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Common YANG Data Types for Traffic Engineering
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Abstract

This document defines a collection of common data types, identities, and groupings in YANG data modeling language. These derived common data types, identities and groupings are intended to be imported by other modules, e.g., those which model the Traffic Engineering (TE) configuration and state capabilities.

This document obsoletes RFC 8776.

Status of This Memo

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

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1. Introduction

YANG [RFC6020] [RFC7950] is a data modeling language used to model configuration data, state data, Remote Procedure Calls, and notifications for network management protocols such as the Network Configuration Protocol (NETCONF) [RFC6241] or RESTCONF [RFC8040]. The YANG language supports a small set of built-in data types and provides mechanisms to derive other types from the built-in types.

This document introduces a collection of common data types derived from the built-in YANG data types. The derived data types, identities, and groupings are mainly designed to be the common definitions applicable for modeling Traffic Engineering (TE) features in model(s) defined outside of this document. Nevertheless, these common definitions can be used by any other module per the guidance in Section 4.12 of [I-D.ietf-netmod-rfc8407bis] and Section 4.13 of [I-D.ietf-netmod-rfc8407bis].

> Note: Some groupings defined in this document do not follow the guidelines of Section 4.13 of [I-D.ietf-netmod-rfc8407bis] not to include "default" statements. This is due to the fact that they were already defined in [RFC8776] and removing "default" statements is not a backward compatible change, as defined in Section 11 of [RFC7950].

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

This document adds new common data types, identities, and groupings to both the "ietf-te-types" and the "ietf-te-packet-types" YANG modules and obsoletes [RFC8776]. For further details, refer to Appendix B.

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

1.2. Prefixes in Data Node Names

Names of data nodes and other data model objects are prefixed using the standard prefix associated with the corresponding YANG imported modules, as shown in Table 1.

Prefix	YANG module	Reference
yang	ietf-yang-types	Section 3 of [RFC6991]
inet	ietf-inet-types	Section 4 of [RFC6991]
rt-types	ietf-routing-types	[RFC8294]
te-types	ietf-te-types	RFCXXXX
te-packet-types	ietf-te-packet-types	RFCXXXX

Table 1: Prefixes and corresponding YANG modules

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

1.3. Tree Diagrams

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

2. Acronyms and Abbreviations

APS: Automatic Protection Switching

DS-TE: Differentiated Services Traffic Engineering

GMPLS: Generalized Multiprotocol Label Switching

LER: Label Edge Router

LSP: Label Switched Path

LSR: Label Switching Router

MPLS: Multiprotocol Label Switching

NBMA: Non-Broadcast Multi-Access

PM: Performance Metrics

RSVP: Resource Reservation Protocol

SD: Signal Degrade

SF: Signal Fail

SRLG: Shared Risk Link Group

TE: Traffic Engineering

WTR: Wait-to-Restore

3. Overview

This document defines two YANG modules for common TE types: "ietf-te-types" for TE generic types and "ietf-te-packet-types" for packet-specific types. Other technology-specific TE types are outside the scope of this document.

3.1. TE Types Module Contents

The "ietf-te-types" module (Section 4) contains common TE types that are independent and agnostic of any specific technology or control-plane instance.

3.1.1. Identities

The "ietf-te-types" module contains the following YANG reusable identities:

path-attribute-flags: A base YANG identity for supported LSP path flags as defined in [RFC3209], [RFC4090], [RFC4736], [RFC5712], [RFC4920], [RFC5420], [RFC7570], [RFC4875], [RFC5151], [RFC5150], [RFC6001], [RFC6790], [RFC7260], [RFC8001], [RFC8149], and [RFC8169].

link-protection-type: A base YANG identity for supported link protection types as defined in [RFC4872].

restoration-scheme-type: A base YANG identity for supported LSP restoration schemes as defined in [RFC4872].

protection-external-commands: A base YANG identity for supported protection-related external commands used for troubleshooting purposes, as defined in [RFC4872], [RFC6368], [RFC7271] and [RFC4427].

association-type: A base YANG identity for supported LSP association types as defined in [RFC6780], [RFC4872], [RFC4873], and [RFC8800].

objective-function-type: A base YANG identity for supported path

objective functions as defined in [RFC5541].

te-tunnel-type: A base YANG identity for supported TE tunnel types as defined in [RFC3209] and [RFC4875].

lsp-encoding-types: A base YANG identity for supported LSP encoding types as defined in [RFC3471], [RFC4328] and [RFC6004].

Additional technology-specific LSP encoding types can be defined in other technology-specific models.

lsp-protection-type: A base YANG identity for supported LSP protection types as defined in [RFC4872] and [RFC4873].

switching-capabilities: A base YANG identity for supported interface switching capabilities as defined in [RFC3471], [RFC6002], [RFC6004], [RFC7074] and [RFC7138].

Additional technology-specific interface switching capabilities can be defined in other technology-specific models.

resource-affinities-type: A base YANG identity for supported attribute filters associated with a tunnel that must be satisfied for a link to be acceptable as defined in [RFC3209] and [RFC2702].

path-metric-type: A base YANG identity for supported path metric types as defined in [RFC3630], [RFC3785], [RFC5440], [RFC7471], [RFC8233], [RFC8570] and [I-D.ietf-pce-sid-algo-14].

The unit of the path metric value is interpreted in the context of the path metric type. The derived identities SHOULD describe the unit and maximum value of the path metric types they define.

For example, the measurement unit is not applicable for the number of hops metric ('path-metric-hop'). Conversely, the bound of the 'path-metric-loss', defined in 'ietf-te-packet-types', is defined in multiples of the basic unit 0.000003% as described in [RFC7471] and [RFC8570].

lsp-provisioning-error-reason: A base YANG identity for indicating LSP provisioning error reasons. No standard LSP provisioning error reasons are defined in this document.

path-computation-error-reason: A base YANG identity for indicating path computation error reasons as defined in Section 3.1.1.1.

protocol-origin-type: A base YANG identity for the type of protocol origin as defined in Section 3.1.1.2.

svec-objective-function-type: A base YANG identity for supported SVEC objective functions as defined in [RFC5541] and [RFC8685].

svec-metric-type: A base YANG identity for supported SVEC objective functions as defined in [RFC5541].

3.1.1.1. Path Computation Errors

The "ietf-te-types" module contains the YANG reusable identities for indicating path computation error reasons as defined in [RFC5440], [RFC5441], [RFC5520], [RFC5557], [RFC8306], and [RFC8685].

It also defines the following additional YANG reusable identities for indicating also the following path computation error reasons:

path-computation-error-no-topology: A YANG identity for indicating path computation error when there is no topology with the provided topology identifier.

path-computation-error-no-dependent-server: A YANG identity for indicating path computation error when one or more dependent path computation servers are unavailable.

The dependent path computation server could be a Backward-Recursive Path Computation (BRPC) downstream PCE or a child PCE.

The derived identities are defined in the "ietf-te-types" module, instead of an IANA-maintained module, because there are error reasons which are:

1. applicable only to the TE YANG models and not to PCEP environments (e.g., path-computation-error-no-topology);

2. technology-specific (e.g., No RWA constraints met) which are better defined in technology-specific YANG models;

3. match more than one PCEP numbers in order to hide the details of the underlay PCE architecture (e.g., path-computation-error-no-dependent-server).

3.1.1.2. Protocol Origin

The "ietf-te-types" module contains the YANG reusable identities for the type of protocol origin as defined in [RFC5440] and [RFC9012].

It also defines the following additional YANG reusable identities for the type of protocol origin:

protocol-origin-api: A YANG identity to be used when the type of protocol origin is an Application Programmable Interface (API).

3.1.2. Data Types

The "ietf-te-types" module contains the following YANG reusable data types:

te-ds-class: A type representing the Differentiated Services (DS) Class-Type of traffic as defined in [RFC4124].

te-label-direction: An enumerated type for specifying the forward or reverse direction of a label.

te-hop-type: An enumerated type for specifying that a hop is loose or strict.

te-global-id: A type representing the identifier that uniquely identifies an operator, which can be either a provider or a client. The definition of this type is taken from Section 3 of [RFC6370] and Section 3 of [RFC5003]. This attribute type is used solely to provide a globally unique context for TE topologies.

te-node-id: A type representing the identifier for a node in a TE topology. The identifier is represented either as 4 octets in dotted-quad notation or as 16 octets in full, mixed, shortened, or shortened-mixed IPv6 address notation.

This attribute MAY be mapped to the Router Address TLV described in Section 2.4.1 of [RFC3630], the TE Router ID described in Section 6.2 of [RFC6827], the Traffic Engineering Router ID TLV described in Section 4.3 of [RFC5305], or the TE Router ID TLV described in Section 3.2.1 of [RFC6119].

The reachability of such a TE node MAY be achieved by a mechanism such as that described in Section 6.2 of [RFC6827].

te-topology-id: A type representing the identifier for a topology. It is optional to have one or more prefixes at the beginning, separated by colons. The prefixes can be "network-types" as defined in the "ietf-network" module in [RFC8345], to help the user better understand the topology before further inquiry is made.

te-tp-id: A type representing the identifier of a TE interface Link Termination Point (LTP) on a specific TE node where the TE link connects. This attribute is mapped to a local or remote link identifier [RFC3630] [RFC5305].

te-path-disjointness: A type representing the different resource disjointness options for a TE tunnel path as defined in [RFC4872].

admin-groups: A union type for a TE link's classic or extended administrative groups as defined in [RFC3630], [RFC5305], and [RFC7308].

srlg: A type representing the Shared Risk Link Group (SRLG) as defined in [RFC4203] and [RFC5307].

te-metric: A type representing the TE metric as defined in [RFC3785].

te-recovery-status: An enumerated type for the different statuses of a recovery action as defined in [RFC6378] and [RFC4427].

te-link-access-type: An enumerated type for the different TE link access types as defined in [RFC3630].

3.1.3. Groupings

The "ietf-te-types" module contains the following YANG reusable groupings:

te-bandwidth: A YANG grouping that defines the generic TE bandwidth. The modeling structure allows augmentation for each technology. For unspecified technologies, the string-encoded "te-bandwidth" type is used.

te-label: A YANG grouping that defines the generic TE label. The modeling structure allows augmentation for each technology. For unspecified technologies, "rt-types:generalized-label" is used.

performance-metrics-attributes: A YANG grouping that defines one-way and two-way measured Performance Metrics (PM) and indications of anomalies on link(s) or the path as defined in [RFC7471], [RFC8570], and [RFC7823].

performance-metrics-throttle-container: A YANG grouping that defines configurable thresholds for advertisement suppression and measurement intervals.

explicit-route-hop: A YANG grouping that defines supported explicit routes as defined in [RFC3209] and [RFC3477].

explicit-route-hop-with-srlg: A YANG grouping that augments the 'explicit-route-hop' to specify also Shared Risk Link Group (SRLG) hops.

encoding-and-switching-type: This is a common grouping to define the LSP encoding and switching types.

3.2. Packet TE Types Module Contents

The "ietf-te-packet-types" module (Section 5) covers the common types and groupings that are specific to packet technology.

3.2.1. Identities

The "ietf-te-packet-types" module contains the following YANG reusable identities:

backup-protection-type: A base YANG identity for supported protection types that a backup or bypass tunnel can provide as defined in [RFC4090].

bc-model-type: A base YANG identity for supported Diffserv-TE Bandwidth Constraints Models as defined in [RFC4125], [RFC4126], and [RFC4127].

bandwidth-profile-type: A base YANG identity for various bandwidth profiles specified in [MEF_10.3], [RFC2697] and [RFC2698] that may be used to limit bandwidth utilization of packet flows (e.g., MPLS-TE LSPs).

3.2.2. Data Types

The "ietf-te-packet-types" module contains the following YANG reusable data types:

te-bandwidth-requested-type: An enumerated type for the different options to request bandwidth for a specific tunnel.

3.2.3. Groupings

The "ietf-te-packet-types" module contains the following YANG reusable groupings:

performance-metrics-attributes-packet: A YANG grouping that contains the generic performance metrics and additional packet-specific metrics.

bandwidth-profile-parameters: A YANG grouping that defines common parameters for bandwidth profiles in packet networks.

te-packet-path-bandwidth: A YANG grouping that defines the path

bandwidth information and could be used in any Packet TE model (e.g., MPLS-TE topology model) for the path bandwidth representation (e.g., the bandwidth of an MPLS-TE LSP).

All the path and LSP bandwidth related sections in the "ietf-te-types" generic module, Section 4, need to be augmented with this grouping for the usage of Packet TE technologies.

te-packet-link-bandwidth: A YANG grouping that defines the link bandwidth information and could be used in any Packet TE model (e.g., MPLS-TE topology) for link bandwidth representation.

All the link bandwidth related sections in the "ietf-te-types" generic module, Section 4, need to be augmented with this grouping for the usage of Packet TE technologies.

4. TE Types YANG Module

The "ietf-te-types" module imports from the following modules:

* "ietf-yang-types" and "ietf-inet-types" as defined in [RFC6991]

* "ietf-routing-types" as defined in [RFC8294]

In addition to [RFC6991] and [RFC8294], this module references the following documents in defining the types and YANG groupings: [RFC9522], [RFC4090], [RFC4202], [RFC4328], [RFC4561], [RFC4657], [RFC4736], [RFC6004], [RFC6378], [RFC6511], [RFC7139], [RFC7271], [RFC7308], [RFC7551], [RFC7571], [RFC7579], and [ITU-T_G.709].

<CODE BEGINS> file "ietf-te-types@2024-11-28.yang"

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

  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-yang-types {
    prefix yang;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-routing-types {
    prefix rt-types;
```

```
      reference
        "RFC 8294: Common YANG Data Types for the Routing Area";
    }
    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";
    }

    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
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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 TE.

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

       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 (RFC 2119) (RFC 8174) when, and only when,
       they appear in all capitals, as shown here.
```

```
    revision 2025-01-24 {
      description
        "This revision adds the following new identities:
         - lsp-provisioning-error-reason;
         - association-type-diversity;
         - tunnel-admin-state-auto;
         - lsp-restoration-restore-none;
         - restoration-scheme-rerouting;
         - path-metric-optimization-type;
         - link-path-metric-type;
         - link-metric-type and its derived identities;
         - path-computation-error-reason and its derived identities;
         - protocol-origin-type and its derived identities;
         - svec-objective-function-type and its derived identities;
         - svec-metric-type and its derived identities.

