one-way-packet-loss?                         decimal64
    | +--rw two-way-min-delay?                            uint32
    | +--rw two-way-max-delay?                            uint32

```



```

| +-rw two-way-delay-variation?      uint32
| +-rw two-way-packet-loss?         decimal64
+-rw threshold-in
| +-rw one-way-delay?                uint32
| +-rw one-way-residual-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-rw one-way-available-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-rw one-way-utilized-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-rw two-way-delay?                uint32
| +-rw one-way-min-delay?            uint32
| +-rw one-way-max-delay?            uint32
| +-rw one-way-delay-variation?     uint32
| +-rw one-way-packet-loss?         decimal64
| +-rw two-way-min-delay?            uint32
| +-rw two-way-max-delay?            uint32
| +-rw two-way-delay-variation?     uint32
| +-rw two-way-packet-loss?         decimal64
+-rw threshold-accelerated-advertisement
  +-rw one-way-delay?                uint32
  +-rw one-way-residual-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-rw one-way-available-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-rw one-way-utilized-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-rw two-way-delay?                uint32
  +-rw one-way-min-delay?            uint32
  +-rw one-way-max-delay?            uint32
  +-rw one-way-delay-variation?     uint32
  +-rw one-way-packet-loss?         decimal64
  +-rw two-way-min-delay?            uint32
  +-rw two-way-max-delay?            uint32
  +-rw two-way-delay-variation?     uint32
  +-rw two-way-packet-loss?         decimal64

```

### 5.2.3. Node Information Source

This augments the node information source with states for performance metrics when the network type is packet.

```

augment /nw:networks/nw:network/nw:node/tet:te
  /tet:information-source-entry/tet:connectivity-matrices:
  +-ro performance-metrics-one-way {te-performance-metric}?
  | +-ro one-way-delay?                uint32

```









```

| +-ro one-way-delay?                uint32
| +-ro one-way-residual-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-ro one-way-available-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-ro one-way-utilized-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-ro two-way-delay?                uint32
| +-ro one-way-min-delay?            uint32
| +-ro one-way-max-delay?            uint32
| +-ro one-way-delay-variation?      uint32
| +-ro one-way-packet-loss?          decimal64
| +-ro two-way-min-delay?            uint32
| +-ro two-way-max-delay?            uint32
| +-ro two-way-delay-variation?      uint32
| +-ro two-way-packet-loss?          decimal64
+--ro threshold-in
| +-ro one-way-delay?                uint32
| +-ro one-way-residual-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-ro one-way-available-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-ro one-way-utilized-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-ro two-way-delay?                uint32
| +-ro one-way-min-delay?            uint32
| +-ro one-way-max-delay?            uint32
| +-ro one-way-delay-variation?      uint32
| +-ro one-way-packet-loss?          decimal64
| +-ro two-way-min-delay?            uint32
| +-ro two-way-max-delay?            uint32
| +-ro two-way-delay-variation?      uint32
| +-ro two-way-packet-loss?          decimal64
+--ro threshold-accelerated-advertisement
  +-ro one-way-delay?                uint32
  +-ro one-way-residual-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-ro one-way-available-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-ro one-way-utilized-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-ro two-way-delay?                uint32
  +-ro one-way-min-delay?            uint32
  +-ro one-way-max-delay?            uint32
  +-ro one-way-delay-variation?      uint32
  +-ro one-way-packet-loss?          decimal64
  +-ro two-way-min-delay?            uint32
  +-ro two-way-max-delay?            uint32

```



```

        +--ro two-way-delay-variation?          uint32
        +--ro two-way-packet-loss?             decimal64
augment /nw:networks/nw:network/nw:node/tet:te
        /tet:information-source-entry/tet:connectivity-matrices
        /tet:connectivity-matrix:
+--ro performance-metrics-one-way {te-performance-metric}?
| +--ro one-way-delay?                          uint32
| +--ro one-way-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro one-way-residual-bandwidth?
| |       rt-types:bandwidth-ieee-float32
| +--ro one-way-residual-bandwidth-normality?
| |       te-types:performance-metrics-normality
| +--ro one-way-available-bandwidth?
| |       rt-types:bandwidth-ieee-float32
| +--ro one-way-available-bandwidth-normality?
| |       te-types:performance-metrics-normality
| +--ro one-way-utilized-bandwidth?
| |       rt-types:bandwidth-ieee-float32
| +--ro one-way-utilized-bandwidth-normality?
| |       te-types:performance-metrics-normality
| +--ro one-way-min-delay?                      uint32
| +--ro one-way-min-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro one-way-max-delay?                      uint32
| +--ro one-way-max-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro one-way-delay-variation?                uint32
| +--ro one-way-delay-variation-normality?
| |       te-types:performance-metrics-normality
| +--ro one-way-packet-loss?                    decimal64
| +--ro one-way-packet-loss-normality?
| |       te-types:performance-metrics-normality
+--ro performance-metrics-two-way {te-performance-metric}?
| +--ro two-way-delay?                          uint32
| +--ro two-way-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro two-way-min-delay?                      uint32
| +--ro two-way-min-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro two-way-max-delay?                      uint32
| +--ro two-way-max-delay-normality?
| |       te-types:performance-metrics-normality
| +--ro two-way-delay-variation?                uint32
| +--ro two-way-delay-variation-normality?
| |       te-types:performance-metrics-normality
| +--ro two-way-packet-loss?                    decimal64
| +--ro two-way-packet-loss-normality?

```



```
|           te-types:performance-metrics-normality
+--ro throttle {te-performance-metric}?
  +--ro one-way-delay-offset?           uint32
  +--ro measure-interval?              uint32
  +--ro advertisement-interval?        uint32
  +--ro suppression-interval?          uint32
  +--ro threshold-out
    | +--ro one-way-delay?              uint32
    | +--ro one-way-residual-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--ro one-way-available-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--ro one-way-utilized-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--ro two-way-delay?             uint32
    | +--ro one-way-min-delay?         uint32
    | +--ro one-way-max-delay?         uint32
    | +--ro one-way-delay-variation?   uint32
    | +--ro one-way-packet-loss?       decimal64
    | +--ro two-way-min-delay?         uint32
    | +--ro two-way-max-delay?         uint32
    | +--ro two-way-delay-variation?   uint32
    | +--ro two-way-packet-loss?       decimal64
  +--ro threshold-in
    | +--ro one-way-delay?             uint32
    | +--ro one-way-residual-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--ro one-way-available-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--ro one-way-utilized-bandwidth?
    | |   rt-types:bandwidth-ieee-float32
    | +--ro two-way-delay?             uint32
    | +--ro one-way-min-delay?         uint32
    | +--ro one-way-max-delay?         uint32
    | +--ro one-way-delay-variation?   uint32
    | +--ro one-way-packet-loss?       decimal64
    | +--ro two-way-min-delay?         uint32
    | +--ro two-way-max-delay?         uint32
    | +--ro two-way-delay-variation?   uint32
    | +--ro two-way-packet-loss?       decimal64
  +--ro threshold-accelerated-advertisement
    +--ro one-way-delay?               uint32
    +--ro one-way-residual-bandwidth?
    |   rt-types:bandwidth-ieee-float32
    +--ro one-way-available-bandwidth?
    |   rt-types:bandwidth-ieee-float32
    +--ro one-way-utilized-bandwidth?
    |   rt-types:bandwidth-ieee-float32
```



```

+--ro two-way-delay?                uint32
+--ro one-way-min-delay?            uint32
+--ro one-way-max-delay?            uint32
+--ro one-way-delay-variation?      uint32
+--ro one-way-packet-loss?          decimal64
+--ro two-way-min-delay?            uint32
+--ro two-way-max-delay?            uint32
+--ro two-way-delay-variation?      uint32
+--ro two-way-packet-loss?          decimal64

```

#### 5.2.4. Node Local Link Connectivity

This augments the node local link connectivity attributes with configuration and states for performance metrics when the network type is packet.

```

augment /nw:networks/nw:network/nw:node/tet:te
  /tet:tunnel-termination-point
  /tet:local-link-connectivities:
+--ro performance-metrics-one-way {te-performance-metric}?
| +--ro one-way-delay?                uint32
| +--ro one-way-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-residual-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +--ro one-way-residual-bandwidth-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-available-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +--ro one-way-available-bandwidth-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-utilized-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +--ro one-way-utilized-bandwidth-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-min-delay?            uint32
| +--ro one-way-min-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-max-delay?            uint32
| +--ro one-way-max-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-delay-variation?      uint32
| +--ro one-way-delay-variation-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-packet-loss?          decimal64
| +--ro one-way-packet-loss-normality?

```





```

|         te-types:performance-metrics-normality
+--ro performance-metrics-two-way {te-performance-metric}?
|   +--ro two-way-delay?                uint32
|   +--ro two-way-delay-normality?
|     |         te-types:performance-metrics-normality
|     +--ro two-way-min-delay?          uint32
|     +--ro two-way-min-delay-normality?
|       |         te-types:performance-metrics-normality
|       +--ro two-way-max-delay?        uint32
|       +--ro two-way-max-delay-normality?
|         |         te-types:performance-metrics-normality
|         +--ro two-way-delay-variation?  uint32
|         +--ro two-way-delay-variation-normality?
|           |         te-types:performance-metrics-normality
|           +--ro two-way-packet-loss?    decimal64
|           +--ro two-way-packet-loss-normality?
|             te-types:performance-metrics-normality
+--rw throttle {te-performance-metric}?
  +--rw one-way-delay-offset?            uint32
  +--rw measure-interval?                uint32
  +--rw advertisement-interval?          uint32
  +--rw suppression-interval?            uint32
  +--rw threshold-out
  |   +--rw one-way-delay?                uint32
  |   +--rw one-way-residual-bandwidth?
  |     |         rt-types:bandwidth-ieee-float32
  |     +--rw one-way-available-bandwidth?
  |       |         rt-types:bandwidth-ieee-float32
  |       +--rw one-way-utilized-bandwidth?
  |         |         rt-types:bandwidth-ieee-float32
  |         +--rw two-way-delay?          uint32
  |         +--rw one-way-min-delay?      uint32
  |         +--rw one-way-max-delay?      uint32
  |         +--rw one-way-delay-variation?  uint32
  |         +--rw one-way-packet-loss?    decimal64
  |         +--rw two-way-min-delay?      uint32
  |         +--rw two-way-max-delay?      uint32
  |         +--rw two-way-delay-variation?  uint32
  |         +--rw two-way-packet-loss?    decimal64
  +--rw threshold-in
  |   +--rw one-way-delay?                uint32
  |   +--rw one-way-residual-bandwidth?
  |     |         rt-types:bandwidth-ieee-float32
  |     +--rw one-way-available-bandwidth?
  |       |         rt-types:bandwidth-ieee-float32
  |       +--rw one-way-utilized-bandwidth?
  |         |         rt-types:bandwidth-ieee-float32
  |         +--rw two-way-delay?          uint32

```