         This revision adds the following new data types:
         - path-type.

         This revision adds the following new groupings:
         - explicit-route-hop-with-srlg;
         - encoding-and-switching-type;
         - te-generic-node-id.

         This revision updates the following identities:
         - objective-function-type;
         - action-exercise;
         - path-metric-type;
         - path-metric-te;
         - path-metric-igp;
         - path-metric-hop;
         - path-metric-delay-average;
         - path-metric-delay-minimum;
         - path-metric-residual-bandwidth;
```

```
          - path-metric-optimize-includes;
          - path-metric-optimize-excludes;
          - te-optimization-criterion.

          This revision updates the following data types:
          - te-node-id.

          This revision updates the following groupings:
          - explicit-route-hop:
           - adds the following leaves:
             - node-id-uri;
             - link-tp-id-uri;
           - updates the following leaves:
             - node-id;
             - link-tp-id;
          - record-route-state:
           - adds the following leaves:
             - node-id-uri;
             - link-tp-id-uri;
           - updates the following leaves:
             - node-id;
             - link-tp-id;
          - optimization-metric-entry:
           - updates the following leaves:
             - metric-type;
          - tunnel-constraints;
           - adds the following leaves:
             - network-id;
          - path-constraints-route-objects:
           - updates the following containers:
             - explicit-route-objects-always;
          - generic-path-metric-bounds:
           - updates the following leaves:
             - metric-type;
          - generic-path-optimization
           - adds the following leaves:
             - tiebreaker;
           - deprecate the following containers:
             - tiebreakers.

          This revision obsoletes the following identities:
          - of-minimize-agg-bandwidth-consumption;
          - of-minimize-load-most-loaded-link;
          - of-minimize-cost-path-set;
          - lsp-protection-reroute-extra;
          - lsp-protection-reroute.