```

    | +-rw one-way-min-delay?          uint32
    | +-rw one-way-max-delay?          uint32
    | +-rw one-way-delay-variation?    uint32
    | +-rw one-way-packet-loss?        decimal64
    | +-rw two-way-min-delay?          uint32
    | +-rw two-way-max-delay?          uint32
    | +-rw two-way-delay-variation?    uint32
    | +-rw two-way-packet-loss?        decimal64
+-rw threshold-accelerated-advertisement
  +-rw one-way-delay?                  uint32
  +-rw one-way-residual-bandwidth?
    | rt-types:bandwidth-ieee-float32
  +-rw one-way-available-bandwidth?
    | rt-types:bandwidth-ieee-float32
  +-rw one-way-utilized-bandwidth?
    | rt-types:bandwidth-ieee-float32
  +-rw two-way-delay?                  uint32
  +-rw one-way-min-delay?              uint32
  +-rw one-way-max-delay?              uint32
  +-rw one-way-delay-variation?        uint32
  +-rw one-way-packet-loss?            decimal64
  +-rw two-way-min-delay?              uint32
  +-rw two-way-max-delay?              uint32
  +-rw two-way-delay-variation?        uint32
  +-rw two-way-packet-loss?            decimal64
augment /nw:networks/nw:network/nw:node/tet:te
  /tet:tunnel-termination-point
  /tet:local-link-connectivities
  /tet:local-link-connectivity:
+-ro performance-metrics-one-way {te-performance-metric}?
| +-ro one-way-delay?                  uint32
| +-ro one-way-delay-normality?
| | te-types:performance-metrics-normality
| +-ro one-way-residual-bandwidth?
| | rt-types:bandwidth-ieee-float32
| +-ro one-way-residual-bandwidth-normality?
| | te-types:performance-metrics-normality
| +-ro one-way-available-bandwidth?
| | rt-types:bandwidth-ieee-float32
| +-ro one-way-available-bandwidth-normality?
| | te-types:performance-metrics-normality
| +-ro one-way-utilized-bandwidth?
| | rt-types:bandwidth-ieee-float32
| +-ro one-way-utilized-bandwidth-normality?
| | te-types:performance-metrics-normality
| +-ro one-way-min-delay?              uint32
| +-ro one-way-min-delay-normality?
| | te-types:performance-metrics-normality

```







```

| +-rw one-way-delay?                uint32
| +-rw one-way-residual-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-rw one-way-available-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-rw one-way-utilized-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +-rw two-way-delay?                uint32
| +-rw one-way-min-delay?            uint32
| +-rw one-way-max-delay?            uint32
| +-rw one-way-delay-variation?      uint32
| +-rw one-way-packet-loss?          decimal64
| +-rw two-way-min-delay?            uint32
| +-rw two-way-max-delay?            uint32
| +-rw two-way-delay-variation?      uint32
| +-rw two-way-packet-loss?          decimal64
+--rw threshold-accelerated-advertisement
  +-rw one-way-delay?                uint32
  +-rw one-way-residual-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-rw one-way-available-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-rw one-way-utilized-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-rw two-way-delay?                uint32
  +-rw one-way-min-delay?            uint32
  +-rw one-way-max-delay?            uint32
  +-rw one-way-delay-variation?      uint32
  +-rw one-way-packet-loss?          decimal64
  +-rw two-way-min-delay?            uint32
  +-rw two-way-max-delay?            uint32
  +-rw two-way-delay-variation?      uint32
  +-rw two-way-packet-loss?          decimal64

```

#### 5.2.5. Link Template for Performance Metrics

This augments the link template attributes with configuration and states for performance metrics when the network type is packet.

```

augment /nw:networks/tet:te/tet:templates/tet:link-template
  /tet:te-link-attributes:
  +-ro performance-metrics-one-way {te-performance-metric}?
  | +-ro one-way-delay?                uint32
  | +-ro one-way-delay-normality?
  | |   te-types:performance-metrics-normality
  | +-ro one-way-residual-bandwidth?

```





```

| |         rt-types:bandwidth-ieee-float32
| +--ro one-way-residual-bandwidth-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-available-bandwidth?
| |         rt-types:bandwidth-ieee-float32
| +--ro one-way-available-bandwidth-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-utilized-bandwidth?
| |         rt-types:bandwidth-ieee-float32
| +--ro one-way-utilized-bandwidth-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-min-delay?                               uint32
| +--ro one-way-min-delay-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-max-delay?                               uint32
| +--ro one-way-max-delay-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-delay-variation?                         uint32
| +--ro one-way-delay-variation-normality?
| |         te-types:performance-metrics-normality
| +--ro one-way-packet-loss?                             decimal64
| +--ro one-way-packet-loss-normality?
| |         te-types:performance-metrics-normality
+--ro performance-metrics-two-way {te-performance-metric}?
| +--ro two-way-delay?                                   uint32
| +--ro two-way-delay-normality?
| |         te-types:performance-metrics-normality
| +--ro two-way-min-delay?                               uint32
| +--ro two-way-min-delay-normality?
| |         te-types:performance-metrics-normality
| +--ro two-way-max-delay?                               uint32
| +--ro two-way-max-delay-normality?
| |         te-types:performance-metrics-normality
| +--ro two-way-delay-variation?                         uint32
| +--ro two-way-delay-variation-normality?
| |         te-types:performance-metrics-normality
| +--ro two-way-packet-loss?                             decimal64
| +--ro two-way-packet-loss-normality?
| |         te-types:performance-metrics-normality
+--rw throttle {te-performance-metric}?
  +--rw one-way-delay-offset?                            uint32
  +--rw measure-interval?                                uint32
  +--rw advertisement-interval?                          uint32
  +--rw suppression-interval?                            uint32
  +--rw threshold-out
  | +--rw one-way-delay?                                  uint32
  | +--rw one-way-residual-bandwidth?
  | |         rt-types:bandwidth-ieee-float32

```



```
| +-rw one-way-available-bandwidth?
| |     rt-types:bandwidth-ieee-float32
| +-rw one-way-utilized-bandwidth?
| |     rt-types:bandwidth-ieee-float32
| +-rw two-way-delay?                uint32
| +-rw one-way-min-delay?            uint32
| +-rw one-way-max-delay?            uint32
| +-rw one-way-delay-variation?      uint32
| +-rw one-way-packet-loss?          decimal64
| +-rw two-way-min-delay?            uint32
| +-rw two-way-max-delay?            uint32
| +-rw two-way-delay-variation?      uint32
| +-rw two-way-packet-loss?          decimal64
+--rw threshold-in
| +-rw one-way-delay?                uint32
| +-rw one-way-residual-bandwidth?
| |     rt-types:bandwidth-ieee-float32
| +-rw one-way-available-bandwidth?
| |     rt-types:bandwidth-ieee-float32
| +-rw one-way-utilized-bandwidth?
| |     rt-types:bandwidth-ieee-float32
| +-rw two-way-delay?                uint32
| +-rw one-way-min-delay?            uint32
| +-rw one-way-max-delay?            uint32
| +-rw one-way-delay-variation?      uint32
| +-rw one-way-packet-loss?          decimal64
| +-rw two-way-min-delay?            uint32
| +-rw two-way-max-delay?            uint32
| +-rw two-way-delay-variation?      uint32
| +-rw two-way-packet-loss?          decimal64
+--rw threshold-accelerated-advertisement
  +-rw one-way-delay?                uint32
  +-rw one-way-residual-bandwidth?
  |     rt-types:bandwidth-ieee-float32
  +-rw one-way-available-bandwidth?
  |     rt-types:bandwidth-ieee-float32
  +-rw one-way-utilized-bandwidth?
  |     rt-types:bandwidth-ieee-float32
  +-rw two-way-delay?                uint32
  +-rw one-way-min-delay?            uint32
  +-rw one-way-max-delay?            uint32
  +-rw one-way-delay-variation?      uint32
  +-rw one-way-packet-loss?          decimal64
  +-rw two-way-min-delay?            uint32
  +-rw two-way-max-delay?            uint32
  +-rw two-way-delay-variation?      uint32
  +-rw two-way-packet-loss?          decimal64
```



### 5.2.6. Link for Performance Metrics

This augments the link attributes with configuration and states for performance metrics when the network type is packet.

```

augment /nw:networks/nw:network/nt:link/tet:te
  /tet:te-link-attributes:
  +--ro performance-metrics-one-way {te-performance-metric}?
  | +--ro one-way-delay?                               uint32
  | +--ro one-way-delay-normality?
  | |         te-types:performance-metrics-normality
  | +--ro one-way-residual-bandwidth?
  | |         rt-types:bandwidth-ieee-float32
  | +--ro one-way-residual-bandwidth-normality?
  | |         te-types:performance-metrics-normality
  | +--ro one-way-available-bandwidth?
  | |         rt-types:bandwidth-ieee-float32
  | +--ro one-way-available-bandwidth-normality?
  | |         te-types:performance-metrics-normality
  | +--ro one-way-utilized-bandwidth?
  | |         rt-types:bandwidth-ieee-float32
  | +--ro one-way-utilized-bandwidth-normality?
  | |         te-types:performance-metrics-normality
  | +--ro one-way-min-delay?                           uint32
  | +--ro one-way-min-delay-normality?
  | |         te-types:performance-metrics-normality
  | +--ro one-way-max-delay?                           uint32
  | +--ro one-way-max-delay-normality?
  | |         te-types:performance-metrics-normality
  | +--ro one-way-delay-variation?                     uint32
  | +--ro one-way-delay-variation-normality?
  | |         te-types:performance-metrics-normality
  | +--ro one-way-packet-loss?                         decimal64
  | +--ro one-way-packet-loss-normality?
  | |         te-types:performance-metrics-normality
  +--ro performance-metrics-two-way {te-performance-metric}?
  | +--ro two-way-delay?                               uint32
  | +--ro two-way-delay-normality?
  | |         te-types:performance-metrics-normality
  | +--ro two-way-min-delay?                           uint32
  | +--ro two-way-min-delay-normality?
  | |         te-types:performance-metrics-normality
  | +--ro two-way-max-delay?                           uint32
  | +--ro two-way-max-delay-normality?
  | |         te-types:performance-metrics-normality
  | +--ro two-way-delay-variation?                     uint32
  | +--ro two-way-delay-variation-normality?

```



```

| |         te-types:performance-metrics-normality
| +--ro two-way-packet-loss?                decimal64
| +--ro two-way-packet-loss-normality?
|         te-types:performance-metrics-normality
+--rw throttle {te-performance-metric}?
  +--rw one-way-delay-offset?                uint32
  +--rw measure-interval?                    uint32
  +--rw advertisement-interval?              uint32
  +--rw suppression-interval?                uint32
  +--rw threshold-out
    | +--rw one-way-delay?                    uint32
    | +--rw one-way-residual-bandwidth?
    | |         rt-types:bandwidth-ieee-float32
    | +--rw one-way-available-bandwidth?
    | |         rt-types:bandwidth-ieee-float32
    | +--rw one-way-utilized-bandwidth?
    | |         rt-types:bandwidth-ieee-float32
    | +--rw two-way-delay?                    uint32
    | +--rw one-way-min-delay?                uint32
    | +--rw one-way-max-delay?                uint32
    | +--rw one-way-delay-variation?          uint32
    | +--rw one-way-packet-loss?              decimal64
    | +--rw two-way-min-delay?                uint32
    | +--rw two-way-max-delay?                uint32
    | +--rw two-way-delay-variation?          uint32
    | +--rw two-way-packet-loss?              decimal64
  +--rw threshold-in
    | +--rw one-way-delay?                    uint32
    | +--rw one-way-residual-bandwidth?
    | |         rt-types:bandwidth-ieee-float32
    | +--rw one-way-available-bandwidth?
    | |         rt-types:bandwidth-ieee-float32
    | +--rw one-way-utilized-bandwidth?
    | |         rt-types:bandwidth-ieee-float32
    | +--rw two-way-delay?                    uint32
    | +--rw one-way-min-delay?                uint32
    | +--rw one-way-max-delay?                uint32
    | +--rw one-way-delay-variation?          uint32
    | +--rw one-way-packet-loss?              decimal64
    | +--rw two-way-min-delay?                uint32
    | +--rw two-way-max-delay?                uint32
    | +--rw two-way-delay-variation?          uint32
    | +--rw two-way-packet-loss?              decimal64
  +--rw threshold-accelerated-advertisement
    +--rw one-way-delay?                      uint32
    +--rw one-way-residual-bandwidth?
    |         rt-types:bandwidth-ieee-float32
    +--rw one-way-available-bandwidth?

```