          This revision provides also few editorial changes.";
```

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

    // RFC Editor: replace XXXX with actual RFC number, update date
    // information and remove this note

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

    /*
     * Features
     */

    feature p2mp-te {
      description
        "Indicates support for Point-to-Multipoint TE (P2MP-TE).";
      reference
        "RFC 4875: Extensions to Resource Reservation Protocol -
                   Traffic Engineering (RSVP-TE) for
                   Point-to-Multipoint TE Label Switched Paths (LSPs)";
    }

    feature frr-te {
      description
        "Indicates support for TE Fast Reroute (FRR).";
      reference
        "RFC 4090: Fast Reroute Extensions to RSVP-TE for LSP Tunnels";
    }

    feature extended-admin-groups {
      description
        "Indicates support for TE link extended administrative
         groups.";
      reference
        "RFC 7308: Extended Administrative Groups in MPLS Traffic
                   Engineering (MPLS-TE)";
    }

    feature named-path-affinities {
      description
        "Indicates support for named path affinities.";
    }
```

```
  feature named-extended-admin-groups {
    description
      "Indicates support for named extended administrative groups.";
  }

  feature named-srlg-groups {
    description
      "Indicates support for named Shared Risk Link Group (SRLG).";
  }

  feature named-path-constraints {
    description
      "Indicates support for named path constraints.";
  }

  feature path-optimization-metric {
    description
      "Indicates support for path optimization metrics.";
  }

  feature path-optimization-objective-function {
    description
      "Indicates support for path optimization objective functions.";
  }

  /*
   * Identities
   */

  identity lsp-provisioning-error-reason {
    description
      "Base identity for LSP provisioning errors.";
  }

  identity session-attributes-flags {
    description
      "Base identity for the RSVP-TE session attributes flags.";
  }

  identity local-protection-desired {
    base session-attributes-flags;
    description
      "Local protection is desired.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
                 Section 4.7.1";
  }
```

```
  identity se-style-desired {
    base session-attributes-flags;
    description
      "Shared explicit style, to allow the LSP to be established
       and share resources with the old LSP.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels";
  }

  identity local-recording-desired {
    base session-attributes-flags;
    description
      "Label recording is desired.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
                 Section 4.7.1";
  }

  identity bandwidth-protection-desired {
    base session-attributes-flags;
    description
      "Requests FRR bandwidth protection on LSRs, if present.";
    reference
      "RFC 4090: Fast Reroute Extensions to RSVP-TE for LSP
                 Tunnels";
  }

  identity node-protection-desired {
    base session-attributes-flags;
    description
      "Requests FRR node protection on LSRs, if present.";
    reference
      "RFC 4090: Fast Reroute Extensions to RSVP-TE for LSP
                 Tunnels";
  }

  identity path-reevaluation-request {
    base session-attributes-flags;
    description
      "This flag indicates that a path re-evaluation (of the
       current path in use) is requested.

       Note that this does not trigger any LSP reroutes but
       instead just signals a request to evaluate whether a
       preferable path exists.";
    reference
      "RFC 4736: Reoptimization of Multiprotocol Label Switching
                (MPLS) Traffic Engineering (TE) Loosely Routed
```

```
                Label Switched Path (LSP)";
    }

    identity soft-preemption-desired {
      base session-attributes-flags;
      description
        "Soft preemption of LSP resources is desired.";
      reference
        "RFC 5712: MPLS Traffic Engineering Soft Preemption";
    }

    identity lsp-attributes-flags {
      description
        "Base identity for LSP attributes flags.";
    }

    identity end-to-end-rerouting-desired {
      base lsp-attributes-flags;
      description
        "Indicates end-to-end rerouting behavior for an LSP
         undergoing establishment.

         This MAY also be used to specify the behavior of end-to-end
         LSP recovery for established LSPs.";
      reference
        "RFC 4920: Crankback Signaling Extensions for MPLS and GMPLS
                   RSVP-TE
         RFC 5420: Encoding of Attributes for MPLS LSP Establishment
                   Using Resource Reservation Protocol Traffic
                   Engineering (RSVP-TE)
         RFC 7570: Label Switched Path (LSP) Attribute in the
                   Explicit Route Object (ERO)";
    }

    identity boundary-rerouting-desired {
      base lsp-attributes-flags;
      description
        "Indicates boundary rerouting behavior for an LSP undergoing
         establishment.

         This MAY also be used to specify segment-based LSP recovery
         through nested crankback for established LSPs.

         The boundary Area Border Router (ABR) / Autonomous System
         Border Router (ASBR) can decide to forward the PathErr
         message upstream to either an upstream boundary ABR/ASBR or
         the ingress LSR.
```

```
          Alternatively, it can try to select another egress boundary
          LSR.";
        reference
          "RFC 4920: Crankback Signaling Extensions for MPLS and GMPLS
                     RSVP-TE
           RFC 5420: Encoding of Attributes for MPLS LSP Establishment
                     Using Resource Reservation Protocol Traffic
                     Engineering (RSVP-TE)
           RFC 7570: Label Switched Path (LSP) Attribute in the
                     Explicit Route Object (ERO)";
      }

      identity segment-based-rerouting-desired {
        base lsp-attributes-flags;
        description
          "Indicates segment-based rerouting behavior for an LSP
           undergoing establishment.

           This MAY also be used to specify segment-based LSP recovery
           for established LSPs.";
        reference
          "RFC 4920: Crankback Signaling Extensions for MPLS and GMPLS
                     RSVP-TE
           RFC 5420: Encoding of Attributes for MPLS LSP Establishment
                     Using Resource Reservation Protocol
                     Traffic Engineering (RSVP-TE)
           RFC 7570: Label Switched Path (LSP) Attribute in the
                     Explicit Route Object (ERO)";
      }

      identity lsp-integrity-required {
        base lsp-attributes-flags;
        description
          "Indicates that LSP integrity is required.";
        reference
          "RFC 4875: Extensions to Resource Reservation Protocol -
                     Traffic Engineering (RSVP-TE) for
                     Point-to-Multipoint TE Label Switched Paths (LSPs)
           RFC 7570: Label Switched Path (LSP) Attribute in the
                     Explicit Route Object (ERO)";
      }

      identity contiguous-lsp-desired {
        base lsp-attributes-flags;
        description
          "Indicates that a contiguous LSP is desired.";
        reference
          "RFC 5151: Inter-Domain MPLS and GMPLS Traffic Engineering --
```

```
                  Resource Reservation Protocol-Traffic Engineering
                  (RSVP-TE) Extensions
       RFC 7570: Label Switched Path (LSP) Attribute in the
                  Explicit Route Object (ERO)";
    }

    identity lsp-stitching-desired {
      base lsp-attributes-flags;
      description
        "Indicates that LSP stitching is desired.";
      reference
        "RFC 5150: Label Switched Path Stitching with Generalized
                   Multiprotocol Label Switching Traffic Engineering
                   (GMPLS TE)
         RFC 7570: Label Switched Path (LSP) Attribute in the
                   Explicit Route Object (ERO)";
    }

    identity pre-planned-lsp-flag {
      base lsp-attributes-flags;
      description
        "Indicates that the LSP MUST be provisioned in the
         control plane only.";
      reference
        "RFC 6001: Generalized MPLS (GMPLS) Protocol Extensions for
                   Multi-Layer and Multi-Region Networks (MLN/MRN)
         RFC 7570: Label Switched Path (LSP) Attribute in the
                   Explicit Route Object (ERO)";
    }

    identity non-php-behavior-flag {
      base lsp-attributes-flags;
      description
        "Indicates that non-PHP (non-Penultimate Hop Popping)
         behavior for the LSP is desired.";
      reference
        "RFC 6511: Non-Penultimate Hop Popping Behavior and
                   Out-of-Band Mapping for RSVP-TE Label Switched
                   Paths
         RFC 7570: Label Switched Path (LSP) Attribute in the
                   Explicit Route Object (ERO)";
    }

    identity oob-mapping-flag {
      base lsp-attributes-flags;
      description
        "Indicates that signaling of the egress binding information
         is out of band (e.g., via the Border Gateway Protocol
```

```
          (BGP)).";
        reference
          "RFC 6511: Non-Penultimate Hop Popping Behavior and
                     Out-of-Band Mapping for RSVP-TE Label Switched
                     Paths
           RFC 7570: Label Switched Path (LSP) Attribute in the
                     Explicit Route Object (ERO)";
      }

      identity entropy-label-capability {
        base lsp-attributes-flags;
        description
          "Indicates entropy label capability.";
        reference
          "RFC 6790: The Use of Entropy Labels in MPLS Forwarding
           RFC 7570: Label Switched Path (LSP) Attribute in the
                     Explicit Route Object (ERO)";
      }

      identity oam-mep-entity-desired {
        base lsp-attributes-flags;
        description
          "OAM Maintenance Entity Group End Point (MEP) entities
           desired.";
        reference
          "RFC 7260: GMPLS RSVP-TE Extensions for Operations,
                     Administration, and Maintenance (OAM)
                     Configuration";
      }

      identity oam-mip-entity-desired {
        base lsp-attributes-flags;
        description
          "OAM Maintenance Entity Group Intermediate Points (MIP)
           entities desired.";
        reference
          "RFC 7260: GMPLS RSVP-TE Extensions for Operations,
                     Administration, and Maintenance (OAM)
                     Configuration";
      }

      identity srlg-collection-desired {
        base lsp-attributes-flags;
        description
          "Shared Risk Link Group (SRLG) collection desired.";
        reference
          "RFC 7570: Label Switched Path (LSP) Attribute in the
                     Explicit Route Object (ERO)
```

```
          RFC 8001: RSVP-TE Extensions for Collecting Shared Risk
                    Link Group (SRLG) Information";
      }

      identity loopback-desired {
        base lsp-attributes-flags;
        description
          "This flag indicates that a particular node on the LSP is
           required to enter loopback mode.

           This can also be used to specify the loopback state of the
           node.";
        reference
          "RFC 7571: GMPLS RSVP-TE Extensions for Lock Instruct and
                     Loopback";
      }

      identity p2mp-te-tree-eval-request {
        base lsp-attributes-flags;
        description
          "P2MP-TE tree re-evaluation request.";
        reference
          "RFC 8149: RSVP Extensions for Reoptimization of Loosely
                     Routed Point-to-Multipoint Traffic Engineering
                     Label Switched Paths (LSPs)";
      }

      identity rtm-set-desired {
        base lsp-attributes-flags;
        description
          "Residence Time Measurement (RTM) attribute flag requested.";
        reference
          "RFC 8169: Residence Time Measurement in MPLS Networks";
      }

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

      identity link-protection-unprotected {
        base link-protection-type;
        description
          "Unprotected link type.";
        reference
          "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                     Generalized Multi-Protocol Label Switching (GMPLS)
                     Recovery";
```

```
  }

  identity link-protection-extra-traffic {
    base link-protection-type;
    description
      "Extra-Traffic protected link type.";
    reference
      "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                 Generalized Multi-Protocol Label Switching (GMPLS)
                 Recovery";
  }

  identity link-protection-shared {
    base link-protection-type;
    description
      "Shared protected link type.";
    reference
      "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                 Generalized Multi-Protocol Label Switching (GMPLS)
                 Recovery";
  }

  identity link-protection-1-for-1 {
    base link-protection-type;
    description
      "One-for-one (1:1) protected link type.";
    reference
      "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                 Generalized Multi-Protocol Label Switching (GMPLS)
                 Recovery";
  }

  identity link-protection-1-plus-1 {
    base link-protection-type;
    description
      "One-plus-one (1+1) protected link type.";
    reference
      "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                 Generalized Multi-Protocol Label Switching (GMPLS)
                 Recovery";
  }

  identity link-protection-enhanced {
    base link-protection-type;
    description
      "A compound link protection type derived from the underlay
       TE tunnel protection configuration supporting the TE link.";
  }
```

```
  identity association-type {
    description
      "Base identity for the tunnel association.";
  }

  identity association-type-recovery {
    base association-type;
    description
      "Association type for recovery, used to associate LSPs of the
       same tunnel for recovery.";
    reference
      "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                 Generalized Multi-Protocol Label Switching (GMPLS)
                 Recovery
       RFC 6780: RSVP ASSOCIATION Object Extensions";
  }

  identity association-type-resource-sharing {
    base association-type;
    description
      "Association type for resource sharing, used to enable
       resource sharing during make-before-break.";
    reference
      "RFC 4873: GMPLS Segment Recovery
       RFC 6780: RSVP ASSOCIATION Object Extensions";
  }

  identity association-type-double-sided-bidir {
    base association-type;
    description
      "Association type for double-sided bidirectional LSPs,
       used to associate two LSPs of two tunnels that are
       independently configured on either endpoint.";
    reference
      "RFC 7551: RSVP-TE Extensions for Associated Bidirectional
                 Label Switched Paths (LSPs)";
  }

  identity association-type-single-sided-bidir {
    base association-type;
    description
      "Association type for single-sided bidirectional LSPs,
       used to associate two LSPs of two tunnels, where one
       tunnel is configured on one side/endpoint and the other
       tunnel is dynamically created on the other endpoint.";
    reference
      "RFC 6780: RSVP ASSOCIATION Object Extensions
       RFC 7551: RSVP-TE Extensions for Associated Bidirectional
```

```
                Label Switched Paths (LSPs)";
    }

    identity association-type-diversity {
      base association-type;
      description
        "Association Type diversity used to associate LSPs whose
         paths are to be diverse from each other.";
      reference
        "RFC 8800: Path Computation Element Communication Protocol
                   (PCEP) Extension for Label Switched Path (LSP)
                   Diversity Constraint Signaling";
    }

    identity objective-function-type {
      description
        "Base identity for path objective function types.";
    }

    identity of-minimize-cost-path {
      base objective-function-type;
      description
        "Objective function for minimizing path cost.";
      reference
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol
                   (PCEP)";
    }

    identity of-minimize-load-path {
      base objective-function-type;
      description
        "Objective function for minimizing the load on one or more
         paths.";
      reference
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol
                   (PCEP)";
    }

    identity of-maximize-residual-bandwidth {
      base objective-function-type;
      description
        "Objective function for maximizing residual bandwidth.";
      reference
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol
                   (PCEP)";
```

```
  }

  identity of-minimize-agg-bandwidth-consumption {
    base objective-function-type;
    status obsolete;
    description
      "Objective function for minimizing aggregate bandwidth
       consumption.

       This identity has been obsoleted: the
       'svec-of-minimize-agg-bandwidth-consumption' identity SHOULD
       be used instead.";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }

  identity of-minimize-load-most-loaded-link {
    base objective-function-type;
    status obsolete;
    description
      "Objective function for minimizing the load on the link that
       is carrying the highest load.

       This identity has been obsoleted: the
       'svec-of-minimize-load-most-loaded-link' identity SHOULD
       be used instead.";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }

  identity of-minimize-cost-path-set {
    base objective-function-type;
    status obsolete;
    description
      "Objective function for minimizing the cost on a path set.

       This identity has been obsoleted: the
       'svec-of-minimize-cost-path-set' identity SHOULD
       be used instead.";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }
```

```
  identity path-computation-method {
    description
      "Base identity for supported path computation mechanisms.";
  }

  identity path-locally-computed {
    base path-computation-method;
    description
      "Indicates a constrained-path LSP in which the
       path is computed by the local LER.";
    reference
      "RFC 9522: Overview and Principles of Internet Traffic
                 Engineering, Section 4.4";
  }

  identity path-externally-queried {
    base path-computation-method;
    description
      "Constrained-path LSP in which the path is obtained by
       querying an external source, such as a PCE server.
       In the case that an LSP is defined to be externally queried,
       it may also have associated explicit definitions (provided
       to the external source to aid computation).

       The path that is returned by the external source may
       require further local computation on the device.";
    reference
      "RFC 9522: Overview and Principles of Internet Traffic
                 Engineering
       RFC 4657: Path Computation Element (PCE) Communication
                 Protocol Generic Requirements";
  }

  identity path-explicitly-defined {
    base path-computation-method;
    description
      "Constrained-path LSP in which the path is
       explicitly specified as a collection of strict and/or loose
       hops.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
       RFC 9522: Overview and Principles of Internet Traffic
                 Engineering";
  }

  identity lsp-metric-type {
    description
      "Base identity for the LSP metric specification types.";
```

```
  }

  identity lsp-metric-relative {
    base lsp-metric-type;
    description
      "The metric specified for the LSPs to which this identity
       refers is specified as a value relative to the IGP metric
       cost to the LSP's tail end.";
    reference
      "RFC 4657: Path Computation Element (PCE) Communication
                 Protocol Generic Requirements";
  }

  identity lsp-metric-absolute {
    base lsp-metric-type;
    description
      "The metric specified for the LSPs to which this identity
       refers is specified as an absolute value.";
    reference
      "RFC 4657: Path Computation Element (PCE) Communication
                 Protocol Generic Requirements";
  }

  identity lsp-metric-inherited {
    base lsp-metric-type;
    description
      "The metric for the LSPs to which this identity refers is
       not specified explicitly; rather, it is directly inherited
       from the IGP cost.";
    reference
      "RFC 4657: Path Computation Element (PCE) Communication
                 Protocol Generic Requirements";
  }

  identity te-tunnel-type {
    description
      "Base identity from which specific tunnel types are derived.";
  }

  identity te-tunnel-p2p {
    base te-tunnel-type;
    description
      "TE Point-to-Point (P2P) tunnel type.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels";