```

|         rt-types:bandwidth-ieee-float32
+--rw one-way-utilized-bandwidth?
|         rt-types:bandwidth-ieee-float32
+--rw two-way-delay?                uint32
+--rw one-way-min-delay?            uint32
+--rw one-way-max-delay?            uint32
+--rw one-way-delay-variation?     uint32
+--rw one-way-packet-loss?         decimal64
+--rw two-way-min-delay?            uint32
+--rw two-way-max-delay?            uint32
+--rw two-way-delay-variation?     uint32
+--rw two-way-packet-loss?         decimal64

```

### 5.2.7. Link Information Source for Performance Metrics

This augments the link information source with states for performance metrics when the network type is packet.

```

augment /nw:networks/nw:network/nt:link/tet:te
  /tet:information-source-entry:
+--ro performance-metrics-one-way {te-performance-metric}?
| +--ro one-way-delay?                uint32
| +--ro one-way-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-residual-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +--ro one-way-residual-bandwidth-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-available-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +--ro one-way-available-bandwidth-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-utilized-bandwidth?
| |   rt-types:bandwidth-ieee-float32
| +--ro one-way-utilized-bandwidth-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-min-delay?            uint32
| +--ro one-way-min-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-max-delay?            uint32
| +--ro one-way-max-delay-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-delay-variation?     uint32
| +--ro one-way-delay-variation-normality?
| |   te-types:performance-metrics-normality
| +--ro one-way-packet-loss?         decimal64

```



```

|   +--ro one-way-packet-loss-normality?
|       te-types:performance-metrics-normality
+--ro performance-metrics-two-way {te-performance-metric}?
|   +--ro two-way-delay?                               uint32
|   +--ro two-way-delay-normality?
|       |       te-types:performance-metrics-normality
|   +--ro two-way-min-delay?                           uint32
|   +--ro two-way-min-delay-normality?
|       |       te-types:performance-metrics-normality
|   +--ro two-way-max-delay?                           uint32
|   +--ro two-way-max-delay-normality?
|       |       te-types:performance-metrics-normality
|   +--ro two-way-delay-variation?                     uint32
|   +--ro two-way-delay-variation-normality?
|       |       te-types:performance-metrics-normality
|   +--ro two-way-packet-loss?                         decimal64
|   +--ro two-way-packet-loss-normality?
|       te-types:performance-metrics-normality
+--ro throttle {te-performance-metric}?
    +--ro one-way-delay-offset?                         uint32
    +--ro measure-interval?                            uint32
    +--ro advertisement-interval?                      uint32
    +--ro suppression-interval?                       uint32
    +--ro threshold-out
        |   +--ro one-way-delay?                         uint32
        |   +--ro one-way-residual-bandwidth?
        |       |       rt-types:bandwidth-ieee-float32
        |   +--ro one-way-available-bandwidth?
        |       |       rt-types:bandwidth-ieee-float32
        |   +--ro one-way-utilized-bandwidth?
        |       |       rt-types:bandwidth-ieee-float32
        |   +--ro two-way-delay?                         uint32
        |   +--ro one-way-min-delay?                     uint32
        |   +--ro one-way-max-delay?                     uint32
        |   +--ro one-way-delay-variation?              uint32
        |   +--ro one-way-packet-loss?                  decimal64
        |   +--ro two-way-min-delay?                     uint32
        |   +--ro two-way-max-delay?                     uint32
        |   +--ro two-way-delay-variation?              uint32
        |   +--ro two-way-packet-loss?                  decimal64
    +--ro threshold-in
        |   +--ro one-way-delay?                         uint32
        |   +--ro one-way-residual-bandwidth?
        |       |       rt-types:bandwidth-ieee-float32
        |   +--ro one-way-available-bandwidth?
        |       |       rt-types:bandwidth-ieee-float32
        |   +--ro one-way-utilized-bandwidth?
        |       |       rt-types:bandwidth-ieee-float32

```



```

| +-ro two-way-delay?                uint32
| +-ro one-way-min-delay?            uint32
| +-ro one-way-max-delay?            uint32
| +-ro one-way-delay-variation?     uint32
| +-ro one-way-packet-loss?         decimal64
| +-ro two-way-min-delay?            uint32
| +-ro two-way-max-delay?            uint32
| +-ro two-way-delay-variation?     uint32
| +-ro two-way-packet-loss?         decimal64
+--ro threshold-accelerated-advertisement
  +-ro one-way-delay?                uint32
  +-ro one-way-residual-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-ro one-way-available-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-ro one-way-utilized-bandwidth?
  |   rt-types:bandwidth-ieee-float32
  +-ro two-way-delay?                uint32
  +-ro one-way-min-delay?            uint32
  +-ro one-way-max-delay?            uint32
  +-ro one-way-delay-variation?     uint32
  +-ro one-way-packet-loss?         decimal64
  +-ro two-way-min-delay?            uint32
  +-ro two-way-max-delay?            uint32
  +-ro two-way-delay-variation?     uint32
  +-ro two-way-packet-loss?         decimal64

```

### 5.2.8. Link Template for Packet-specific Attributes

This augments the link template attributes with configuration and states for packet-specific attributes when the network type is packet.

```

augment /nw:networks/tet:te/tet:templates/tet:link-template
  /tet:te-link-attributes
  /tet:interface-switching-capability:
    +-rw packet-switch-capable
    +-rw minimum-lsp-bandwidth?     rt-types:bandwidth-ieee-float32
    +-rw interface-mtu?              uint16

```

### 5.2.9. Link for Packet-specific Attributes

This augments the link attributes with configuration and states for packet-specific attributes when the network type is packet.



```

augment /nw:networks/nw:network/nt:link/tet:te
  /tet:te-link-attributes
  /tet:interface-switching-capability:
+--rw packet-switch-capable
  +--rw minimum-lsp-bandwidth?  rt-types:bandwidth-ieee-float32
  +--rw interface-mtu?          uint16

```

#### **5.2.10. Link Information Source for Packet-specific Attributes**

This augments the link information source with states for packet-specific attributes when the network type is packet.

```

augment /nw:networks/nw:network/nt:link/tet:te
  /tet:information-source-entry
  /tet:interface-switching-capability:
+--ro packet-switch-capable
  +--ro minimum-lsp-bandwidth?  rt-types:bandwidth-ieee-float32
  +--ro interface-mtu?          uint16

```

#### **5.2.11. TE Bandwidth for Packet-specific Technologies**

These augmentations specify TE bandwidth for packet-specific technologies.

```

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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?    bandwidth-scientific-notation
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?    bandwidth-scientific-notation
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?    bandwidth-scientific-notation
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?    bandwidth-scientific-notation
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?    bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation
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?  bandwidth-scientific-notation

```

## 6. YANG Modules

### 6.1. Layer 3 TE Topology Module

This module references [\[RFC8345\]](#), [\[RFC8346\]](#), and [\[RFC8795\]](#).

```

<CODE BEGINS> file "ietf-l3-te-topology@2020-05-03.yang"
module ietf-l3-te-topology {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-l3-te-topology";
  prefix "l3tet";

  import ietf-network {
    prefix "nw";
    reference "RFC 8345: A YANG Data Model for Network Topologies";
  }
  import ietf-network-topology {
    prefix "nt";
    reference "RFC 8345: A YANG Data Model for Network Topologies";
  }
  import ietf-l3-unicast-topology {
    prefix "l3t";
    reference "RFC 8346: A YANG Data Model for Layer 3 Topologies";
  }
  import ietf-te-topology {
    prefix "tet";
    reference
      "I-D.ietf-teas-yang-te-topo: YANG Data Model for Traffic
      Engineering (TE) Topologies";
  }
  organization

```



"IETF Traffic Engineering Architecture and Signaling (TEAS)  
Working Group";

contact

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description

"YANG data model for representing and manipulating Layer 3 TE  
Topologies.

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

revision 2020-05-03 {

description

"Initial revision";

reference "RFC XXXX: YANG Data Model for Layer 3 TE Topologies";

}





```
grouping l3-te-topology-type {
  description
    "Identifies the L3 TE topology type.";
  container l3-te {
    presence "Indicates L3 TE Topology";
    description
      "Its presence identifies the L3 TE topology type.";
  }
}

augment "/nw:networks/nw:network/nw:network-types/"
+ "l3t:l3-unicast-topology" {
  description
    "Defines the L3 TE topology type.";
  uses l3-te-topology-type;
}

augment "/nw:networks/nw:network/l3t:l3-topology-attributes" {
  when "../nw:network-types/l3t:l3-unicast-topology/l3tet:l3-te" {
    description
      "Augment only for L3 TE topology";
  }
  description
    "Augment topology configuration";
  uses l3-te-topology-attributes;
}

augment "/nw:networks/nw:network/nw:node/l3t:l3-node-attributes" {
  when "../nw:network-types/l3t:l3-unicast-topology/"
+ "l3tet:l3-te" {
    description
      "Augment only for L3 TE topology";
  }
  description
    "Augment node configuration";
  uses l3-te-node-attributes;
}

augment "/nw:networks/nw:network/nw:node/nt:termination-point/"
+ "l3t:l3-termination-point-attributes" {
  when "../nw:network-types/l3t:l3-unicast-topology/"
+ "l3tet:l3-te" {
    description
      "Augment only for L3 TE topology";
  }
  description
    "Augment termination point configuration";
  uses l3-te-tp-attributes;
}
```



```
}

augment "/nw:networks/nw:network/nt:link/l3t:l3-link-attributes" {
  when "../../../nw:network-types/l3t:l3-unicast-topology/"
  + "l3tet:l3-te" {
    description
      "Augment only for L3 TE topology";
  }
  description
    "Augment link configuration";
  uses l3-te-link-attributes;
}

grouping l3-te-topology-attributes {
  description
    "L3 TE topology scope attributes";
  container l3-te-topology-attributes {
    must "/nw:networks/nw:network"
    + "[nw:network-id = current()/network-ref]/nw:network-types/"
    + "tet:te-topology" {
      error-message
        "The referenced network must be a TE topology.";
      description
        "The referenced network must be a TE topology.";
    }
  }
  description
    "Containing TE topology references";
  uses nw:network-ref;
} // l3-te-topology-attributes
} // l3-te-topology-attributes

grouping l3-te-node-attributes {
  description
    "L3 TE node scope attributes";
  container l3-te-node-attributes {
    must "/nw:networks/nw:network"
    + "[nw:network-id = current()/network-ref]/nw:network-types/"
    + "tet:te-topology" {
      error-message
        "The referenced network must be a TE topology.";
      description
        "The referenced network must be a TE topology.";
    }
  }
  description
    "Containing TE node references";
  uses nw:node-ref;
} // l3-te
} // l3-te-node-attributes
```



```

grouping l3-te-tp-attributes {
  description
    "L3 TE termination point scope attributes";
  container l3-te-tp-attributes {
    must "/nw:networks/nw:network"
      + "[nw:network-id = current()/network-ref]/nw:network-types/"
      + "tet:te-topology" {
      error-message
        "The referenced network must be a TE topology.";
      description
        "The referenced network must be a TE topology.";
    }
    description
      "Containing TE termination point references";
    uses nt:tp-ref;
  } // l3-te
} // l3-te-tp-attributes

grouping l3-te-link-attributes {
  description
    "L3 TE link scope attributes";
  container l3-te-link-attributes {
    must "/nw:networks/nw:network"
      + "[nw:network-id = current()/network-ref]/nw:network-types/"
      + "tet:te-topology" {
      error-message
        "The referenced network must be a TE topology.";
      description
        "The referenced network must be a TE topology.";
    }
    description
      "Containing TE link references";
    uses nt:link-ref;
  }
} // l3-te-link-attributes
}
<CODE ENDS>

```

## 6.2. Packet TE YANG Types Module

This module references [\[RFC2697\]](#), [\[RFC2698\]](#), [\[RFC4115\]](#), [\[RFC4124\]](#), [\[RFC4125\]](#), [\[RFC4126\]](#), [\[RFC4127\]](#), [\[RFC5481\]](#), [\[RFC7471\]](#), [\[RFC7823\]](#), [\[RFC8570\]](#), [\[RFC8776\]](#), [\[IEEE754\]](#), and [\[ISO-IEC-C99\]](#)

```
<CODE BEGINS> file "ietf-te-packet-types@2020-06-10.yang"
```



```
module ietf-te-packet-types {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-te-packet-types";
  prefix te-packet-types;

  /* Import TE generic types */

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

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

     Editor:   Tarek Saad
               <mailto:tsaad@juniper.net>

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

     Editor:   Igor Bryskin
               <mailto:i_bryskin@yahoo.com>";
  description
    "This YANG module contains a collection of generally useful YANG
     data type definitions specific to MPLS TE. The model fully
     conforms to the Network Management Datastore Architecture
     (NMDA).

     Copyright (c) 2021 IETF Trust and the persons identified as
     authors of the code. All rights reserved.

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     Relating to IETF Documents
```





(<https://trustee.ietf.org/license-info>).

This version of this YANG module is part of [RFC 8776](#); see the RFC itself for full legal notices.";

```
revision 2021-10-24 {
  description
    "Added common TE packet identities:
     - bandwidth-profile-type.

     Added common TE packet types:
     - bandwidth-scientific-notation.

     Added common TE packet groupings:
     - te-packet-path-bandwidth;
     - te-packet-link-bandwidth.";
  reference
    "draft-busizheng-teas-yang-te-mpls-topology";
}

revision 2020-06-10 {
  description
    "Latest revision of TE MPLS types.";
  reference
    "RFC 8776: Common YANG Data Types for Traffic Engineering";
}

/*
 * Identities
 */

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";
}

/*
 * Typedefs
 */

typedef te-bandwidth-requested-type {
  type enumeration {
    enum specified {
      description
        "Bandwidth is explicitly specified.";
    }
    enum auto {
      description
        "Bandwidth is automatically computed.";
    }
  }
  description
    "Enumerated type for specifying whether bandwidth is
    explicitly specified or automatically computed.";
}

typedef te-class-type {
  type uint8;
  description
    "Diffserv-TE Class-Type. Defines a set of Traffic Trunks
    crossing a link that is governed by a specific set of
    bandwidth constraints. Class-Type is used for the purposes
    of link bandwidth allocation, constraint-based routing, and
    admission control.";
  reference
    "RFC 4124: Protocol Extensions for Support of Diffserv-aware
    MPLS Traffic Engineering";
}

typedef bc-type {
  type uint8 {
    range "0..7";
  }
}
```



```
    }
    description
      "Diffserv-TE bandwidth constraints as defined in RFC 4124.";
    reference
      "RFC 4124: Protocol Extensions for Support of Diffserv-aware
      MPLS Traffic Engineering";
  }

  typedef bandwidth-kbps {
    type uint64;
    units "Kbps";
    description
      "Bandwidth values, expressed in kilobits per second.";
  }

  typedef bandwidth-mbps {
    type uint64;
    units "Mbps";
    description
      "Bandwidth values, expressed in megabits per second.";
  }

  typedef bandwidth-gbps {
    type uint64;
    units "Gbps";
    description
      "Bandwidth values, expressed in gigabits per second.";
  }

  typedef bandwidth-scientific-notation {
    type string {
      pattern
        '0(\.0?)?([eE](\+)?0?)?|'
        + '[1-9](\.[0-9]{0,6})?[eE](\+)?(9[0-6]|[1-8][0-9]|0?[0-9])?';
    }
    units "bps";
    description
      "Bandwidth values, expressed using the scientific notation
      in bits per second.
      The encoding format is the external decimal-significant
      character sequences specified in IEEE 754 and ISO/IEC C99
      for 32-bit decimal floating-point numbers:
      (-1)**(S) * 10**(Exponent) * (Significant),
      where Significant uses 7 digits.
      An implementation for this representation may use decimal32
      or binary32. The range of the Exponent is from -95 to +96
      for decimal32, and from -38 to +38 for binary32.
      As a bandwidth value, the format is restricted to be
```



```
normalized, non-negative, and non-fraction:
n.dddddde{+}dd, N.DDDDDDE{+}DD, 0e0 or 0E0,
where 'd' and 'D' are decimal digits; 'n' and 'N' are
non-zero decimal digits; 'e' and 'E' indicate a power of ten.
Some examples are 0e0, 1e10, and 9.953e9.";
reference
"IEEE Std 754-2008: IEEE Standard for Floating-Point
Arithmetic.
ISO/IEC C99: Information technology - Programming
Languages - C.";
}

identity backup-protection-type {
  description
    "Base identity for the backup protection type.";
}

identity backup-protection-link {
  base backup-protection-type;
  description
    "Backup provides link protection only.";
}

identity backup-protection-node-link {
  base backup-protection-type;
  description
    "Backup offers node (preferred) or link protection.";
}

identity bc-model-type {
  description
    "Base identity for the Diffserv-TE Bandwidth Constraints
    Model type.";
  reference
    "RFC 4124: Protocol Extensions for Support of Diffserv-aware
    MPLS Traffic Engineering";
}

identity bc-model-rdm {
  base bc-model-type;
  description
    "Russian Dolls Bandwidth Constraints Model type.";
  reference
    "RFC 4127: Russian Dolls Bandwidth Constraints Model for
    Diffserv-aware MPLS Traffic Engineering";
}

identity bc-model-mam {
```





```
base bc-model-type;
description
  "Maximum Allocation Bandwidth Constraints Model type.";
reference
  "RFC 4125: Maximum Allocation Bandwidth Constraints Model for
    Diffserv-aware MPLS Traffic Engineering";
}

identity bc-model-mar {
  base bc-model-type;
  description
    "Maximum Allocation with Reservation Bandwidth Constraints
      Model type.";
  reference
    "RFC 4126: Max Allocation with Reservation Bandwidth
      Constraints Model for Diffserv-aware MPLS Traffic Engineering
      & Performance Comparisons";
}

/*
 * Groupings
 */

grouping performance-metrics-attributes-packet {
  description
    "Contains PM attributes.";
  uses te-types:performance-metrics-attributes {
    augment "performance-metrics-one-way" {
      leaf one-way-min-delay {
        type uint32 {
          range "0..16777215";
        }
        description
          "One-way minimum delay or latency in microseconds.";
      }
      leaf one-way-min-delay-normality {
        type te-types:performance-metrics-normality;
        default "normal";
        description
          "One-way minimum delay or latency normality.";
      }
      leaf one-way-max-delay {
        type uint32 {
          range "0..16777215";
        }
        description
          "One-way maximum delay or latency in microseconds.";
      }
    }
  }
}
```



```
leaf one-way-max-delay-normality {
  type te-types:performance-metrics-normality;
  default "normal";
  description
    "One-way maximum delay or latency normality.";
}
leaf one-way-delay-variation {
  type uint32 {
    range "0..16777215";
  }
  description
    "One-way delay variation in microseconds.";
  reference
    "RFC 5481: Packet Delay Variation Applicability
    Statement, Section 4.2";
}
leaf one-way-delay-variation-normality {
  type te-types:performance-metrics-normality;
  default "normal";
  description
    "One-way delay variation normality.";
  reference
    "RFC 7471: OSPF Traffic Engineering (TE) Metric
    Extensions
    RFC 7823: Performance-Based Path Selection for
    Explicitly Routed Label Switched Paths (LSPs) Using
    TE Metric Extensions
    RFC 8570: IS-IS Traffic Engineering (TE) Metric
    Extensions";
}
leaf one-way-packet-loss {
  type decimal64 {
    fraction-digits 6;
    range "0..50.331642";
  }
  description
    "One-way packet loss as a percentage of the total traffic
    sent over a configurable interval. The finest precision
    is 0.000003%, where the maximum is 50.331642%.";
  reference
    "RFC 8570: IS-IS Traffic Engineering (TE) Metric
    Extensions, Section 4.4";
}
leaf one-way-packet-loss-normality {
  type te-types:performance-metrics-normality;
  default "normal";
  description
    "Packet loss normality.";
```



```
reference
  "RFC 7471: OSPF Traffic Engineering (TE) Metric
  Extensions
  RFC 7823: Performance-Based Path Selection for
  Explicitly Routed Label Switched Paths (LSPs) Using
  TE Metric Extensions
  RFC 8570: IS-IS Traffic Engineering (TE) Metric
  Extensions";
}
description
  "PM one-way packet-specific augmentation for a generic PM
  grouping.";
}
augment "performance-metrics-two-way" {
  leaf two-way-min-delay {
    type uint32 {
      range "0..16777215";
    }
    default "0";
    description
      "Two-way minimum delay or latency in microseconds.";
  }
  leaf two-way-min-delay-normality {
    type te-types:performance-metrics-normality;
    default "normal";
    description
      "Two-way minimum delay or latency normality.";
    reference
      "RFC 7471: OSPF Traffic Engineering (TE) Metric
      Extensions
      RFC 7823: Performance-Based Path Selection for
      Explicitly Routed Label Switched Paths (LSPs) Using
      TE Metric Extensions
      RFC 8570: IS-IS Traffic Engineering (TE) Metric
      Extensions";
  }
  leaf two-way-max-delay {
    type uint32 {
      range "0..16777215";
    }
    default "0";
    description
      "Two-way maximum delay or latency in microseconds.";
  }
  leaf two-way-max-delay-normality {
    type te-types:performance-metrics-normality;
    default "normal";
    description
```