  }

  identity te-tunnel-p2mp {
```

```
      base te-tunnel-type;
      description
        "TE P2MP tunnel type.";
      reference
        "RFC 4875: Extensions to Resource Reservation Protocol -
                   Traffic Engineering (RSVP-TE) for
                   Point-to-Multipoint TE Label Switched Paths
                   (LSPs)";
    }

    identity tunnel-action-type {
      description
        "Base identity from which specific tunnel action types
         are derived.";
    }

    identity tunnel-action-resetup {
      base tunnel-action-type;
      description
        "TE tunnel action that tears down the tunnel's current LSP
         (if any) and attempts to re-establish a new LSP.";
    }

    identity tunnel-action-reoptimize {
      base tunnel-action-type;
      description
        "TE tunnel action that reoptimizes the placement of the
         tunnel LSP(s).";
    }

    identity tunnel-action-switchpath {
      base tunnel-action-type;
      description
        "TE tunnel action that switches the tunnel's LSP to use the
         specified path.";
    }

    identity te-action-result {
      description
        "Base identity from which specific TE action results
         are derived.";
    }

    identity te-action-success {
      base te-action-result;
      description
        "TE action was successful.";
    }
```

```
  identity te-action-fail {
    base te-action-result;
    description
      "TE action failed.";
  }

  identity tunnel-action-inprogress {
    base te-action-result;
    description
      "TE action is in progress.";
  }

  identity tunnel-admin-state-type {
    description
      "Base identity for TE tunnel administrative states.";
  }

  identity tunnel-admin-state-up {
    base tunnel-admin-state-type;
    description
      "Tunnel's administrative state is up.";
  }

  identity tunnel-admin-state-down {
    base tunnel-admin-state-type;
    description
      "Tunnel's administrative state is down.";
  }

  identity tunnel-admin-state-auto {
    base tunnel-admin-state-type;
    description
      "Tunnel administrative auto state. The administrative status
       in state datastore transitions to 'tunnel-admin-up' when the
       tunnel used by the client layer, and to 'tunnel-admin-down'
       when it is not used by the client layer.";
  }

  identity tunnel-state-type {
    description
      "Base identity for TE tunnel states.";
  }

  identity tunnel-state-up {
    base tunnel-state-type;
    description
      "Tunnel's state is up.";
  }
```

```
  identity tunnel-state-down {
    base tunnel-state-type;
    description
      "Tunnel's state is down.";
  }

  identity lsp-state-type {
    description
      "Base identity for TE LSP states.";
  }

  identity lsp-path-computing {
    base lsp-state-type;
    description
      "State path computation is in progress.";
  }

  identity lsp-path-computation-ok {
    base lsp-state-type;
    description
      "State path computation was successful.";
  }

  identity lsp-path-computation-failed {
    base lsp-state-type;
    description
      "State path computation failed.";
  }

  identity lsp-state-setting-up {
    base lsp-state-type;
    description
      "State is being set up.";
  }

  identity lsp-state-setup-ok {
    base lsp-state-type;
    description
      "State setup was successful.";
  }

  identity lsp-state-setup-failed {
    base lsp-state-type;
    description
      "State setup failed.";
  }

  identity lsp-state-up {
```

```
      base lsp-state-type;
      description
        "State is up.";
    }

    identity lsp-state-tearing-down {
      base lsp-state-type;
      description
        "State is being torn down.";
    }

    identity lsp-state-down {
      base lsp-state-type;
      description
        "State is down.";
    }

    identity path-invalidation-action-type {
      description
        "Base identity for TE path invalidation action types.";
    }

    identity path-invalidation-action-drop {
      base path-invalidation-action-type;
      description
        "Upon invalidation of the TE tunnel path, the tunnel remains
         valid, but any packet mapped over the tunnel is dropped.";
      reference
        "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
                   Section 2.5";
    }

    identity path-invalidation-action-teardown {
      base path-invalidation-action-type;
      description
        "TE path invalidation action teardown.";
      reference
        "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
                   Section 2.5";
    }

    identity lsp-restoration-type {
      description
        "Base identity from which LSP restoration types are derived.";
    }

    identity lsp-restoration-restore-none {
      base lsp-restoration-type;
```

```
      description
        "No LSP affected by a failure is restored.";
    }

    identity lsp-restoration-restore-any {
      base lsp-restoration-type;
      description
        "Any LSP affected by a failure is restored.";
    }

    identity lsp-restoration-restore-all {
      base lsp-restoration-type;
      description
        "Affected LSPs are restored after all LSPs of the tunnel are
         broken.";
    }

    identity restoration-scheme-type {
      description
        "Base identity for LSP restoration schemes.";
    }

    identity restoration-scheme-rerouting {
      base restoration-scheme-type;
      description
        "Restoration LSP is computed, signalled and configured after
         the failure detection.

         This restoration scheme is also known as
         'Full LSP Re-routing', with the alternate route being
         computed after the failure occurs.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    identity restoration-scheme-preconfigured {
      base restoration-scheme-type;
      description
        "Restoration LSP is precomputed, presignalled and
         preconfigured prior to the failure.";
    }

    identity restoration-scheme-precomputed {
      base restoration-scheme-type;
      description
        "Restoration LSP is precomputed, but not presignalled nor
```

```
          preconfigured, prior to the failure.

          This restoration scheme is also known as
          'Full LSP Re-routing', with the alternate route being
          pre-computed and stored for use when the failure occurs.";
        reference
          "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                     Generalized Multi-Protocol Label Switching (GMPLS)
                     Recovery";
      }

      identity restoration-scheme-presignaled {
        base restoration-scheme-type;
        description
          "Restoration LSP is presignaled, but not preconfigured,
           prior to the failure.

           This restoration scheme is also known as
           'Pre-planned LSP Re-routing'.";
        reference
          "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                     Generalized Multi-Protocol Label Switching (GMPLS)
                     Recovery";
      }

      identity lsp-protection-type {
        description
          "Base identity from which LSP protection types are derived.";
        reference
          "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                      Generalized Multi-Protocol Label Switching (GMPLS)
                      Recovery";
      }

      identity lsp-protection-unprotected {
        base lsp-protection-type;
        description
          "'Unprotected' LSP protection type.";
        reference
          "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                     Generalized Multi-Protocol Label Switching (GMPLS)
                     Recovery";
      }

      identity lsp-protection-reroute-extra {
        base lsp-protection-type;
        status obsolete;
        description
```

```
        "'(Full) Rerouting' LSP protection type.

         This identity has been obsoleted: the
         'restoration-scheme-rerouting' identity SHOULD be used
         instead.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    identity lsp-protection-reroute {
      base lsp-protection-type;
      status obsolete;
      description
        "'Rerouting without Extra-Traffic' LSP protection type.

         This identity has been obsoleted: the
         'restoration-scheme-rerouting' identity SHOULD be used
         instead.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    identity lsp-protection-1-for-n {
      base lsp-protection-type;
      description
        "'1:N Protection with Extra-Traffic' LSP protection type.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    identity lsp-protection-1-for-1 {
      base lsp-protection-type;
      description
        "LSP protection '1:1 Protection Type'.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    identity lsp-protection-unidir-1-plus-1 {
      base lsp-protection-type;
```

```
      description
        "'1+1 Unidirectional Protection' LSP protection type.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    identity lsp-protection-bidir-1-plus-1 {
      base lsp-protection-type;
      description
        "'1+1 Bidirectional Protection' LSP protection type.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    identity lsp-protection-extra-traffic {
      base lsp-protection-type;
      description
        "Extra-Traffic LSP protection type.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    identity lsp-protection-state {
      description
        "Base identity of protection states for reporting purposes.";
    }

    identity normal {
      base lsp-protection-state;
      description
        "Normal state.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity signal-fail-of-protection {
      base lsp-protection-state;
      description
        "The protection transport entity has a signal fail condition
```

```
         that is of higher priority than the forced switchover
         command.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity lockout-of-protection {
      base lsp-protection-state;
      description
        "A Loss of Protection (LoP) command is active.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity forced-switch {
      base lsp-protection-state;
      description
        "A forced switchover command is active.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity signal-fail {
      base lsp-protection-state;
      description
        "There is a signal fail condition on either the working path
         or the protection path.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity signal-degrade {
      base lsp-protection-state;
      description
        "There is a signal degrade condition on either the working
         path or the protection path.";
```

```
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity manual-switch {
      base lsp-protection-state;
      description
        "A manual switchover command is active.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity wait-to-restore {
      base lsp-protection-state;
      description
        "A Wait-to-Restore (WTR) timer is running.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity do-not-revert {
      base lsp-protection-state;
      description
        "A Do Not Revert (DNR) condition is active because of
         non-revertive behavior.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity failure-of-protocol {
      base lsp-protection-state;
      description
        "LSP protection is not working because of a protocol failure
         condition.";
      reference
        "RFC 7271: MPLS Transport Profile (MPLS-TP) Linear Protection
```

```
                  to Match the Operational Expectations of
                  Synchronous Digital Hierarchy, Optical Transport
                  Network, and Ethernet Transport Network Operators
       RFC 4427: Recovery (Protection and Restoration) Terminology
                  for Generalized Multi-Protocol Label Switching
                  (GMPLS)";
  }

  identity protection-external-commands {
    description
      "Base identity from which protection-related external commands
       used for troubleshooting purposes are derived.";
  }

  identity action-freeze {
    base protection-external-commands;
    description
      "A temporary configuration action initiated by an operator
       command that prevents any switchover action from being taken
       and, as such, freezes the current state.";
    reference
      "RFC 7271: MPLS Transport Profile (MPLS-TP) Linear Protection
                  to Match the Operational Expectations of
                  Synchronous Digital Hierarchy, Optical Transport
                  Network, and Ethernet Transport Network Operators
       RFC 4427: Recovery (Protection and Restoration) Terminology
                  for Generalized Multi-Protocol Label Switching
                  (GMPLS)";
  }

  identity clear-freeze {
    base protection-external-commands;
    description
      "An action that clears the active freeze state.";
    reference
      "RFC 7271: MPLS Transport Profile (MPLS-TP) Linear Protection
                  to Match the Operational Expectations of
                  Synchronous Digital Hierarchy, Optical Transport
                  Network, and Ethernet Transport Network Operators
       RFC 4427: Recovery (Protection and Restoration) Terminology
                  for Generalized Multi-Protocol Label Switching
                  (GMPLS)";
  }

  identity action-lockout-of-normal {
    base protection-external-commands;
    description
      "A temporary configuration action initiated by an operator
```

```
         command to ensure that the normal traffic is not allowed
         to use the protection transport entity.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity clear-lockout-of-normal {
      base protection-external-commands;
      description
        "An action that clears the active lockout of the
         normal state.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity action-lockout-of-protection {
      base protection-external-commands;
      description
        "A temporary configuration action initiated by an operator
         command to ensure that the protection transport entity is
         temporarily not available to transport a traffic signal
         (either normal or Extra-Traffic).";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity action-forced-switch {
      base protection-external-commands;
      description
        "A switchover action initiated by an operator command to
         switch the Extra-Traffic signal, the normal traffic signal,
         or the null signal to the protection transport entity,
         unless a switchover command of equal or higher priority is
```

```
          in effect.";
        reference
          "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                     Generalized Multi-Protocol Label Switching (GMPLS)
                     Recovery
           RFC 4427: Recovery (Protection and Restoration) Terminology
                     for Generalized Multi-Protocol Label Switching
                     (GMPLS)";
      }

      identity action-manual-switch {
        base protection-external-commands;
        description
          "A switchover action initiated by an operator command to
           switch the Extra-Traffic signal, the normal traffic signal,
           or the null signal to the protection transport entity,
           unless a fault condition exists on other transport entities
           or a switchover command of equal or higher priority is in
           effect.";
        reference
          "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                     Generalized Multi-Protocol Label Switching (GMPLS)
                     Recovery
           RFC 4427: Recovery (Protection and Restoration) Terminology
                     for Generalized Multi-Protocol Label Switching
                     (GMPLS)";
      }

      identity action-exercise {
        base protection-external-commands;
        description
          "An action that starts testing whether or not Automatic
           Protection Switching (APS) communication is operating
           correctly.

           It is of lower priority than any other state or command.";
        reference
          "RFC 7271: MPLS Transport Profile (MPLS-TP) Linear Protection
                     to Match the Operational Expectations of
                     Synchronous Digital Hierarchy, Optical Transport
                     Network, and Ethernet Transport Network Operators
           RFC 4427: Recovery (Protection and Restoration) Terminology
                     for Generalized Multi-Protocol Label Switching
                     (GMPLS)";
      }

      identity clear {
        base protection-external-commands;
```

```
      description
        "An action that clears the active near-end lockout of a
         protection, forced switchover, manual switchover,
         Wait-to-Restore (WTR) state, or exercise command.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    identity switching-capabilities {
      description
        "Base identity for interface switching capabilities.";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description";
    }

    identity switching-psc1 {
      base switching-capabilities;
      description
        "Packet-Switch Capable-1 (PSC-1).";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description";
    }

    identity switching-evpl {
      base switching-capabilities;
      description
        "Ethernet Virtual Private Line (EVPL).";
      reference
        "RFC 6004: Generalized MPLS (GMPLS) Support for Metro
                   Ethernet Forum and G.8011 Ethernet Service
                   Switching";
    }

    identity switching-l2sc {
      base switching-capabilities;
      description
        "Layer-2 Switch Capable (L2SC).";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description";
    }

    identity switching-tdm {
```

```
      base switching-capabilities;
      description
        "Time-Division-Multiplex Capable (TDM).";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description";
    }

    identity switching-otn {
      base switching-capabilities;
      description
        "OTN-TDM capable.";
      reference
        "RFC 7138: Traffic Engineering Extensions to OSPF for GMPLS
                   Control of Evolving G.709 Optical Transport
                   Networks";
    }

    identity switching-dcsc {
      base switching-capabilities;
      description
        "Data Channel Switching Capable (DCSC).";
      reference
        "RFC 6002: Generalized MPLS (GMPLS) Data Channel
                   Switching Capable (DCSC) and Channel Set Label
                   Extensions";
    }

    identity switching-lsc {
      base switching-capabilities;
      description
        "Lambda-Switch Capable (LSC).";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description";
    }

    identity switching-fsc {
      base switching-capabilities;
      description
        "Fiber-Switch Capable (FSC).";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description";
    }

    identity lsp-encoding-types {
      description
```

```
      "Base identity for encoding types.";
    reference
      "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description";
  }

  identity lsp-encoding-packet {
    base lsp-encoding-types;
    description
      "Packet LSP encoding.";
    reference
      "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description";
  }

  identity lsp-encoding-ethernet {
    base lsp-encoding-types;
    description
      "Ethernet LSP encoding.";
    reference
      "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description";
  }

  identity lsp-encoding-pdh {
    base lsp-encoding-types;
    description
      "ANSI/ETSI PDH LSP encoding.";
    reference
      "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description";
  }

  identity lsp-encoding-sdh {
    base lsp-encoding-types;
    description
      "SDH ITU-T G.707 / SONET ANSI T1.105 LSP encoding.";
    reference
      "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description";
  }

  identity lsp-encoding-digital-wrapper {
    base lsp-encoding-types;
    description
      "Digital Wrapper LSP encoding.";
    reference
      "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
```

```
                Signaling Functional Description";
    }

    identity lsp-encoding-lambda {
      base lsp-encoding-types;
      description
        "Lambda (photonic) LSP encoding.";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                Signaling Functional Description";
    }

    identity lsp-encoding-fiber {
      base lsp-encoding-types;
      description
        "Fiber LSP encoding.";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                Signaling Functional Description";
    }

    identity lsp-encoding-fiber-channel {
      base lsp-encoding-types;
      description
        "FiberChannel LSP encoding.";
      reference
        "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                Signaling Functional Description";
    }

    identity lsp-encoding-oduk {
      base lsp-encoding-types;
      description
        "G.709 ODUk (Digital Path) LSP encoding.";
      reference
        "RFC 4328: Generalized Multi-Protocol Label Switching (GMPLS)
                Signaling Extensions for G.709 Optical Transport
                Networks Control";
    }

    identity lsp-encoding-optical-channel {
      base lsp-encoding-types;
      description
        "G.709 Optical Channel LSP encoding.";
      reference
        "RFC 4328: Generalized Multi-Protocol Label Switching (GMPLS)
                Signaling Extensions for G.709 Optical Transport
                Networks Control";
```

```
  }

  identity lsp-encoding-line {
    base lsp-encoding-types;
    description
      "Line (e.g., 8B/10B) LSP encoding.";
    reference
      "RFC 6004: Generalized MPLS (GMPLS) Support for Metro
                 Ethernet Forum and G.8011 Ethernet Service
                 Switching";
  }

  identity path-signaling-type {
    description
      "Base identity from which specific LSP path setup types
       are derived.";
  }

  identity path-setup-static {
    base path-signaling-type;
    description
      "Static LSP provisioning path setup.";
  }

  identity path-setup-rsvp {
    base path-signaling-type;
    description
      "RSVP-TE signaling path setup.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels";
  }

  identity path-setup-sr {
    base path-signaling-type;
    description
      "Segment-routing path setup.";
  }

  identity path-scope-type {
    description
      "Base identity from which specific path scope types are
       derived.";
  }

  identity path-scope-segment {
    base path-scope-type;
    description
      "Path scope segment.";
```

```
      reference
        "RFC 4873: GMPLS Segment Recovery";
    }

    identity path-scope-end-to-end {
      base path-scope-type;
      description
        "Path scope end to end.";
      reference
        "RFC 4873: GMPLS Segment Recovery";
    }

    identity route-usage-type {
      description
        "Base identity for route usage.";
    }

    identity route-include-object {
      base route-usage-type;
      description
        "'Include route' object.";
    }

    identity route-exclude-object {
      base route-usage-type;
      description
        "'Exclude route' object.";
      reference
        "RFC 4874: Exclude Routes - Extension to Resource ReserVation
                   Protocol-Traffic Engineering (RSVP-TE)";
    }

    identity route-exclude-srlg {
      base route-usage-type;
      description
        "Excludes Shared Risk Link Groups (SRLGs).";
      reference
        "RFC 4874: Exclude Routes - Extension to Resource ReserVation
                   Protocol-Traffic Engineering (RSVP-TE)";
    }

    identity path-metric-optimization-type {
      description
        "Base identity used to define the path metric optimization
         types.";
    }

    identity link-path-metric-type {
```

```
    description
      "Base identity used to define the link and the path metric
       types.

       The unit of the path metric value is interpreted in the
       context of the path metric type and the derived identities
       SHOULD describe the unit of the path metric types they
       define.";
  }

  identity link-metric-type {
    base link-path-metric-type;
    description
      "Base identity for the link metric types.";
  }

  identity link-metric-te {
    base link-metric-type;
    description
      "Traffic Engineering (TE) Link Metric.";
    reference
      "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
                 Version 2, Section 2.5.5
       RFC 5305: IS-IS Extensions for Traffic Engineering,
                 Section 3.7";
  }

  identity link-metric-igp {
    base link-metric-type;
    description
      "Interior Gateway Protocol (IGP) Link Metric.";
    reference
      "RFC 3785: Use of Interior Gateway Protocol (IGP) Metric
                 as a second MPLS Traffic Engineering (TE)
                 Metric";
  }

  identity link-metric-delay-average {
    base link-metric-type;
    description
      "Unidirectional Link Delay, measured in units of
       microseconds.";
    reference
      "RFC 7471: OSPF Traffic Engineering (TE) Metric
                 Extensions, Section 4.1
       RFC 8570: IS-IS Traffic Engineering (TE) Metric
                 Extensions, Section 4.1";
  }
```

```
  identity link-metric-delay-minimum {
    base link-metric-type;
    description
      "Minimum unidirectional Link Delay, measured in units of
       microseconds.";
    reference
      "RFC 7471: OSPF Traffic Engineering (TE) Metric
                 Extensions, Section 4.2
       RFC 8570: IS-IS Traffic Engineering (TE) Metric
                 Extensions, Section 4.2";
  }

  identity link-metric-delay-maximum {
    base link-metric-type;
    description
      "Maximum unidirectional Link Delay, measured in units of
       microseconds.";
    reference
      "RFC 7471: OSPF Traffic Engineering (TE) Metric
                 Extensions, Section 4.2
       RFC 8570: IS-IS Traffic Engineering (TE) Metric
                 Extensions, Section 4.2";
  }

  identity link-metric-residual-bandwidth {
    base link-metric-type;
    description
      "Unidirectional Residual Bandwidth, measured in units of
       bytes per second.

       It is defined to be Maximum Bandwidth minus the bandwidth
       currently allocated to LSPs.";
    reference
      "RFC 7471: OSPF Traffic Engineering (TE) Metric
                 Extensions, Section 4.5
       RFC 8570: IS-IS Traffic Engineering (TE) Metric
                 Extensions, Section 4.5";
  }

  identity path-metric-type {
    base link-path-metric-type;
    base path-metric-optimization-type;
    description
      "Base identity for the path metric types.";
  }

  identity path-metric-te {
    base path-metric-type;
```

```
      description
        "Traffic Engineering (TE) Path Metric.";
      reference
        "RFC 5440: Path Computation Element (PCE) Communication
                   Protocol (PCEP), Section 7.8";
    }

    identity path-metric-igp {
      base path-metric-type;
      description
        "Interior Gateway Protocol (IGP) Path Metric.";
      reference
        "RFC 5440: Path Computation Element (PCE) Communication
                   Protocol (PCEP), section 7.8";
    }

    identity path-metric-hop {
      base path-metric-type;
      description
        "Hop Count Path Metric.";
      reference
        "RFC 5440: Path Computation Element (PCE) Communication
                   Protocol (PCEP), Section 7.8";
    }

    identity path-metric-delay-average {
      base path-metric-type;
      description
        "The Path Delay Metric, measured in units of
         microseconds.";
      reference
        "RFC 8233: Extensions to the Path Computation Element
                   Communication Protocol (PCEP) to Compute
                   Service-Aware Label Switched Paths (LSPs),
                   Section 3.1.1";
    }

    identity path-metric-delay-minimum {
      base path-metric-type;
      description
        "The Path Min Delay Metric, measured in units of
         microseconds.";
      reference
        "I-D.ietf-pce-sid-algo: Carrying SR-Algorithm information
                                in PCE-based Networks,
                                draft-ietf-pce-sid-algo-14,
                                Sections 3.5.1 and 3.5.2";
    }
```

```
  identity path-metric-residual-bandwidth {
    base path-metric-type;
    description
      "The Path Residual Bandwidth, defined as the minimum Link
       Residual Bandwidth all the links along the path.

       The Path Residual Bandwidth can be seen as the path
       metric associated with the Maximum residual Bandwidth Path
       (MBP) objective function.";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }

  identity path-metric-optimize-includes {
    base path-metric-optimization-type;
    description
      "A metric that optimizes the number of included resources
       specified in a set.";
  }

  identity path-metric-optimize-excludes {
    base path-metric-optimization-type;
    description
      "A metric that optimizes to a maximum the number of excluded
       resources specified in a set.";
  }

  identity path-tiebreaker-type {
    description
      "Base identity for the path tiebreaker type.";
  }

  identity path-tiebreaker-minfill {
    base path-tiebreaker-type;
    description
      "Min-Fill LSP path placement: selects the path with the most
       available bandwidth (load balance LSPs over more links).";
  }

  identity path-tiebreaker-maxfill {
    base path-tiebreaker-type;
    description
      "Max-Fill LSP path placement: selects the path with the least
       available bandwidth (packing more LSPs over few links).";
  }
```

```
  identity path-tiebreaker-random {
    base path-tiebreaker-type;
    description
      "Random LSP path placement.";
  }

  identity resource-affinities-type {
    description
      "Base identity for resource class affinities.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
       RFC 2702: Requirements for Traffic Engineering Over MPLS";
  }

  identity resource-aff-include-all {
    base resource-affinities-type;
    description
      "The set of attribute filters associated with a
       tunnel, all of which must be present for a link
       to be acceptable.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
       RFC 2702: Requirements for Traffic Engineering Over MPLS";
  }

  identity resource-aff-include-any {
    base resource-affinities-type;
    description
      "The set of attribute filters associated with a
       tunnel, any of which must be present for a link
       to be acceptable.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
       RFC 2702: Requirements for Traffic Engineering Over MPLS";
  }

  identity resource-aff-exclude-any {
    base resource-affinities-type;
    description
      "The set of attribute filters associated with a
       tunnel, any of which renders a link unacceptable.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
       RFC 2702: Requirements for Traffic Engineering Over MPLS";
  }

  identity te-optimization-criterion {
    description
```

```
      "Base identity for the TE optimization criteria.";
    reference
      "RFC 9522: Overview and Principles of Internet Traffic
                 Engineering";
  }

  identity not-optimized {
    base te-optimization-criterion;
    description
      "Optimization is not applied.";
  }

  identity cost {
    base te-optimization-criterion;
    description
      "Optimized on cost.";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }

  identity delay {
    base te-optimization-criterion;
    description
      "Optimized on delay.";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }

  identity path-computation-srlg-type {
    description
      "Base identity for Shared Risk Link Group (SRLG) path
       computation.";
  }

  identity srlg-ignore {
    base path-computation-srlg-type;
    description
      "Ignores Shared Risk Link Groups (SRLGs) in the path
       computation.";
  }

  identity srlg-strict {
    base path-computation-srlg-type;
    description
```

```
        "Includes a strict Shared Risk Link Group (SRLG) check in
         the path computation.";
    }

    identity srlg-preferred {
      base path-computation-srlg-type;
      description
        "Includes a preferred Shared Risk Link Group (SRLG) check in
         the path computation.";
    }

    identity srlg-weighted {
      base path-computation-srlg-type;
      description
        "Includes a weighted Shared Risk Link Group (SRLG) check in
         the path computation.";
    }

    identity path-computation-error-reason {
      description
        "Base identity for path computation error reasons.";
    }

    identity path-computation-error-path-not-found {
      base path-computation-error-reason;
      description
        "Path computation has failed because of an unspecified
         reason.";
      reference
        "RFC 5440: Path Computation Element (PCE) Communication
                   Protocol (PCEP), Section 7.5";
    }

    identity path-computation-error-no-topology {
      base path-computation-error-reason;
      description
        "Path computation has failed because there is no topology
         with the provided topology-identifier.";
    }

    identity path-computation-error-no-dependent-server {
      base path-computation-error-reason;
      description
        "Path computation has failed because one or more dependent
         path computation servers are unavailable.

         The dependent path computation server could be
         a Backward-Recursive Path Computation (BRPC) downstream
```

```
          PCE or a child PCE.";
        reference
          "RFC 5441: A Backward-Recursive PCE-Based Computation (BRPC)
                     Procedure to Compute Shortest Constrained
                     Inter-Domain Traffic Engineering Label Switched
                     Paths
           RFC 8685: Path Computation Element Communication Protocol
                     (PCEP) Extensions for the Hierarchical Path
                     Computation Element (H-PCE) Architecture";
      }

      identity path-computation-error-pce-unavailable {
        base path-computation-error-reason;
        description
          "Path computation has failed because PCE is not available.

           It corresponds to bit 31 of the Flags field of the
           NO-PATH-VECTOR TLV.";
        reference
          "RFC 5440: Path Computation Element (PCE) Communication
                     Protocol (PCEP)

           https://www.iana.org/assignments/pcep
           /pcep.xhtml#no-path-vector-tlv";
      }

      identity path-computation-error-no-inclusion-hop {
        base path-computation-error-reason;
        description
          "Path computation has failed because there is no
           node or link provided by one or more inclusion hops.";
      }

      identity path-computation-error-destination-unknown-in-domain {
        base path-computation-error-reason;
        description
          "Path computation has failed because the destination node is
           unknown in indicated destination domain.

           It corresponds to bit 19 of the Flags field of the
           NO-PATH-VECTOR TLV.";
        reference
          "RFC 8685: Path Computation Element Communication Protocol
                     (PCEP) Extensions for the Hierarchical Path
                     Computation Element (H-PCE) Architecture

           https://www.iana.org/assignments/pcep
           /pcep.xhtml#no-path-vector-tlv";
```

```
  }

  identity path-computation-error-no-resource {
    base path-computation-error-reason;
    description
      "Path computation has failed because there is no
       available resource in one or more domains.

       It corresponds to bit 20 of the Flags field of the
       NO-PATH-VECTOR TLV.";
    reference
      "RFC 8685: Path Computation Element Communication Protocol
                 (PCEP) Extensions for the Hierarchical Path
                 Computation Element (H-PCE) Architecture

       https://www.iana.org/assignments/pcep
       /pcep.xhtml#no-path-vector-tlv";
  }

  identity path-computation-error-child-pce-unresponsive {
    base path-computation-error-no-dependent-server;
    description
      "Path computation has failed because child PCE is not
       responsive.

       It corresponds to bit 21 of the Flags field of the
       NO-PATH-VECTOR TLV.";
    reference
      "RFC 8685: Path Computation Element Communication Protocol
                 (PCEP) Extensions for the Hierarchical Path
                 Computation Element (H-PCE) Architecture

       https://www.iana.org/assignments/pcep
       /pcep.xhtml#no-path-vector-tlv";
  }

  identity path-computation-error-destination-domain-unknown {
    base path-computation-error-reason;
    description
      "Path computation has failed because the destination domain
       was unknown.

       It corresponds to bit 22 of the Flags field of the
       NO-PATH-VECTOR TLV.";
    reference
      "RFC 8685: Path Computation Element Communication Protocol
                 (PCEP) Extensions for the Hierarchical Path
                 Computation Element (H-PCE) Architecture
```

```
          https://www.iana.org/assignments/pcep
          /pcep.xhtml#no-path-vector-tlv";
      }

      identity path-computation-error-p2mp {
        base path-computation-error-reason;
        description
          "Path computation has failed because of P2MP reachability
           problem.

           It corresponds to bit 24 of the Flags field of the
           NO-PATH-VECTOR TLV.";
        reference
          "RFC 8306: Extensions to the Path Computation Element
                     Communication Protocol (PCEP) for
                     Point-to-Multipoint Traffic Engineering Label
                     Switched Paths

           https://www.iana.org/assignments/pcep
           /pcep.xhtml#no-path-vector-tlv";
      }

      identity path-computation-error-no-gco-migration {
        base path-computation-error-reason;
        description
          "Path computation has failed because of no Global Concurrent
           Optimization (GCO) migration path found.

           It corresponds to bit 26 of the Flags field of the
           NO-PATH-VECTOR TLV.";
        reference
          "RFC 5557: Path Computation Element Communication Protocol
                     (PCEP) Requirements and Protocol Extensions in
                     Support of Global Concurrent Optimization

           https://www.iana.org/assignments/pcep
           /pcep.xhtml#no-path-vector-tlv";
      }

      identity path-computation-error-no-gco-solution {
        base path-computation-error-reason;
        description
          "Path computation has failed because of no GCO solution
           found.

           It corresponds to bit 25 of the Flags field of the
           NO-PATH-VECTOR TLV.";
        reference
```

```
         "RFC 5557: Path Computation Element Communication Protocol
                    (PCEP) Requirements and Protocol Extensions in
                    Support of Global Concurrent Optimization

          https://www.iana.org/assignments/pcep
          /pcep.xhtml#no-path-vector-tlv";
      }

      identity path-computation-error-pks-expansion {
        base path-computation-error-reason;
        description
          "Path computation has failed because of Path-Key Subobject
           (PKS) expansion failure.

           It corresponds to bit 27 of the Flags field of the
           NO-PATH-VECTOR TLV.";
        reference
          "RFC 5520: Preserving Topology Confidentiality in
                     Inter-Domain Path Computation Using a
                     Path-Key-Based Mechanism

           https://www.iana.org/assignments/pcep
           /pcep.xhtml#no-path-vector-tlv";
      }

      identity path-computation-error-brpc-chain-unavailable {
        base path-computation-error-no-dependent-server;
        description
          "Path computation has failed because PCE BRPC chain
           unavailable.

           It corresponds to bit 28 of the Flags field of the
           NO-PATH-VECTOR TLV.";
        reference
          "RFC 5441: A Backward-Recursive PCE-Based Computation (BRPC)
                     Procedure to Compute Shortest Constrained
                     Inter-Domain Traffic Engineering Label Switched
                     Paths

           https://www.iana.org/assignments/pcep
           /pcep.xhtml#no-path-vector-tlv";
      }

      identity path-computation-error-source-unknown {
        base path-computation-error-reason;
        description
          "Path computation has failed because source node is
           unknown.
```

```
         It corresponds to bit 29 of the Flags field of the
         NO-PATH-VECTOR TLV.";
       reference
         "RFC 5440: Path Computation Element (PCE) Communication
                    Protocol (PCEP);

         https://www.iana.org/assignments/pcep
         /pcep.xhtml#no-path-vector-tlv";
     }

     identity path-computation-error-destination-unknown {
       base path-computation-error-reason;
       description
         "Path computation has failed because destination node is
          unknown.

          It corresponds to bit 30 of the Flags field of the
          NO-PATH-VECTOR TLV.";
       reference
         "RFC 5440: Path Computation Element (PCE) Communication
                    Protocol (PCEP);

         https://www.iana.org/assignments/pcep
         /pcep.xhtml#no-path-vector-tlv";
     }

     identity protocol-origin-type {
       description
         "Base identity for protocol origin type.";
     }

     identity protocol-origin-api {
       base protocol-origin-type;
       description
         "Protocol origin is via Application Programming Interface
          (API).";
     }

     identity protocol-origin-pcep {
       base protocol-origin-type;
       description