```
    "Two-way maximum delay or latency normality.";
  reference
    "RFC 7471: OSPF Traffic Engineering (TE) Metric
    Extensions
    RFC 7823: Performance-Based Path Selection for
    Explicitly Routed Label Switched Paths (LSPs) Using
    TE Metric Extensions
    RFC 8570: IS-IS Traffic Engineering (TE) Metric
    Extensions";
}
leaf two-way-delay-variation {
  type uint32 {
    range "0..16777215";
  }
  default "0";
  description
    "Two-way delay variation in microseconds.";
  reference
    "RFC 5481: Packet Delay Variation Applicability
    Statement, Section 4.2";
}
leaf two-way-delay-variation-normality {
  type te-types:performance-metrics-normality;
  default "normal";
  description
    "Two-way delay variation normality.";
  reference
    "RFC 7471: OSPF Traffic Engineering (TE) Metric
    Extensions
    RFC 7823: Performance-Based Path Selection for
    Explicitly Routed Label Switched Paths (LSPs) Using
    TE Metric Extensions
    RFC 8570: IS-IS Traffic Engineering (TE) Metric
    Extensions";
}
leaf two-way-packet-loss {
  type decimal64 {
    fraction-digits 6;
    range "0..50.331642";
  }
  default "0";
  description
    "Two-way packet loss as a percentage of the total traffic
    sent over a configurable interval. The finest precision
    is 0.000003%.";
}
leaf two-way-packet-loss-normality {
  type te-types:performance-metrics-normality;
```





```
        default "normal";
        description
            "Two-way packet loss normality.";
    }
    description
        "PM two-way packet-specific augmentation for a generic PM
        grouping.";
    reference
        "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions
        RFC 7823: Performance-Based Path Selection for
        Explicitly Routed Label Switched Paths (LSPs) Using
        TE Metric Extensions
        RFC 8570: IS-IS Traffic Engineering (TE) Metric
        Extensions";
    }
}
}

grouping one-way-performance-metrics-packet {
    description
        "One-way packet PM throttle grouping.";
    leaf one-way-min-delay {
        type uint32 {
            range "0..16777215";
        }
        default "0";
        description
            "One-way minimum delay or latency in microseconds.";
    }
    leaf one-way-max-delay {
        type uint32 {
            range "0..16777215";
        }
        default "0";
        description
            "One-way maximum delay or latency in microseconds.";
    }
    leaf one-way-delay-variation {
        type uint32 {
            range "0..16777215";
        }
        default "0";
        description
            "One-way delay variation in microseconds.";
    }
    leaf one-way-packet-loss {
        type decimal64 {
            fraction-digits 6;
        }
    }
}
```



```
        range "0..50.331642";
    }
    default "0";
    description
        "One-way packet loss as a percentage of the total traffic
        sent over a configurable interval. The finest precision is
        0.000003%.";
}
}

grouping two-way-performance-metrics-packet {
    description
        "Two-way packet PM throttle grouping.";
    leaf two-way-min-delay {
        type uint32 {
            range "0..16777215";
        }
        default "0";
        description
            "Two-way minimum delay or latency in microseconds.";
    }
    leaf two-way-max-delay {
        type uint32 {
            range "0..16777215";
        }
        default "0";
        description
            "Two-way maximum delay or latency in microseconds.";
    }
    leaf two-way-delay-variation {
        type uint32 {
            range "0..16777215";
        }
        default "0";
        description
            "Two-way delay variation in microseconds.";
    }
    leaf two-way-packet-loss {
        type decimal64 {
            fraction-digits 6;
            range "0..50.331642";
        }
        default "0";
        description
            "Two-way packet loss as a percentage of the total traffic
            sent over a configurable interval. The finest precision is
            0.000003%.";
    }
}
```



```
}

grouping performance-metrics-throttle-container-packet {
  description
    "Packet PM threshold grouping.";
  uses te-types:performance-metrics-throttle-container {
    augment "throttle/threshold-out" {
      uses one-way-performance-metrics-packet;
      uses two-way-performance-metrics-packet;
      description
        "PM threshold-out packet augmentation for a
        generic grouping.";
    }
    augment "throttle/threshold-in" {
      uses one-way-performance-metrics-packet;
      uses two-way-performance-metrics-packet;
      description
        "PM threshold-in packet augmentation for a
        generic grouping.";
    }
    augment "throttle/threshold-accelerated-advertisement" {
      uses one-way-performance-metrics-packet;
      uses two-way-performance-metrics-packet;
      description
        "PM accelerated advertisement packet augmentation for a
        generic grouping.";
    }
  }
}

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 = "eth-types:mef-10-bwp" or ' +
        '../bw-profile-type = "eth-types:rfc-2698-bwp" or ' +
        '../bw-profile-type = "eth-types:rfc-4115-bwp"'

      must
        '../bw-profile-type != "eth-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 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 bandwidth-scientific-notation;
    description
      "Available bandwidth value expressed in kilobits per
       second";
  }
}
}
}
<CODE ENDS>
```





### 6.3. Packet Switching TE Topology Module

This module references [\[RFC7471\]](#), [\[RFC7823\]](#), [\[RFC8294\]](#), [\[RFC8345\]](#), [\[RFC8346\]](#), [\[RFC8570\]](#), [\[RFC8776\]](#), and [\[RFC8795\]](#).

```
<CODE BEGINS> file "ietf-te-topology-packet@2021-07-11.yang"
module ietf-te-topology-packet {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-te-topology-packet";

  prefix "tet-pkt";

  import ietf-network {
    prefix "nw";
    reference
      "RFC 8345: A YANG Data Model for Network Topologies";
  }

  import ietf-network-topology {
    prefix "nt";
    reference
      "RFC 8345: A YANG Data Model for Network Topologies";
  }

  import ietf-routing-types {
    prefix "rt-types";
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }

  import ietf-te-topology {
    prefix "tet";
    reference
      "I-D.ietf-teas-yang-te-topo: YANG Data Model for Traffic
      Engineering (TE) Topologies";
  }

  import ietf-te-types {
    prefix "te-types";
    reference
      "I-D.ietf-teas-yang-te-types: Traffic Engineering Common YANG
      Types";
  }

  import ietf-te-packet-types {
    prefix "te-packet-types";
    reference
```



```
"I-D.ietf-teas-yang-te-types: Traffic Engineering Common YANG
Types";
}
```

organization

```
"Traffic Engineering Architecture and Signaling (TEAS)
Working Group";
```

contact

```
"WG Web: <http://tools.ietf.org/wg/teas/>
WG List: <mailto:teas@ietf.org>
```

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```
Editor: Himanshu Shah
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```

```
Editor: Oscar Gonzalez De Dios
<mailto:oscar.gonzalezdedios@telefonica.com>";
```

description

```
"YANG data model for representing and manipulating PSC (Packet
Switching) TE Topologies.
```

```
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authors of the code. All rights reserved.
```

```
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```

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

```
revision 2021-07-11 {
```



```
    description
      "Initial revision";
    reference
      "RFC XXXX: YANG Data Model for Layer 3 TE Topologies";
  }

/*
 * Features
 */

feature te-performance-metric {
  description
    "This feature indicates that the system supports
    TE performance metric.";
  reference
    "RFC7471: OSPF Traffic Engineering (TE) Metric Extensions.
    RFC8570: IS-IS Traffic Engineering (TE) Metric Extensions.
    RFC7823: Performance-Based Path Selection for Explicitly
    Routed Label Switched Paths (LSPs) Using TE Metric
    Extensions";
}

/*
 * Groupings
 */

grouping packet-switch-capable-container {
  description
    "The container of packet switch capable attributes.";
  container packet-switch-capable {
    description
      "Interface has packet-switching capabilities.";
    leaf minimum-lsp-bandwidth {
      type rt-types:bandwidth-ieee-float32;
      description
        "Minimum LSP Bandwidth. Units in bytes per second";
    }
    leaf interface-mtu {
      type uint16;
      description
        "Interface MTU.";
    }
  }
}

/*
 * Augmentations
 */

/* Augmentations to network-types */
```



```
augment "/nw:networks/nw:network/nw:network-types/"
+ "tet:te-topology" {
  description
    "Defines the packet TE topology type.";
  container packet {
    presence "Indicates packet TE topology.";
    description
      "Its presence identifies the packet TE topology type.";
  }
}

/* Augmentations to connectivity-matrix */
augment "/nw:networks/nw:network/nw:node/tet:te/"
+ "tet:te-node-attributes/tet:connectivity-matrices" {
  when "../../../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet" {
    description
      "Augment only for packet TE topology";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature te-performance-metric;
    refine performance-metrics-one-way {
      config false;
    }
    refine performance-metrics-two-way {
      config false;
    }
  }
}
uses
  te-packet-types:performance-metrics-throttle-container-packet {
    if-feature te-performance-metric;
  }
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
+ "tet:te-node-attributes/tet:connectivity-matrices/"
+ "tet:connectivity-matrix" {
  when "../../../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet" {
    description
      "Augment only for packet TE topology";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature te-performance-metric;
  }
}
```





```
    refine performance-metrics-one-way {
      config false;
    }
    refine performance-metrics-two-way {
      config false;
    }
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
      if-feature te-performance-metric;
    }
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
  + "tet:information-source-entry/tet:connectivity-matrices" {
  when "../../../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
    description
      "Augment only for packet TE topology";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
      if-feature te-performance-metric;
    }
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
  + "tet:information-source-entry/tet:connectivity-matrices/"
  + "tet:connectivity-matrix" {
  when "../../../nw:network-types/tet:te-topology/"
    + "tet-pkt:packet" {
    description
      "Augment only for packet TE topology";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
      if-feature te-performance-metric;
    }
}
```



```
}

/* Augmentations to tunnel-termination-point */
augment "/nw:networks/nw:network/nw:node/tet:te/"
  + "tet:tunnel-termination-point/"
  + "tet:local-link-connectivities" {
when "../../../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet" {
  description
    "Augment only for packet TE topology";
}
description
  "Parameters for PSC TE topology.";
uses te-packet-types:performance-metrics-attributes-packet {
  if-feature te-performance-metric;
  refine performance-metrics-one-way {
    config false;
  }
  refine performance-metrics-two-way {
    config false;
  }
}
uses
  te-packet-types:performance-metrics-throttle-container-packet {
  if-feature te-performance-metric;
}
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
  + "tet:tunnel-termination-point/"
  + "tet:local-link-connectivities/"
  + "tet:local-link-connectivity" {
when "../../../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet" {
  description
    "Augment only for packet TE topology";
}
description
  "Parameters for PSC TE topology.";
uses te-packet-types:performance-metrics-attributes-packet {
  if-feature te-performance-metric;
  refine performance-metrics-one-way {
    config false;
  }
  refine performance-metrics-two-way {
    config false;
  }
}
}
```



```
    uses
      te-packet-types:performance-metrics-throttle-container-packet {
        if-feature te-performance-metric;
      }
  }
}

/* Augmentations to te-link-attributes */
augment "/nw:networks/tet:te/tet:templates/"
  + "tet:link-template/tet:te-link-attributes" {
  when "tet:interface-switching-capability "
    + "[tet:switching-capability = 'te-types:switching-psc1']" {
    description
      "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature te-performance-metric;
    refine performance-metrics-one-way {
      config false;
    }
    refine performance-metrics-two-way {
      config false;
    }
  }
}
uses
  te-packet-types:performance-metrics-throttle-container-packet {
    if-feature te-performance-metric;
  }
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
  + "tet:te-link-attributes" {
  when "(../../../../nw:network-types/tet:te-topology/tet-pkt:packet)"
    + " and (tet:interface-switching-capability "
    + "[tet:switching-capability = 'te-types:switching-psc1'])" {
    description
      "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature te-performance-metric;
    refine performance-metrics-one-way {
      config false;
    }
  }
  refine performance-metrics-two-way {
    config false;
  }
}
```



```

    }
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
      if-feature te-performance-metric;
    }
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
  + "tet:information-source-entry" {
  when "(../../../../nw:network-types/tet:te-topology/tet-pkt:packet)"
  + " and (tet:interface-switching-capability "
  + "[tet:switching-capability = 'te-types:switching-psc1'])" {
    description
      "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
      if-feature te-performance-metric;
    }
}

/* Augmentations to interface-switching-capability */
augment "/nw:networks/tet:te/tet:templates/"
  + "tet:link-template/tet:te-link-attributes/"
  + "tet:interface-switching-capability" {
  when "tet:switching-capability = 'te-types:switching-psc1' " {
    description
      "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses packet-switch-capable-container;
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
  + "tet:te-link-attributes/"
  + "tet:interface-switching-capability" {
  when "(../../../../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet) and "
  + "(tet:switching-capability = 'te-types:switching-psc1')" {
    description
      "Valid only for PSC";
  }
}

```





```
    }
    description
      "Parameters for PSC TE topology.";
    uses packet-switch-capable-container;
  }

augment "/nw:networks/nw:network/nt:link/tet:te/"
  + "tet:information-source-entry/"
  + "tet:interface-switching-capability" {
  when "(../../../../nw:network-types/tet:te-topology/"
  + "tet-pkt:packet) and "
  + "(tet:switching-capability = 'te-types:switching-psc1')" {
    description
      "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses packet-switch-capable-container;
}

/*
 * Augment TE bandwidth
 */

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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-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 te-packet-types:te-packet-link-bandwidth;
  }
}
}
<CODE ENDS>

```

## 7. IANA Considerations

RFC Ed.: In this section, replace all occurrences of 'XXXX' with the actual RFC number (and remove this note).

This document registers the following namespace URIs in the IETF XML registry [[RFC3688](https://www.rfc-editor.org/rfc/rfc3688)):

```

-----
URI: urn:ietf:params:xml:ns:yang:ietf-l3-te-topology
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.
-----

```

```

-----
URI: urn:ietf:params:xml:ns:yang:ietf-l3-te-topology-state
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.
-----

```

```

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

```





-----  
URI: urn:ietf:params:xml:ns:yang:ietf-te-topology-packet-state  
Registrant Contact: The IESG.  
XML: N/A, the requested URI is an XML namespace.  
-----

This document registers the following YANG modules in the YANG Module Names registry [[RFC6020](#)]:

-----  
name: ietf-l3-te-topology  
namespace: urn:ietf:params:xml:ns:yang:ietf-l3-te-topology  
prefix: l3tet  
reference: RFC XXXX  
-----

-----  
name: ietf-l3-te-topology-state  
namespace: urn:ietf:params:xml:ns:yang:ietf-l3-te-topology-state  
prefix: l3tet-s  
reference: RFC XXXX  
-----

-----  
name: ietf-te-topology-packet  
namespace: urn:ietf:params:xml:ns:yang:ietf-te-topology-packet  
prefix: tet-pkt  
reference: RFC XXXX  
-----

-----  
name: ietf-te-topology-packet-state  
namespace: urn:ietf:params:xml:ns:yang:ietf-te-topology-packet-state  
prefix: tet-pkt-s  
reference: RFC XXXX  
-----

## 8. Security Considerations

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



The 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 may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability:

`/nw:networks/nw:network/nw:network-types/l3t:l3-unicast-topology/l3-te`

This subtree specifies the layer 3 TE topology type. Modifying the configurations can make layer 3 TE topology type invalid and cause interruption to all layer 3 TE networks.

`/nw:networks/nw:network/l3t:l3-topology-attributes/l3-te-topology-attributes`

This subtree specifies the topology-wide configurations, including the reference to a TE topology from a layer 3 TE topology. Modifying the configurations here can cause traffic disabled or rerouted in this topology and the connected topologies.

`/nw:networks/nw:network/nw:node/l3t:l3-node-attributes/l3-te-node-attributes`

This subtree specifies the configurations of layer 3 TE nodes. Modifying the configurations in this subtree can change the relationship between a TE node and a node in a layer 3 TE topology, causing traffic disabled or rerouted in the specified nodes and the related layer 3 topologies.

`/nw:networks/nw:network/nw:node/nt:termination-point//l3t:l3-termination-point-attributes/l3-te-tp-attributes`

This subtree specifies the configurations of layer 3 TE link termination points. Modifying the configurations in this subtree can change the relationship between a TE link termination point and a link termination point in a layer 3 TE topology, causing traffic disabled or rerouted on the related layer 3 links and the related layer 3 topologies.

`/nw:networks/nw:network/nt:link/l3t:l3-link-attributes/l3-te-link-attributes`

This subtree specifies the configurations of layer 3 TE links. Modifying the configurations in this subtree can change the relationship between a TE link and a link in a layer 3 TE



topology, causing traffic disabled or rerouted on the specified layer 3 link and the related layer 3 topologies.

#### performance-metric containers

The container "performance-metric" is augmented to multiple locations of the base TE topology model, as specified in [Section 3.2](#). Modifying the configuration in such a container can change the behaviors of performance metric monitoring, causing traffic disabled or rerouted on the related layer 3 links, nodes, or topologies.

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. These are the subtrees and data nodes and their sensitivity/vulnerability:

/nw:networks/nw:network/nw:network-types/l3t:l3-unicast-topology/  
l3-te

Unauthorized access to this subtree can disclose the layer 3 TE topology type.

/nw:networks/nw:network/l3t:l3-topology-attributes/l3-te-topology-  
attributes

Unauthorized access to this subtree can disclose the topology-wide configurations, including the reference to a TE topology from a layer 3 topology.

/nw:networks/nw:network/nw:node/l3t:l3-node-attributes/l3-te-node-  
attributes

Unauthorized access to this subtree can disclose the operational state information of layer 3 TE nodes.

/nw:networks/nw:network/nw:node/nt:termination-point//l3t:l3-  
termination-point-attributes/l3-te-tp-attributes

Unauthorized access to this subtree can disclose the operational state information of layer 3 TE link termination points.

/nw:networks/nw:network/nt:link/l3t:l3-link-attributes/l3-te-link-  
attributes

Unauthorized access to this subtree can disclose the operational state information of layer 3 TE links.

#### performance-metric containers

The container "performance-metric" is augmented to multiple locations of the base TE topology model, as specified in [Section 3.2](#). Unauthorized access to this subtree can disclose the operational state information of performance metric monitoring.



## 9. References

### 9.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
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## **Appendix A. Companion YANG Model for Non-NMDA Compliant Implementations**

The YANG modules `ietf-l3-te-topology` and `ietf-te-topology-packet` defined in this document are designed to be used in conjunction with implementations that support the Network Management Datastore Architecture (NMDA) defined in [[RFC8342](#)]. In order to allow implementations to use the model even in cases when NMDA is not supported, the following companion modules, `ietf-l3-te-topology-state` and `ietf-te-topology-packet-state`, are defined as state models, which mirror the modules `ietf-l3-te-topology` and `ietf-te-topology-packet` defined earlier in this document. However, all data nodes in the companion module are non-configurable, to represent the applied configuration or the derived operational states.

The companion modules, `ietf-l3-te-topology-state` and `ietf-te-topology-packet-state`, are redundant and SHOULD NOT be supported by implementations that support NMDA.

As the structure of the companion modules mirrors that of the cooresponding NMDA models, the YANG trees of the companion modules are not depicted separately.

### **A.1. Layer 3 TE Topology State Module**

This module references [[RFC8345](#)], and [[RFC8346](#)].

```
<CODE BEGINS> file "ietf-l3-te-topology-state@2020-05-03.yang"
module ietf-l3-te-topology-state {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-l3-te-topology-state";
  prefix "l3tet-s";

  import ietf-l3-te-topology {
    prefix "l3tet";
  }
  import ietf-network-state {
    prefix "nw-s";
    reference "RFC 8345: A YANG Data Model for Network Topologies";
  }
  import ietf-network-topology-state {
    prefix "nt-s";
    reference "RFC 8345: A YANG Data Model for Network Topologies";
  }
  import ietf-l3-unicast-topology-state {
    prefix "l3t-s";
    reference "RFC 8346: A YANG Data Model for Layer 3 Topologies";
  }
}
```





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## description

"YANG data model for representing operational state information  
of Layer 3 TE Topologies, when NMDA is not supported.

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

```
revision 2020-05-03 {  
  description  
    "Initial revision";  
  reference "RFC XXXX: YANG Data Model for Layer 3 TE Topologies";  
}
```



```
augment "/nw-s:networks/nw-s:network/nw-s:network-types/"
  + "l3t-s:l3-unicast-topology" {
    description
      "Defines the L3 TE topology type.";
    uses l3tet:l3-te-topology-type;
  }

augment "/nw-s:networks/nw-s:network/"
  + "l3t-s:l3-topology-attributes" {
    when "../nw-s:network-types/l3t-s:l3-unicast-topology/"
      + "l3tet-s:l3-te" {
      description
        "Augment only for L3 TE topology";
    }
    description
      "Augment topology configuration";
    uses l3tet:l3-te-topology-attributes;
  }

augment "/nw-s:networks/nw-s:network/nw-s:node/"
  + "l3t-s:l3-node-attributes" {
    when "../..nw-s:network-types/l3t-s:l3-unicast-topology/"
      + "l3tet-s:l3-te" {
      description
        "Augment only for L3 TE topology";
    }
    description
      "Augment node configuration";
    uses l3tet:l3-te-node-attributes;
  }

augment "/nw-s:networks/nw-s:network/nw-s:node/"
  + "nt-s:termination-point/"
  + "l3t-s:l3-termination-point-attributes" {
    when "../..nw-s:network-types/l3t-s:l3-unicast-topology/"
      + "l3tet-s:l3-te" {
      description
        "Augment only for L3 TE topology";
    }
    description
      "Augment termination point configuration";
    uses l3tet:l3-te-tp-attributes;
  }

augment "/nw-s:networks/nw-s:network/nt-s:link/"
  + "l3t-s:l3-link-attributes" {
    when "../..nw-s:network-types/l3t-s:l3-unicast-topology/"
      + "l3tet-s:l3-te" {
```



```
        description
            "Augment only for L3 TE topology";
    }
    description
        "Augment link configuration";
    uses l3tet:l3-te-link-attributes;
    }
}
<CODE ENDS>
```