         "Protocol origin is Path Computation Engine Protocol
          (PCEP).";
       reference
         "RFC 5440: Path Computation Element (PCE) Communication
                    Protocol (PCEP)";
     }
```

```
  identity protocol-origin-bgp {
    base protocol-origin-type;
    description
      "Protocol origin is Border Gateway Protocol (BGP).";
    reference
      "RFC 9012: The BGP Tunnel Encapsulation Attribute";
  }

  identity svec-objective-function-type {
    description
      "Base identity for SVEC objective function type.";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol (PCEP)";
  }

  identity svec-of-minimize-agg-bandwidth-consumption {
    base svec-objective-function-type;
    description
      "Objective function for minimizing aggregate bandwidth
       consumption (MBC).";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }

  identity svec-of-minimize-load-most-loaded-link {
    base svec-objective-function-type;
    description
      "Objective function for minimizing the load on the link that
       is carrying the highest load (MLL).";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }

  identity svec-of-minimize-cost-path-set {
    base svec-objective-function-type;
    description
      "Objective function for minimizing the cost on a path set
       (MCC).";
    reference
      "RFC 5541: Encoding of Objective Functions in the Path
                 Computation Element Communication Protocol
                 (PCEP)";
  }
```

```
  identity svec-of-minimize-common-transit-domain {
    base svec-objective-function-type;
    description
      "Objective function for minimizing the number of common
       transit domains (MCTD).";
    reference
      "RFC 8685: Path Computation Element Communication Protocol
                 (PCEP) Extensions for the Hierarchical Path
                 Computation Element (H-PCE) Architecture.";
  }

  identity svec-of-minimize-shared-link {
    base svec-objective-function-type;
    description
      "Objective function for minimizing the number of shared
       links (MSL).";
    reference
      "RFC 8685: Path Computation Element Communication Protocol
                 (PCEP) Extensions for the Hierarchical Path
                 Computation Element (H-PCE) Architecture.";
  }

  identity svec-of-minimize-shared-srlg {
    base svec-objective-function-type;
    description
      "Objective function for minimizing the number of shared
       Shared Risk Link Groups (SRLG) (MSS).";
    reference
      "RFC 8685: Path Computation Element Communication Protocol
                 (PCEP) Extensions for the Hierarchical Path
                 Computation Element (H-PCE) Architecture.";
  }

  identity svec-of-minimize-shared-nodes {
    base svec-objective-function-type;
    description
      "Objective function for minimizing the number of shared
       nodes (MSN).";
    reference
      "RFC 8685: Path Computation Element Communication Protocol
                 (PCEP) Extensions for the Hierarchical Path
                 Computation Element (H-PCE) Architecture.";
  }

  identity svec-metric-type {
    description
      "Base identity for SVEC metric type.";
    reference
```

```
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol (PCEP)";
    }

    identity svec-metric-cumulative-te {
      base svec-metric-type;
      description
        "Cumulative TE cost.";
      reference
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol
                   (PCEP)";
    }

    identity svec-metric-cumulative-igp {
      base svec-metric-type;
      description
        "Cumulative IGP cost.";
      reference
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol
                   (PCEP)";
    }

    identity svec-metric-cumulative-hop {
      base svec-metric-type;
      description
        "Cumulative Hop path metric.";
      reference
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol
                   (PCEP)";
    }

    identity svec-metric-aggregate-bandwidth-consumption {
      base svec-metric-type;
      description
        "Aggregate bandwidth consumption.";
      reference
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol
                   (PCEP)";
    }

    identity svec-metric-load-of-the-most-loaded-link {
      base svec-metric-type;
      description
        "Load of the most loaded link.";
```

```
      reference
        "RFC 5541: Encoding of Objective Functions in the Path
                   Computation Element Communication Protocol
                   (PCEP)";
    }

    /*
     * Typedefs
     */

    typedef admin-group {
      type yang:hex-string {
        /* 01:02:03:04 */
        length "1..11";
      }
      description
        "Administrative group / resource class / color representation
         in 'hex-string' type.

         The most significant byte in the hex-string is the farthest
         to the left in the byte sequence.

         Leading zero bytes in the configured value may be omitted
         for brevity.";
      reference
        "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
                   Version 2
         RFC 5305: IS-IS Extensions for Traffic Engineering
         RFC 7308: Extended Administrative Groups in MPLS Traffic
                   Engineering (MPLS-TE)";
    }

    typedef admin-groups {
      type union {
        type admin-group;
        type extended-admin-group;
      }
      description
        "Derived types for TE administrative groups.";
    }

    typedef extended-admin-group {
      type yang:hex-string;
      description
        "Extended administrative group / resource class / color
         representation in 'hex-string' type.

         The most significant byte in the hex-string is the farthest
```

```
          to the left in the byte sequence.

          Leading zero bytes in the configured value may be omitted
          for brevity.";
        reference
          "RFC 7308: Extended Administrative Groups in MPLS Traffic
                     Engineering (MPLS-TE)";
      }

      typedef path-attribute-flags {
        type union {
          type identityref {
            base session-attributes-flags;
          }
          type identityref {
            base lsp-attributes-flags;
          }
        }
        description
          "Path attributes flags type.";
      }

      typedef performance-metrics-normality {
        type enumeration {
          enum unknown {
            value 0;
            description
              "Unknown.";
          }
          enum normal {
            value 1;
            description
              "Normal.

               Indicates that the anomalous bit is not set.";
          }
          enum abnormal {
            value 2;
            description
              "Abnormal.

               Indicates that the anomalous bit is set.";
          }
        }
        description
          "Indicates whether a performance metric is normal (anomalous
           bit not set), abnormal (anomalous bit set), or unknown.";
        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";
      }

      typedef srlg {
        type uint32;
        description
          "Shared Risk Link Group (SRLG) type.";
        reference
          "RFC 4203: OSPF Extensions in Support of Generalized
                     Multi-Protocol Label Switching (GMPLS)
           RFC 5307: IS-IS Extensions in Support of Generalized
                     Multi-Protocol Label Switching (GMPLS)";
      }

      typedef te-common-status {
        type enumeration {
          enum up {
            description
              "Enabled.";
          }
          enum down {
            description
              "Disabled.";
          }
          enum testing {
            description
              "In some test mode.";
          }
          enum preparing-maintenance {
            description
              "The resource is disabled in the control plane to prepare
               for a graceful shutdown for maintenance purposes.";
            reference
              "RFC 5817: Graceful Shutdown in MPLS and Generalized MPLS
                         Traffic Engineering Networks";
          }
          enum maintenance {
            description
              "The resource is disabled in the data plane for maintenance
               purposes.";
          }
          enum unknown {
            description
              "Status is unknown.";
```

```
        }
      }
      description
        "Defines a type representing the common states of a TE
         resource.";
    }

    typedef te-bandwidth {
      type string {
        pattern '0[xX](0((\.0?)?[pP](\+)?0?|(\.0?))|'
              + '1(\.([\da-fA-F]{0,5}[02468aAcCeE]?)?)?'
              + '[pP](\+)?(12[0-7]|'
              + '1[01]\d|0?\d?\d)?)|0[xX][\da-fA-F]{1,8}|\d+'
              + '(,(0[xX](0((\.0?)?[pP](\+)?0?|(\.0?))|'
              + '1(\.([\da-fA-F]{0,5}[02468aAcCeE]?)?)?'
              + '[pP](\+)?(12[0-7]|'
              + '1[01]\d|0?\d?\d)?)|0[xX][\da-fA-F]{1,8}|\d+))*';
      }
      description
        "This is the generic bandwidth type.

         It is a string containing a list of numbers separated by
         commas, where each of these numbers can be non-negative
         decimal, hex integer, or hex float:

         (dec | hex | float)[*(',’(dec | hex | float))]

         For the packet-switching type, the string encoding may follow
         the type 'bandwidth-ieee-float32' as defined in RFC 8294
         (e.g., 0x1p10), where the units are in bytes per second.

         Canonically, the string is represented as all lowercase and in
         hex, where the prefix '0x' precedes the hex number.";
      reference
        "RFC 8294: Common YANG Data Types for the Routing Area
         ITU-T G.709: Interfaces for the optical transport network -
                      Edition 6.0 (06/2020)";
    }

    typedef te-ds-class {
      type uint8 {
        range "0..7";
      }
      description
        "The Differentiated Services Class-Type of traffic.";
      reference
        "RFC 4124: Protocol Extensions for Support of Diffserv-aware
                   MPLS Traffic Engineering, Section 4.3.1";
```

```
  }

  typedef te-global-id {
    type uint32;
    description
      "An identifier to uniquely identify an operator, which can be
       either a provider or a client.

       The definition of this type is taken from RFCs 6370 and 5003.

       This attribute type is used solely to provide a globally
       unique context for TE topologies.";
    reference
      "RFC 5003: Attachment Individual Identifier (AII) Types for
                 Aggregation
       RFC 6370: MPLS Transport Profile (MPLS-TP) Identifiers";
  }

  typedef te-hop-type {
    type enumeration {
      enum loose {
        description
          "A loose hop in an explicit path.";
      }
      enum strict {
        description
          "A strict hop in an explicit path.";
      }
    }
    description
      "Enumerated type for specifying loose or strict paths.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
                 Section 4.3.3";
  }

  typedef te-link-access-type {
    type enumeration {
      enum point-to-point {
        description
          "The link is point-to-point.";
      }
      enum multi-access {
        description
          "The link is multi-access, including broadcast and NBMA.";
      }
    }
    description
```

```
        "Defines a type representing the access type of a TE link.";
      reference
        "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
                   Version 2";
    }

    typedef te-label-direction {
      type enumeration {
        enum forward {
          description
            "Label allocated for the forward LSP direction.";
        }
        enum reverse {
          description
            "Label allocated for the reverse LSP direction.";
        }
      }
      description
        "Enumerated type for specifying the forward or reverse
         label.";
    }

    typedef te-link-direction {
      type enumeration {
        enum incoming {
          description
            "The explicit route represents an incoming link on
             a node.";
        }
        enum outgoing {
          description
            "The explicit route represents an outgoing link on
             a node.";
        }
      }
      description
        "Enumerated type for specifying the direction of a link on
         a node.";
    }

    typedef te-metric {
      type uint32;
      description
        "Traffic Engineering (TE)  metric.";
      reference
        "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
                   Version 2, Section 2.5.5
         RFC 5305: IS-IS Extensions for Traffic Engineering,
```

```
                Section 3.7";
    }

    typedef te-node-id {
      type union {
        type yang:dotted-quad;
        type inet:ipv6-address-no-zone;
      }
      description
        "A type representing the identifier for a node in a TE
         topology.

         The identifier is represented either as 4 octets in
         dotted-quad notation, or as 16 octets in full, mixed,
         shortened, or shortened-mixed IPv6 address notation.

         This attribute MAY be mapped to the Router Address TLV
         described in Section 2.4.1 of RFC 3630, the TE Router ID
         described in Section 3 of RFC 6827, the Traffic Engineering
         Router ID TLV described in Section 4.3 of RFC 5305, the TE
         Router ID TLV described in Section 3.2.1 of RFC 6119, or the
         IPv6 TE Router ID TLV described in Section 4.1 of RFC 6119.

         The reachability of such a TE node MAY be achieved by a
         mechanism such as that described in Section 6.2 of RFC 6827.";
      reference
        "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
                   Version 2, Section 2.4.1
         RFC 5305: IS-IS Extensions for Traffic Engineering,
                   Section 4.3
         RFC 6119: IPv6 Traffic Engineering in IS-IS, Section 3.2.1
         RFC 6827: Automatically Switched Optical Network (ASON)
                   Routing for OSPFv2 Protocols, Section 3";
    }

    typedef te-oper-status {
      type te-common-status;
      description
        "Defines a type representing the operational status of
         a TE resource.";
    }

    typedef te-admin-status {
      type te-common-status;
      description
        "Defines a type representing the administrative status of
         a TE resource.";
    }
```

```
    typedef te-path-disjointness {
      type bits {
        bit node {
          position 0;
          description
            "Node disjoint.";
        }
        bit link {
          position 1;
          description
            "Link disjoint.";
        }
        bit srlg {
          position 2;
          description
            "Shared Risk Link Group (SRLG) disjoint.";
        }
      }
      description
        "Type of the resource disjointness for a TE tunnel path.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery";
    }

    typedef te-recovery-status {
      type enumeration {
        enum normal {
          description
            "Both the recovery span and the working span are fully
             allocated and active, data traffic is being
             transported over (or selected from) the working
             span, and no trigger events are reported.";
        }
        enum recovery-started {
          description
            "The recovery action has been started but not completed.";
        }
        enum recovery-succeeded {
          description
            "The recovery action has succeeded.

             The working span has reported a failure/degrade condition,
             and the user traffic is being transported (or selected)
             on the recovery span.";
        }
        enum recovery-failed {
```

```
          description
            "The recovery action has failed.";
        }
        enum reversion-started {
          description
            "The reversion has started.";
        }
        enum reversion-succeeded {
          description
            "The reversion action has succeeded.";
        }
        enum reversion-failed {
          description
            "The reversion has failed.";
        }
        enum recovery-unavailable {
          description
            "The recovery is unavailable, as a result of either an
             operator's lockout command or a failure condition
             detected on the recovery span.";
        }
        enum recovery-admin {
          description
            "The operator has issued a command to switch the user
             traffic to the recovery span.";
        }
        enum wait-to-restore {
          description
            "The recovery domain is recovering from a failure/degrade
             condition on the working span that is being controlled by
             the Wait-to-Restore (WTR) timer.";
        }
      }
      description
        "Defines the status of a recovery action.";
      reference
        "RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection
         RFC 4427: Recovery (Protection and Restoration) Terminology
                   for Generalized Multi-Protocol Label Switching
                   (GMPLS)";
    }

    typedef te-template-name {
      type string {
        pattern '/?([a-zA-Z0-9\-_.]+)(/[a-zA-Z0-9\-_.]+)*';
      }
      description
        "A type for the name of a TE node template or TE link
```

```
          template.";
      }

      typedef te-topology-event-type {
        type enumeration {
          enum add {
            value 0;
            description
              "A TE node or TE link has been added.";
          }
          enum remove {
            value 1;
            description
              "A TE node or TE link has been removed.";
          }
          enum update {
            value 2;
            description
              "A TE node or TE link has been updated.";
          }
        }
        description
          "TE event type for notifications.";
      }

      typedef te-topology-id {
        type union {
          type string {
            length "0";
            // empty string
          }
          type string {
            pattern '([a-zA-Z0-9\-_.]+:)*'
                  + '/?([a-zA-Z0-9\-_.]+)(/[a-zA-Z0-9\-_.]+)*';
          }
        }
        description
          "An identifier for a topology.

           It is optional to have one or more prefixes at the beginning,
           separated by colons.

           The prefixes can be 'network-types' as defined in the
           'ietf-network' module in RFC 8345, to help the user better
           understand the topology before further inquiry is made.";
        reference
          "RFC 8345: A YANG Data Model for Network Topologies";
      }
```

```
     typedef te-tp-id {
       type union {
         type uint32;
         // Unnumbered
         type inet:ip-address;
         // IPv4 or IPv6 address
       }
       description
         "An identifier for a TE link endpoint on a node.

          This attribute is mapped to a local or remote link identifier
          as defined in RFCs 3630 and 5305.";
       reference
         "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
                    Version 2
          RFC 5305: IS-IS Extensions for Traffic Engineering";
     }

     typedef path-type {
       type enumeration {
         enum primary-path {
           description
             "Indicates that the TE path is a primary path.";
         }
         enum secondary-path {
           description
             "Indicates that the TE path is a secondary path.";
         }
         enum primary-reverse-path {
           description
             "Indicates that the TE path is a primary reverse path.";
         }
         enum secondary-reverse-path {
           description
             "Indicates that the TE path is a secondary reverse path.";
         }
       }
       description
         "The type of TE path, indicating whether a path is a primary,
          or a reverse primary, or a secondary, or a reverse secondary
          path.";
     }

     /*
      * TE bandwidth groupings
      */

     grouping te-bandwidth {
```

```
      description
        "This grouping defines the generic TE bandwidth.

         For some known data-plane technologies, specific modeling
         structures are specified.

         The string-encoded 'te-bandwidth' type is used for
         unspecified technologies.

         The modeling structure can be augmented later for other
         technologies.";
      container te-bandwidth {
        description
          "Container that specifies TE bandwidth.

           The choices can be augmented for specific data-plane
           technologies.";
        choice technology {
          default "generic";
          description
            "Data-plane technology type.";
          case generic {
            leaf generic {
              type te-bandwidth;
              description
                "Bandwidth specified in a generic format.";
            }
          }
        }
      }
    }

    /*
     * TE label groupings
     */

    grouping te-label {