## [A.2.](#) Packet Switching TE Topology State Module

```
<CODE BEGINS> file "ietf-te-topology-packet-state@2020-07-03.yang"
module ietf-te-topology-packet-state {
    yang-version 1.1;
    namespace
        "urn:ietf:params:xml:ns:yang:ietf-te-topology-packet-state";

    prefix "tet-pkt-s";

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

    import ietf-network-state {
        prefix "nw-s";
        reference
            "RFC 8345: A YANG Data Model for Network Topologies";
    }

    import ietf-network-topology-state {
        prefix "nt-s";
        reference
            "RFC 8345: A YANG Data Model for Network Topologies";
    }

    import ietf-te-topology-state {
        prefix "tet-s";
        reference
            "I-D.ietf-teas-yang-te-topo: YANG Data Model for Traffic
            Engineering (TE) Topologies";
    }

    import ietf-te-types {
        prefix "te-types";
```



```
reference
  "I-D.ietf-teas-yang-te-types: Traffic Engineering Common YANG
  Types";
}

import ietf-te-packet-types {
  prefix "te-packet-types";
  reference
    "I-D.ietf-teas-yang-te-types: Traffic Engineering Common YANG
    Types";
}

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  Editor: Himanshu Shah
         <mailto:hshah@ciena.com>

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description
  "YANG data model for representing operational state information
  of PSC (Packet Switching) TE Topologies, when NMDA is not
  supported.

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```
revision 2020-07-03 {
  description
    "Initial revision";
  reference
    "RFC XXXX: YANG Data Model for Layer 3 TE Topologies";
}

/*
 * Augmentations
 */
/* Augmentations to network-types */
augment "/nw-s:networks/nw-s:network/nw-s:network-types/"
+ "tet-s:te-topology" {
  description
    "Defines the packet TE topology type.";
  container packet {
    presence "Indicates packet TE topology.";
    description
      "Its presence identifies the packet TE topology type.";
  }
}

/* Augmentations to connectivity-matrix */
augment "/nw-s:networks/nw-s:network/nw-s:node/tet-s:te/"
+ "tet-s:te-node-attributes/tet-s:connectivity-matrices" {
  when "../..../nw-s:network-types/tet-s:te-topology/"
+ "tet-pkt-s:packet" {
    description
      "Augment only for packet TE topology";
  }
  description
    "Parameters for PSC (Packet Switching) TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature tet-pkt:te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
    if-feature tet-pkt:te-performance-metric;
  }
}
```



```
augment "/nw-s:networks/nw-s:network/nw-s:node/tet-s:te/"
  + "tet-s:te-node-attributes/tet-s:connectivity-matrices/"
  + "tet-s:connectivity-matrix" {
when "../../../../../../../nw-s:network-types/tet-s:te-topology/"
  + "tet-pkt-s:packet" {
  description
    "Augment only for packet TE topology";
}
description
  "Parameters for PSC TE topology.";
uses te-packet-types:performance-metrics-attributes-packet {
  if-feature tet-pkt:te-performance-metric;
}
uses
  te-packet-types:performance-metrics-throttle-container-packet {
  if-feature tet-pkt:te-performance-metric;
}
}
```

```
augment "/nw-s:networks/nw-s:network/nw-s:node/tet-s:te/"
  + "tet-s:information-source-entry/"
  + "tet-s:connectivity-matrices" {
when "../../../../../../../nw-s:network-types/tet-s:te-topology/"
  + "tet-pkt-s:packet" {
  description
    "Augment only for packet TE topology";
}
description
  "Parameters for PSC TE topology.";
uses te-packet-types:performance-metrics-attributes-packet {
  if-feature tet-pkt:te-performance-metric;
}
uses
  te-packet-types:performance-metrics-throttle-container-packet {
  if-feature tet-pkt:te-performance-metric;
}
}
```

```
augment "/nw-s:networks/nw-s:network/nw-s:node/tet-s:te/"
  + "tet-s:information-source-entry/"
  + "tet-s:connectivity-matrices/"
  + "tet-s:connectivity-matrix" {
when "../../../../../../../nw-s:network-types/tet-s:te-topology/"
  + "tet-pkt-s:packet" {
  description
    "Augment only for packet TE topology";
}
description
```



```
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature tet-pkt:te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
      if-feature tet-pkt:te-performance-metric;
    }
}

/* Augmentations to tunnel-termination-point */
augment "/nw-s:networks/nw-s:network/nw-s:node/tet-s:te/"
  + "tet-s:tunnel-termination-point/"
  + "tet-s:local-link-connectivities" {
  when "../../../nw-s:network-types/tet-s:te-topology/"
  + "tet-pkt-s:packet" {
    description
      "Augment only for packet TE topology";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature tet-pkt:te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
      if-feature tet-pkt:te-performance-metric;
    }
}

augment "/nw-s:networks/nw-s:network/nw-s:node/tet-s:te/"
  + "tet-s:tunnel-termination-point/"
  + "tet-s:local-link-connectivities/"
  + "tet-s:local-link-connectivity" {
  when "../../../nw-s:network-types/tet-s:te-topology/"
  + "tet-pkt-s:packet" {
    description
      "Augment only for packet TE topology";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature tet-pkt:te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
      if-feature tet-pkt:te-performance-metric;
    }
}
```



```
}

/* Augmentations to te-link-attributes */
augment "/nw-s:networks/tet-s:te/tet-s:templates/"
  + "tet-s:link-template/tet-s:te-link-attributes" {
  when "tet-s:interface-switching-capability "
    + "[tet-s:switching-capability = 'te-types:switching-psc1']" {
    description
      "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature tet-pkt:te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
    if-feature tet-pkt:te-performance-metric;
  }
}

augment "/nw-s:networks/nw-s:network/nt-s:link/tet-s:te/"
  + "tet-s:te-link-attributes" {
  when "(../../../../nw-s:network-types/tet-s:te-topology/"
    + "tet-pkt-s:packet) and "
    + "(tet-s:interface-switching-capability "
    + "[tet-s:switching-capability = 'te-types:switching-psc1'])" {
    description "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses te-packet-types:performance-metrics-attributes-packet {
    if-feature tet-pkt:te-performance-metric;
  }
  uses
    te-packet-types:performance-metrics-throttle-container-packet {
    if-feature tet-pkt:te-performance-metric;
  }
}

augment "/nw-s:networks/nw-s:network/nt-s:link/tet-s:te/"
  + "tet-s:information-source-entry" {
  when "(../../../../nw-s:network-types/tet-s:te-topology/"
    + "tet-pkt-s:packet) and "
    + "(tet-s:interface-switching-capability "
    + "[tet-s:switching-capability = 'te-types:switching-psc1'])" {
    description "Valid only for PSC";
  }
}
```





```
description
  "Parameters for PSC TE topology.";
uses te-packet-types:performance-metrics-attributes-packet {
  if-feature tet-pkt:te-performance-metric;
}
uses
  te-packet-types:performance-metrics-throttle-container-packet {
  if-feature tet-pkt:te-performance-metric;
}
}

/* Augmentations to interface-switching-capability */
augment "/nw-s:networks/tet-s:te/tet-s:templates/"
  + "tet-s:link-template/tet-s:te-link-attributes/"
  + "tet-s:interface-switching-capability" {
  when "tet-s:switching-capability = 'te-types:switching-psc1' " {
    description "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses tet-pkt:packet-switch-capable-container;
}

augment "/nw-s:networks/nw-s:network/nt-s:link/tet-s:te/"
  + "tet-s:te-link-attributes/"
  + "tet-s:interface-switching-capability" {
  when "(../../../../nw-s:network-types/tet-s:te-topology/"
  + "tet-pkt-s:packet) and "
  + "(tet-s:switching-capability = 'te-types:switching-psc1')" {
    description "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses tet-pkt:packet-switch-capable-container;
}

augment "/nw-s:networks/nw-s:network/nt-s:link/tet-s:te/"
  + "tet-s:information-source-entry/"
  + "tet-s:interface-switching-capability" {
  when "(../../../../nw-s:network-types/tet-s:te-topology/"
  + "tet-pkt-s:packet) and "
  + "(tet-s:switching-capability = 'te-types:switching-psc1')" {
    description
      "Valid only for PSC";
  }
  description
    "Parameters for PSC TE topology.";
  uses tet-pkt:packet-switch-capable-container;
```



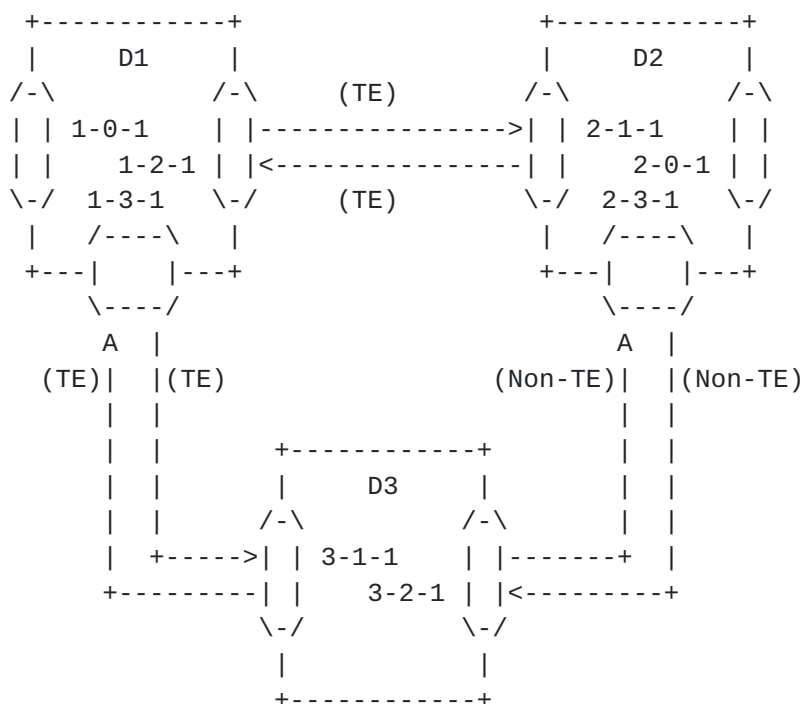
```

}
}
<CODE ENDS>

```

### Appendix B. Data Tree Example

This section contains an example of an instance data tree in the JSON encoding [RFC7951]. The example instantiates "ietf-l3-te-topology" for the topology that is depicted in the following diagram.