      description
        "This grouping defines the generic TE label.

         The modeling structure can be augmented for each technology.

         For unspecified technologies, 'rt-types:generalized-label'
         is used.";
      container te-label {
        description
          "Container that specifies the TE label.
```

```
           The choices can be augmented for specific data-plane
           technologies.";
        choice technology {
          default "generic";
          description
            "Data-plane technology type.";
          case generic {
            leaf generic {
              type rt-types:generalized-label;
              description
                "TE label specified in a generic format.";
            }
          }
        }
        leaf direction {
          type te-label-direction;
          default "forward";
          description
            "Label direction.";
        }
      }
    }

    grouping te-topology-identifier {
      description
        "Augmentation for a TE topology.";
      container te-topology-identifier {
        description
          "TE topology identifier container.";
        leaf provider-id {
          type te-global-id;
          default "0";
          description
            "An identifier to uniquely identify a provider.
             If omitted, it assumes that the topology provider ID
             value = 0 (the default).";
        }
        leaf client-id {
          type te-global-id;
          default "0";
          description
            "An identifier to uniquely identify a client.
             If omitted, it assumes that the topology client ID
             value = 0 (the default).";
        }
        leaf topology-id {
          type te-topology-id;
          default "";
```

```
          description
            "When the datastore contains several topologies,
             'topology-id' distinguishes between them.

             If omitted, the default (empty) string for this leaf is
             assumed.";
        }
      }
    }

    /*
     * TE performance metrics groupings
     */

    grouping performance-metrics-one-way-delay-loss {
      description
        "Performance Metrics (PM) information in real time that can
         be applicable to links or connections.

         PM defined in this grouping are applicable to generic TE PM
         as well as packet TE PM.";
      reference
        "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions
         RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions
         RFC 7823: Performance-Based Path Selection for Explicitly
                   Routed Label Switched Paths (LSPs) Using TE Metric
                   Extensions";
      leaf one-way-delay {
        type uint32 {
          range "0..16777215";
        }
        units "microseconds";
        description
          "One-way delay or latency.";
      }
      leaf one-way-delay-normality {
        type te-types:performance-metrics-normality;
        description
          "One-way delay normality.";
      }
    }

    grouping performance-metrics-two-way-delay-loss {
      description
        "Performance Metrics (PM) information in real time that can be
         applicable to links or connections.

         PM defined in this grouping are applicable to generic TE PM
```

```
         as well as packet TE PM.";
      reference
        "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions
         RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions
         RFC 7823: Performance-Based Path Selection for Explicitly
                   Routed Label Switched Paths (LSPs) Using TE Metric
                   Extensions";
      leaf two-way-delay {
        type uint32 {
          range "0..16777215";
        }
        units "microseconds";
        description
          "Two-way delay or latency.";
      }
      leaf two-way-delay-normality {
        type te-types:performance-metrics-normality;
        description
          "Two-way delay normality.";
      }
    }

    grouping performance-metrics-one-way-bandwidth {
      description
        "Performance Metrics (PM) information in real time that can be
         applicable to links.

         PM defined in this grouping are applicable to generic TE PM
         as well as packet TE PM.";
      reference
        "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions
         RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions
         RFC 7823: Performance-Based Path Selection for Explicitly
                   Routed Label Switched Paths (LSPs) Using TE Metric
                   Extensions";
      leaf one-way-residual-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        units "bytes per second";
        default "0x0p0";
        description
          "Residual bandwidth that subtracts tunnel reservations from
           Maximum Bandwidth (or link capacity) (RFC 3630) and
           provides an aggregated remainder across QoS classes.";
        reference
          "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
                     Version 2";
      }
      leaf one-way-residual-bandwidth-normality {
```

```
        type te-types:performance-metrics-normality;
        default "normal";
        description
          "Residual bandwidth normality.";
      }
      leaf one-way-available-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        units "bytes per second";
        default "0x0p0";
        description
          "Available bandwidth that is defined to be residual
           bandwidth minus the measured bandwidth used for the
           actual forwarding of non-RSVP-TE LSP packets.

           For a bundled link, available bandwidth is defined to be
           the sum of the component link available bandwidths.";
      }
      leaf one-way-available-bandwidth-normality {
        type te-types:performance-metrics-normality;
        default "normal";
        description
          "Available bandwidth normality.";
      }
      leaf one-way-utilized-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        units "bytes per second";
        default "0x0p0";
        description
          "Bandwidth utilization that represents the actual
           utilization of the link (i.e., as measured in the router).
           For a bundled link, bandwidth utilization is defined to
           be the sum of the component link bandwidth utilizations.";
      }
      leaf one-way-utilized-bandwidth-normality {
        type te-types:performance-metrics-normality;
        default "normal";
        description
          "Bandwidth utilization normality.";
      }
    }

    grouping one-way-performance-metrics {
      description
        "One-way Performance Metrics (PM) throttle grouping.";
      leaf one-way-delay {
        type uint32 {
          range "0..16777215";
        }
```

```
        units "microseconds";
        default "0";
        description
          "One-way delay or latency.";
      }
      leaf one-way-residual-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        units "bytes per second";
        default "0x0p0";
        description
          "Residual bandwidth that subtracts tunnel reservations from
           Maximum Bandwidth (or link capacity) (RFC 3630) and
           provides an aggregated remainder across QoS classes.";
        reference
          "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
                     Version 2";
      }
      leaf one-way-available-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        units "bytes per second";
        default "0x0p0";
        description
          "Available bandwidth that is defined to be residual
           bandwidth minus the measured bandwidth used for the
           actual forwarding of non-RSVP-TE LSP packets.

           For a bundled link, available bandwidth is defined to be
           the sum of the component link available bandwidths.";
      }
      leaf one-way-utilized-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        units "bytes per second";
        default "0x0p0";
        description
          "Bandwidth utilization that represents the actual
           utilization of the link (i.e., as measured in the router).
           For a bundled link, bandwidth utilization is defined to
           be the sum of the component link bandwidth utilizations.";
      }
    }

    grouping two-way-performance-metrics {
      description
        "Two-way Performance Metrics (PM) throttle grouping.";
      leaf two-way-delay {
        type uint32 {
          range "0..16777215";
        }
```

```
        units "microseconds";
        default "0";
        description
          "Two-way delay or latency.";
      }
    }

    grouping performance-metrics-thresholds {
      description
        "Grouping for configurable thresholds for measured
         attributes.";
      uses one-way-performance-metrics;
      uses two-way-performance-metrics;
    }

    grouping performance-metrics-attributes {
      description
        "Contains Performance Metrics (PM) attributes.";
      container performance-metrics-one-way {
        description
          "One-way link performance information in real time.";
        reference
          "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions
           RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions
           RFC 7823: Performance-Based Path Selection for Explicitly
                     Routed Label Switched Paths (LSPs) Using TE Metric
                     Extensions";
        uses performance-metrics-one-way-delay-loss;
        uses performance-metrics-one-way-bandwidth;
      }
      container performance-metrics-two-way {
        description
          "Two-way link performance information in real time.";
        reference
          "RFC 6374: Packet Loss and Delay Measurement for MPLS
                     Networks";
        uses performance-metrics-two-way-delay-loss;
      }
    }

    grouping performance-metrics-throttle-container {
      description
        "Controls Performance Metrics (PM) throttling.";
      container throttle {
        must 'suppression-interval >= measure-interval' {
          error-message "'suppression-interval' cannot be less than "
                      + "'measure-interval'.";
          description
```

```
            "Constraint on 'suppression-interval' and
             'measure-interval'.";
          }
          description
            "Link performance information in real time.";
          reference
            "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions
             RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions
             RFC 7823: Performance-Based Path Selection for Explicitly
                       Routed Label Switched Paths (LSPs) Using TE Metric
                       Extensions";
          leaf one-way-delay-offset {
            type uint32 {
              range "0..16777215";
            }
            units "microseconds";
            default "0";
            description
              "Offset value to be added to the measured delay value.";
          }
          leaf measure-interval {
            type uint32;
            units "seconds";
            default "30";
            description
              "Interval to measure the extended metric values.";
          }
          leaf advertisement-interval {
            type uint32;
            units "seconds";
            default "0";
            description
              "Interval to advertise the extended metric values.";
          }
          leaf suppression-interval {
            type uint32 {
              range "1..max";
            }
            units "seconds";
            default "120";
            description
              "Interval to suppress advertisement of the extended metric
               values.";
            reference
              "RFC 8570: IS-IS Traffic Engineering (TE) Metric
                         Extensions, Section 6";
          }
          container threshold-out {
```

```
          description
            "If the measured parameter falls outside an upper bound
             for all but the minimum-delay metric (or a lower bound
             for the minimum-delay metric only) and the advertised
             value is not already outside that bound, an 'anomalous'
             announcement (anomalous bit set) will be triggered.";
          uses performance-metrics-thresholds;
        }
        container threshold-in {
          description
            "If the measured parameter falls inside an upper bound
             for all but the minimum-delay metric (or a lower bound
             for the minimum-delay metric only) and the advertised
             value is not already inside that bound, a 'normal'
             announcement (anomalous bit cleared) will be triggered.";
          uses performance-metrics-thresholds;
        }
        container threshold-accelerated-advertisement {
          description
            "When the difference between the last advertised value and
             the current measured value exceeds this threshold, an
             'anomalous' announcement (anomalous bit set) will be
             triggered.";
          uses performance-metrics-thresholds;
        }
      }
    }

    /*
     * TE tunnel generic groupings
     */

    grouping explicit-route-hop {
      description
        "The explicit route entry grouping.";
      choice type {
        description
          "The explicit route entry type.";
        case numbered-node-hop {
          container numbered-node-hop {
            must 'node-id-uri or node-id' {
              description
                "At least one node identifier needs to be present.";
            }
            description
              "Numbered node route hop.";
            reference
              "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
```

```
                        Section 4.3, EXPLICIT_ROUTE in RSVP-TE
                   RFC 3477: Signalling Unnumbered Links in Resource
                        ReSerVation Protocol - Traffic Engineering
                        (RSVP-TE)";
              leaf node-id-uri {
                type nw:node-id;
                description
                  "The identifier of a node in the topology.";
              }
              leaf node-id {
                type te-node-id;
                description
                  "The identifier of a node in the TE topology.";
              }
              leaf hop-type {
                type te-hop-type;
                default "strict";
                description
                  "Strict or loose hop.";
              }
            }
          }
          case numbered-link-hop {
            container numbered-link-hop {
              description
                "Numbered link explicit route hop.";
              reference
                "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
                        Section 4.3, EXPLICIT_ROUTE in RSVP-TE
                   RFC 3477: Signalling Unnumbered Links in Resource
                        ReSerVation Protocol - Traffic Engineering
                        (RSVP-TE)";
              leaf link-tp-id {
                type te-tp-id;
                mandatory true;
                description
                  "TE Link Termination Point (LTP) identifier.";
              }
              leaf hop-type {
                type te-hop-type;
                default "strict";
                description
                  "Strict or loose hop.";
              }
              leaf direction {
                type te-link-direction;
                default "outgoing";
                description
```

```
                "Link route object direction.";
            }
          }
        }
        case unnumbered-link-hop {
          container unnumbered-link-hop {
            must '(link-tp-id-uri or link-tp-id) and '
               + '(node-id-uri or node-id)' {
              description
                "At least one node identifier and at least one Link
                 Termination Point (LTP) identifier need to be
                 present.";
            }
            description
              "Unnumbered link explicit route hop.";
            reference
              "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
                         Section 4.3, EXPLICIT_ROUTE in RSVP-TE
               RFC 3477: Signalling Unnumbered Links in Resource
                         ReSerVation Protocol - Traffic Engineering
                         (RSVP-TE)";
            leaf link-tp-id-uri {
              type nt:tp-id;
              description
                "Link Termination Point (LTP) identifier.";
            }
            leaf link-tp-id {
              type te-tp-id;
              description
                "TE LTP identifier.

                 The combination of the TE link ID and the TE node ID
                 is used to identify an unnumbered TE link.";
            }
            leaf node-id-uri {
              type nw:node-id;
              description
                "The identifier of a node in the topology.";
            }
            leaf node-id {
              type te-node-id;
              description
                "The identifier of a node in the TE topology.";
            }
            leaf hop-type {
              type te-hop-type;
              default "strict";
              description
```

```
                "Strict or loose hop.";
            }
            leaf direction {
              type te-link-direction;
              default "outgoing";
              description
                "Link route object direction.";
            }
          }
        }
        case as-number {
          container as-number-hop {
            description
              "AS explicit route hop.";
            leaf as-number {
              type inet:as-number;
              mandatory true;
              description
                "The Autonomous System (AS) number.";
            }
            leaf hop-type {
              type te-hop-type;
              default "strict";
              description
                "Strict or loose hop.";
            }
          }
        }
        case label {
          description
            "The label explicit route hop type.";
          container label-hop {
            description
              "Label hop type.";
            uses te-label;
          }
        }
      }
    }

    grouping explicit-route-hop-with-srlg {
      description
        "Augments the explicit route entry grouping with Shared Risk
         Link Group (SRLG) hop type.";
      uses explicit-route-hop {
        augment "type" {
          description
            "Augmentation for a generic explicit route for Shared
```

```
             Risk Link Group (SRLG) inclusion or exclusion.";
          case srlg {
            description
              "An Shared Risk Link Group (SRLG) value to be
               included or excluded.";
            container srlg {
              description
                "Shared Risk Link Group (SRLG) container.";
              leaf srlg {
                type uint32;
                description
                  "Shared Risk Link Group (SRLG) value.";
              }
            }
          }
        }
      }
    }

    grouping record-route-state {
      description
        "The Record Route grouping.";
      leaf index {
        type uint32;
        description
          "Record Route hop index.

           The index is used to identify an entry in the list.

           The order of entries is defined by the user without relying
           on key values.";
      }
      choice type {
        description
          "The Record Route entry type.";
        case numbered-node-hop {
          description
            "Numbered node route hop.";
          container numbered-node-hop {
            must 'node-id-uri or node-id' {
              description
                "At least one node identifier need to be present.";
            }
            description
              "Numbered node route hop container.";
            leaf node-id-uri {
              type nw:node-id;
              description
```

```
                "The identifier of a node in the topology.";
            }
            leaf node-id {
              type te-node-id;
              description
                "The identifier of a node in the TE topology.";
            }
            leaf-list flags {
              type path-attribute-flags;
              description
                "Path attributes flags.";
              reference
                "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
                 RFC 4090: Fast Reroute Extensions to RSVP-TE for LSP
                           Tunnels
                 RFC 4561: Definition of a Record Route Object (RRO)
                           Node-Id Sub-Object";
            }
          }
        }
        case numbered-link-hop {
          description
            "Numbered link route hop.";
          container numbered-link-hop {
            description
              "Numbered link route hop container.";
            leaf link-tp-id {