The corresponding instance data tree is depicted below. Note that some lines have been wrapped to adhere to the 72-character line limitation of RFCs.

```

{
  "ietf-network:networks": {
    "network": [
      {
        "network-id": "example-topo-te",
        "network-types": {
          "ietf-te-topology:te-topology": {
          }
        }
      }
    ],
  },
}

```



```
"ietf-te-topology:te-topology-identifier": {
  "provider-id":200,
  "client-id":300,
  "topology-id":"example-topo-te"
},
"ietf-te-topology:te": {
},
"node": [
  {
    "node-id":"D1",
    "ietf-te-topology:te-node-id":"2.0.1.1",
    "ietf-te-topology:te": {
      "te-node-attributes": {
      }
    },
    "ietf-network-topology:termination-point": [
      {
        "tp-id":"1-2-1",
        "ietf-te-topology:te-tp-id":10201,
        "ietf-te-topology:te": {
          "interface-switching-capability": [
            {
              "switching-capability":
                "ietf-te-types:switching-psc1",
              "encoding":
                "ietf-te-types:lsp-encoding-ethernet"
            }
          ]
        }
      }
    ],
    "ietf-network-topology:termination-point": [
      {
        "tp-id": "1-3-1",
        "ietf-te-topology:te-tp-id":10301,
        "ietf-te-topology:te": {
          "interface-switching-capability": [
            {
              "switching-capability":
                "ietf-te-types:switching-psc1",
              "encoding":
                "ietf-te-types:lsp-encoding-ethernet"
            }
          ]
        }
      }
    ]
  }
],
{
  "node-id":"D2",
```



```
"ietf-te-topology:te-node-id":"2.0.2.1",
"ietf-te-topology:te": {
  "te-node-attributes": {
  }
},
"ietf-network-topology:termination-point": [
  {
    "tp-id":"2-1-1",
    "ietf-te-topology:te-tp-id":20101,
    "ietf-te-topology:te": {
      "interface-switching-capability": [
        {
          "switching-capability":
            "ietf-te-types:switching-psc1",
          "encoding":
            "ietf-te-types:lsp-encoding-ethernet"
        }
      ]
    }
  }
],
{
  "node-id":"D3",
  "ietf-te-topology:te-node-id":"2.0.3.1",
  "ietf-te-topology:te": {
    "te-node-attributes": {
    }
  },
  "ietf-network-topology:termination-point": [
    {
      "tp-id":"3-1-1",
      "ietf-te-topology:te-tp-id":30101,
      "ietf-te-topology:te": {
        "interface-switching-capability": [
          {
            "switching-capability":
              "ietf-te-types:switching-psc1",
            "encoding":
              "ietf-te-types:lsp-encoding-ethernet"
          }
        ]
      }
    }
  ]
}
],
"ietf-network-topology:link": [
```





```
{
  "link-id": "D1,1-2-1,D2,2-1-1",
  "source": {
    "source-node": "D1",
    "source-tp": "1-2-1"
  },
  "destination": {
    "dest-node": "D2",
    "dest-tp": "2-1-1"
  },
  "ietf-te-topology:te": {
    "te-link-attributes": {
      "interface-switching-capability": [
        {
          "switching-capability":
            "ietf-te-types:switching-psc1",
          "encoding": "ietf-te-types:lsp-encoding-ethernet"
        }
      ],
      "max-link-bandwidth": {
        "te-bandwidth": {
          "generic": "0x1p+18"
        }
      },
      "te-default-metric": 100
    }
  }
},
{
  "link-id": "D2,2-1-1,D1,1-2-1",
  "source": {
    "source-node": "D2",
    "source-tp": "2-1-1"
  },
  "destination": {
    "dest-node": "D1",
    "dest-tp": "1-2-1"
  },
  "ietf-te-topology:te": {
    "te-link-attributes": {
      "interface-switching-capability": [
        {
          "switching-capability":
            "ietf-te-types:switching-psc1",
          "encoding": "ietf-te-types:lsp-encoding-ethernet"
        }
      ],
      "max-link-bandwidth": {
```



```
        "te-bandwidth": {
          "generic": "0x1p+18"
        }
      },
      "te-default-metric": 100
    }
  },
  {
    "link-id": "D1,1-3-1,D3,3-1-1",
    "source": {
      "source-node": "D1",
      "source-tp": "1-3-1"
    },
    "destination": {
      "dest-node": "D3",
      "dest-tp": "3-1-1"
    },
    "ietf-te-topology:te": {
      "te-link-attributes": {
        "interface-switching-capability": [
          {
            "switching-capability":
              "ietf-te-types:switching-psc1",
            "encoding": "ietf-te-types:lsp-encoding-ethernet"
          }
        ],
        "max-link-bandwidth": {
          "te-bandwidth": {
            "generic": "0x1p+18"
          }
        }
      },
      "te-default-metric": 100
    }
  },
  {
    "link-id": "D3,3-1-1,D1,1-3-1",
    "source": {
      "source-node": "D3",
      "source-tp": "3-1-1"
    },
    "destination": {
      "dest-node": "D1",
      "dest-tp": "1-3-1"
    },
    "ietf-te-topology:te": {
      "te-link-attributes": {
```



```

        "interface-switching-capability": [
            {
                "switching-capability":
                    "ietf-te-types:switching-psc1",
                "encoding":"ietf-te-types:lsp-encoding-ethernet"
            }
        ],
        "max-link-bandwidth": {
            "te-bandwidth": {
                "generic":"0x1p+18"
            }
        },
        "te-default-metric":100
    }
}
]
},
{
    "network-id":"example-topo-l3-te",
    "network-types": {
        "ietf-l3-unicast-topology:l3-unicast-topology": {
            "ietf-l3-te-topology:l3-te": {
            }
        }
    },
    "ietf-l3-unicast-topology:l3-topology-attributes": {
        "ietf-l3-te-topology:l3-te-topology-attributes": {
            "network-ref":"example-topo-te"
        }
    },
    "node": [
        {
            "node-id":"D1",
            "ietf-l3-unicast-topology:l3-node-attributes": {
                "router-id": [
                    "203.0.113.1"
                ],
                "prefix": [
                    {
                        "prefix":"203.0.113.1/32"
                    }
                ],
                "ietf-l3-te-topology:l3-te-node-attributes": {
                    "node-ref":"D1",
                    "network-ref":"example-topo-te"
                }
            }
        },
    ],
}

```



```
    "ietf-network-topology:termination-point": [
      {
        "tp-id": "1-0-1",
        "ietf-l3-unicast-topology:l3-termination-point-attributes": {
          "unnumbered-id": 101
        }
      },
      {
        "tp-id": "1-2-1",
        "ietf-l3-unicast-topology:l3-termination-point-attributes": {
          "unnumbered-id": 121,
          "ietf-l3-te-topology:l3-te-tp-attributes": {
            "network-ref": "example-topo-te",
            "tp-ref": "1-2-1"
          }
        }
      },
      {
        "tp-id": "1-3-1",
        "ietf-l3-unicast-topology:l3-termination-point-attributes": {
          "unnumbered-id": 131,
          "ietf-l3-te-topology:l3-te-tp-attributes": {
            "network-ref": "example-topo-te",
            "tp-ref": "1-3-1"
          }
        }
      }
    ]
  },
  {
    "node-id": "D2",
    "ietf-l3-unicast-topology:l3-node-attributes": {
      "router-id": [
        "203.0.113.2"
      ],
      "prefix": [
        {
          "prefix": "203.0.113.2/32"
        }
      ],
      "ietf-l3-te-topology:l3-te-node-attributes": {
        "node-ref": "D2",
        "network-ref": "example-topo-te"
      }
    },
    "ietf-network-topology:termination-point": [
      {
        "tp-id": "2-0-1",
```





```
"ietf-l3-unicast-topology:l3-termination-point-attributes": {
    "unnumbered-id":201
  }
},
{
  "tp-id":"2-1-1",
"ietf-l3-unicast-topology:l3-termination-point-attributes": {
    "unnumbered-id":211,
    "ietf-l3-te-topology:l3-te-tp-attributes": {
      "tp-ref":"2-1-1",
      "network-ref":"example-topo-te"
    }
  }
},
{
  "tp-id":"2-3-1",
"ietf-l3-unicast-topology:l3-termination-point-attributes": {
    "unnumbered-id":231
  }
}
]
},
{
  "node-id":"D3",
  "ietf-l3-unicast-topology:l3-node-attributes": {
    "router-id": [
      "203.0.113.3"
    ],
    "prefix": [
      {
        "prefix":"203.0.113.3/32"
      }
    ],
    "ietf-l3-te-topology:l3-te-node-attributes": {
      "node-ref":"D3",
      "network-ref":"example-topo-te"
    }
  },
  "ietf-network-topology:termination-point": [
    {
      "tp-id":"3-0-1",
"ietf-l3-unicast-topology:l3-termination-point-attributes": {
    "unnumbered-id":301
  }
  },
  {
    "tp-id":"3-1-1",
"ietf-l3-unicast-topology:l3-termination-point-attributes": {
```



```
        "unnumbered-id":311,
        "ietf-l3-te-topology:l3-te-tp-attributes": {
            "tp-ref":"3-1-1",
            "network-ref":"example-topo-te"
        }
    },
    {
        "tp-id":"3-2-1",
        "ietf-l3-unicast-topology:l3-termination-point-attributes": {
            "unnumbered-id":321
        }
    }
]
},
"ietf-network-topology:link": [
    {
        "link-id":"D1,1-2-1,D2,2-1-1",
        "source": {
            "source-node":"D1",
            "source-tp":"1-2-1"
        },
        "destination": {
            "dest-node":"D2",
            "dest-tp":"2-1-1"
        },
        "ietf-l3-unicast-topology:l3-link-attributes": {
            "metric1":"100",
            "ietf-l3-te-topology:l3-te-link-attributes": {
                "link-ref":"D1,1-2-1,D2,2-1-1",
                "network-ref":"example-topo-te"
            }
        }
    },
    {
        "link-id":"D2,2-1-1,D1,1-2-1",
        "source": {
            "source-node":"D2",
            "source-tp":"2-1-1"
        },
        "destination": {
            "dest-node":"D1",
            "dest-tp":"1-2-1"
        },
        "ietf-l3-unicast-topology:l3-link-attributes": {
            "metric1":"100",
            "ietf-l3-te-topology:l3-te-link-attributes": {
```



```
        "link-ref": "D2, 2-1-1, D1, 1-2-1",
        "network-ref": "example-topo-te"
    }
}
},
{
    "link-id": "D1, 1-3-1, D3, 3-1-1",
    "source": {
        "source-node": "D1",
        "source-tp": "1-3-1"
    },
    "destination": {
        "dest-node": "D3",
        "dest-tp": "3-1-1"
    },
    "ietf-l3-unicast-topology:l3-link-attributes": {
        "metric1": "100",
        "ietf-l3-te-topology:l3-te-link-attributes": {
            "link-ref": "D1, 1-3-1, D3, 3-1-1",
            "network-ref": "example-topo-te"
        }
    }
}
},
{
    "link-id": "D3, 3-1-1, D1, 1-3-1",
    "source": {
        "source-node": "D3",
        "source-tp": "3-1-1"
    },
    "destination": {
        "dest-node": "D1",
        "dest-tp": "1-3-1"
    },
    "ietf-l3-unicast-topology:l3-link-attributes": {
        "metric1": "100",
        "ietf-l3-te-topology:l3-te-link-attributes": {
            "link-ref": "D3, 3-1-1, D1, 1-3-1",
            "network-ref": "example-topo-te"
        }
    }
}
},
{
    "link-id": "D2, 2-3-1, D3, 3-2-1",
    "source": {
        "source-node": "D2",
        "source-tp": "2-3-1"
    },
    "destination": {
```



```
        "dest-node": "D3",
        "dest-tp": "3-2-1"
    },
    "ietf-l3-unicast-topology:l3-link-attributes": {
        "metric1": "100"
    }
},
{
    "link-id": "D3, 3-2-1, D2, 2-3-1",
    "source": {
        "source-node": "D3",
        "source-tp": "3-2-1"
    },
    "destination": {
        "dest-node": "D2",
        "dest-tp": "2-3-1"
    },
    "ietf-l3-unicast-topology:l3-link-attributes": {
        "metric1": "100"
    }
}
]
}
]
}
}
```

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