              type te-tp-id;
              mandatory true;
              description
                "Numbered TE LTP identifier.";
            }
            leaf-list flags {
              type path-attribute-flags;
              description
                "Path attributes flags.";
              reference
                "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
                 RFC 4090: Fast Reroute Extensions to RSVP-TE for LSP
                           Tunnels
                 RFC 4561: Definition of a Record Route Object (RRO)
                           Node-Id Sub-Object";
            }
          }
        }
        case unnumbered-link-hop {
          description
            "Unnumbered link route hop.";
```

```
          container unnumbered-link-hop {
            must '(link-tp-id-uri or link-tp-id) and '
               + '(node-id-uri or node-id)' {
              description
                "At least one node identifier and at least one Link
                 Termination Point (LTP) identifier need to be
                 present.";
            }
            description
              "Unnumbered link Record Route hop.";
            reference
              "RFC 3477: Signalling Unnumbered Links in Resource
                         ReSerVation Protocol - Traffic Engineering
                         (RSVP-TE)";
            leaf link-tp-id-uri {
              type nt:tp-id;
              description
                "Link Termination Point (LTP) identifier.";
            }
            leaf link-tp-id {
              type te-tp-id;
              description
                "TE LTP identifier.

                 The combination of the TE link ID and the TE node ID
                 is used to identify an unnumbered TE link.";
            }
            leaf node-id-uri {
              type nw:node-id;
              description
                "The identifier of a node in the topology.";
            }
            leaf node-id {
              type te-node-id;
              description
                "The identifier of a node in the TE topology.";
            }
            leaf-list flags {
              type path-attribute-flags;
              description
                "Path attributes flags.";
              reference
                "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
                 RFC 4090: Fast Reroute Extensions to RSVP-TE for LSP
                           Tunnels
                 RFC 4561: Definition of a Record Route Object (RRO)
                           Node-Id Sub-Object";
            }
```

```
          }
        }
        case label {
          description
            "The label Record Route entry types.";
          container label-hop {
            description
              "Label route hop type.";
            uses te-label;
            leaf-list flags {
              type path-attribute-flags;
              description
                "Path attributes flags.";
              reference
                "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
                 RFC 4090: Fast Reroute Extensions to RSVP-TE for LSP
                           Tunnels
                 RFC 4561: Definition of a Record Route Object (RRO)
                           Node-Id Sub-Object";
            }
          }
        }
      }
    }

    grouping label-restriction-info {
      description
        "Label set item information.";
      leaf restriction {
        type enumeration {
          enum inclusive {
            description
              "The label or label range is inclusive.";
          }
          enum exclusive {
            description
              "The label or label range is exclusive.";
          }
        }
        default "inclusive";
        description
          "Indicates whether the list item is inclusive or exclusive.";
      }
      leaf index {
        type uint32;
        description
          "The index of the label restriction list entry.";
      }
```

```
      container label-start {
        must "(not(../label-end/te-label/direction) and"
           + " not(te-label/direction))"
           + " or "
           + "(../label-end/te-label/direction = te-label/direction)"
           + " or "
           + "(not(te-label/direction) and"
           + " (../label-end/te-label/direction = 'forward'))"
           + " or "
           + "(not(../label-end/te-label/direction) and"
           + " (te-label/direction = 'forward'))" {
          error-message "'label-start' and 'label-end' must have the "
                      + "same direction.";
        }
        description
          "This is the starting label if a label range is specified.
           This is the label value if a single label is specified,
           in which case the 'label-end' attribute is not set.";
        uses te-label;
      }
      container label-end {
        must "(not(../label-start/te-label/direction) and"
           + " not(te-label/direction))"
           + " or "
           + "(../label-start/te-label/direction = te-label/direction)"
           + " or "
           + "(not(te-label/direction) and"
           + " (../label-start/te-label/direction = 'forward'))"
           + " or "
           + "(not(../label-start/te-label/direction) and"
           + " (te-label/direction = 'forward'))" {
          error-message "'label-start' and 'label-end' must have the "
                      + "same direction.";
        }
        description
          "This is the ending label if a label range is specified.
           This attribute is not set if a single label is specified.";
        uses te-label;
      }
      container label-step {
        description
          "The step increment between labels in the label range.

           The label start/end values MUST be consistent with the sign
           of label step.

           For example:
              'label-start' < 'label-end' enforces 'label-step' > 0
```

```
            'label-start' > 'label-end' enforces 'label-step' < 0.";
        choice technology {
          default "generic";
          description
            "Data-plane technology type.";
          case generic {
            leaf generic {
              type int32;
              default "1";
              description
                "Label range step.";
            }
          }
        }
      }
      leaf range-bitmap {
        type yang:hex-string;
        description
          "When there are gaps between 'label-start' and 'label-end',
           this attribute is used to specify the positions
           of the used labels.

           This is represented in big endian as 'hex-string'.

           In case the restriction is 'inclusive', the bit-position is
           set if the corresponding mapped label is available.
           In this case, if the range-bitmap is not present, all the
           labels in the range are available.

           In case the restriction is 'exclusive', the bit-position is
           set if the corresponding mapped label is not available.
           In this case, if the range-bitmap is not present, all the
           labels in the range are not available.

           The most significant byte in the hex-string is the farthest
           to the left in the byte sequence.

           Leading zero bytes in the configured value may be omitted
           for brevity.

           Each bit position in the 'range-bitmap' 'hex-string' maps
           to a label in the range derived from 'label-start'.

           For example, assuming that 'label-start' = 16000 and
           'range-bitmap' = 0x01000001, then:
           - bit position (0) is set, and the corresponding mapped
             label from the range is 16000 + (0 * 'label-step') or
             16000 for default 'label-step' = 1.
```

```
            - bit position (24) is set, and the corresponding mapped
              label from the range is 16000 + (24 * 'label-step') or
              16024 for default 'label-step' = 1.";
      }
    }

    grouping label-set-info {
      description
        "Grouping for the list of label restrictions specifying what
         labels may or may not be used.";
      container label-restrictions {
        description
          "The label restrictions container.";
        list label-restriction {
          key "index";
          description
            "The absence of the label restrictions container implies
             that all labels are acceptable; otherwise, only restricted
             labels are available.";
          reference
            "RFC 7579: General Network Element Constraint Encoding
                       for GMPLS-Controlled Networks";
          uses label-restriction-info;
        }
      }
    }

    grouping optimization-metric-entry {
      description
        "Optimization metrics configuration grouping.";
      leaf metric-type {
        type identityref {
          base path-metric-optimization-type;
        }
        description
          "Identifies the 'metric-type' that the path computation
           process uses for optimization.";
      }
      leaf weight {
        type uint8;
        default "1";
        description
          "TE path metric normalization weight.";
      }
      container explicit-route-exclude-objects {
        when "../metric-type = "
           + "'te-types:path-metric-optimize-excludes'";
        description
```

```
          "Container for the 'exclude route' object list.";
        uses path-route-exclude-objects;
      }
      container explicit-route-include-objects {
        when "../metric-type = "
           + "'te-types:path-metric-optimize-includes'";
        description
          "Container for the 'include route' object list.";
        uses path-route-include-objects;
      }
    }

    grouping common-constraints {
      description
        "Common constraints grouping that can be set on
         a constraint set or directly on the tunnel.";
      uses te-bandwidth {
        description
          "A requested bandwidth to use for path computation.";
      }
      leaf link-protection {
        type identityref {
          base link-protection-type;
        }
        default "te-types:link-protection-unprotected";
        description
          "Link protection type required for the links included
           in the computed path.";
        reference
          "RFC 4202: Routing Extensions in Support of
                     Generalized Multi-Protocol Label Switching
                     (GMPLS)";
      }
      leaf setup-priority {
        type uint8 {
          range "0..7";
        }
        default "7";
        description
          "TE LSP requested setup priority.";
        reference
          "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels";
      }
      leaf hold-priority {
        type uint8 {
          range "0..7";
        }
        default "7";
```

```
        description
          "TE LSP requested hold priority.";
        reference
          "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels";
      }
      leaf signaling-type {
        type identityref {
          base path-signaling-type;
        }
        default "te-types:path-setup-rsvp";
        description
          "TE tunnel path signaling type.";
      }
    }

    grouping tunnel-constraints {
      description
        "Tunnel constraints grouping that can be set on
         a constraint set or directly on the tunnel.";
      leaf network-id {
        type nw:network-id;
        description
          "The network topology identifier.";
      }
      uses te-topology-identifier;
      uses common-constraints;
    }

    grouping path-constraints-route-objects {
      description
        "List of route entries to be included or excluded when
         performing the path computation.";
      container explicit-route-objects {
        description
          "Container for the explicit route object lists.";
        list route-object-exclude-always {
          key "index";
          ordered-by user;
          description
            "List of route objects to always exclude from the path
             computation.";
          leaf index {
            type uint32;
            description
              "Explicit Route Object index.

               The index is used to identify an entry in the list.
```

```
              The order of entries is defined by the user without
              relying on key values.";
          }
          uses explicit-route-hop;
        }
        list route-object-include-exclude {
          key "index";
          ordered-by user;
          description
            "List of route objects to include or exclude in the path
             computation.";
          leaf explicit-route-usage {
            type identityref {
              base route-usage-type;
            }
            default "te-types:route-include-object";
            description
              "Indicates whether to include or exclude the
               route object.

               The default is to include it.";
          }
          leaf index {
            type uint32;
            description
              "Route object include-exclude index.

               The index is used to identify an entry in the list.

               The order of entries is defined by the user without
               relying on key values.";
          }
          uses explicit-route-hop-with-srlg;
        }
      }
    }

    grouping path-route-include-objects {
      description
        "List of route objects to be included when performing
         the path computation.";
      list route-object-include-object {
        key "index";
        ordered-by user;
        description
          "List of Explicit Route Objects to be included in the
           path computation.";
        leaf index {
```

```
          type uint32;
          description
            "Route object entry index.

               The index is used to identify an entry in the list.

               The order of entries is defined by the user without
               relying on key values.";
        }
        uses explicit-route-hop;
      }
    }

    grouping path-route-exclude-objects {
      description
        "List of route objects to be excluded when performing
         the path computation.";
      list route-object-exclude-object {
        key "index";
        ordered-by user;
        description
          "List of Explicit Route Objects to be excluded in the
           path computation.";
        leaf index {
          type uint32;
          description
            "Route object entry index.

               The index is used to identify an entry in the list.

               The order of entries is defined by the user without
               relying on key values.";
        }
        uses explicit-route-hop-with-srlg;
      }
    }

    grouping generic-path-metric-bounds {
      description
        "TE path metric bounds grouping.";
      container path-metric-bounds {
        description
          "Top-level container for the list of path metric bounds.";
        list path-metric-bound {
          key "metric-type";
          description
            "List of path metric bounds, which can apply to link and
             path metrics.
```

```
            TE paths which have at least one path metric which
            exceeds the specified bounds MUST NOT be selected.

            TE paths that traverse TE links which have at least one
            link metric which exceeds the specified bounds MUST NOT
            be selected.";
          leaf metric-type {
            type identityref {
              base link-path-metric-type;
            }
            description
              "Identifies an entry in the list of 'metric-type' items
               bound for the TE path.";
          }
          leaf upper-bound {
            type uint64;
            default "0";
            description
              "Upper bound on the specified 'metric-type'.

               A zero indicates an unbounded upper limit for the
               specified 'metric-type'.

               The unit of is interpreted in the context of the
               'metric-type' identity.";
          }
        }
      }
    }

    grouping generic-path-optimization {
      description
        "TE generic path optimization grouping.";
      container optimizations {
        description
          "The objective function container that includes
           attributes to impose when computing a TE path.";
        choice algorithm {
          description
            "Optimizations algorithm.";
          case metric {
            if-feature "path-optimization-metric";
            /* Optimize by metric */
            list optimization-metric {
              key "metric-type";
              description
                "TE path metric type.";
              uses optimization-metric-entry;
```

```
            }
            /* Tiebreakers */
            container tiebreakers {
              status deprecated;
              description
                "Container for the list of tiebreakers.

                 This container has been deprecated by the tiebreaker
                 leaf.";
              list tiebreaker {
                key "tiebreaker-type";
                status deprecated;
                description
                  "The list of tiebreaker criteria to apply on an
                   equally favored set of paths, in order to pick
                   the best.";
                leaf tiebreaker-type {
                  type identityref {
                    base path-metric-type;
                  }
                  status deprecated;
                  description
                    "Identifies an entry in the list of tiebreakers.";
                }
              }
            }
          }
          case objective-function {
            if-feature "path-optimization-objective-function";
            /* Objective functions */
            container objective-function {
              description
                "The objective function container that includes
                 attributes to impose when computing a TE path.";
              leaf objective-function-type {
                type identityref {
                  base objective-function-type;
                }
                default "te-types:of-minimize-cost-path";
                description
                  "Objective function entry.";
              }
            }
          }
        }
      }
      leaf tiebreaker {
        type identityref {
```

```
          base path-tiebreaker-type;
        }
        default "te-types:path-tiebreaker-random";
        description
          "The tiebreaker criteria to apply on an equally favored set
           of paths, in order to pick the best.";
      }
    }

    grouping generic-path-affinities {
      description
        "Path affinities grouping.";
      container path-affinities-values {
        description
          "Path affinities represented as values.";
        list path-affinities-value {
          key "usage";
          description
            "List of named affinity constraints.";
          leaf usage {
            type identityref {
              base resource-affinities-type;
            }
            description
              "Identifies an entry in the list of value affinity
               constraints.";
          }
          leaf value {
            type admin-groups;
            default "";
            description
              "The affinity value.

               The default is empty.";
          }
        }
      }
      container path-affinity-names {
        description
          "Path affinities represented as names.";
        list path-affinity-name {
          key "usage";
          description
            "List of named affinity constraints.";
          leaf usage {
            type identityref {
              base resource-affinities-type;
            }
```

```
            description
              "Identifies an entry in the list of named affinity
               constraints.";
          }
          list affinity-name {
            key "name";
            description
              "List of named affinities.";
            leaf name {
              type string;
              description
                "Identifies a named affinity entry.";
            }
          }
        }
      }
    }

    grouping generic-path-srlgs {
      description
        "Path Shared Risk Link Group (SRLG) grouping.";
      container path-srlgs-lists {
        description
          "Path Shared Risk Link Group (SRLG) properties container.";
        list path-srlgs-list {
          key "usage";
          description
            "List of Shared Risk Link Group (SRLG) values to be
             included or excluded.";
          leaf usage {
            type identityref {
              base route-usage-type;
            }
            description
              "Identifies an entry in a list of Shared Risk Link Groups
               (SRLGs) to either include or exclude.";
          }
          leaf-list values {
            type srlg;
            description
              "List of Shared Risk Link Group (SRLG) values.";
          }
        }
      }
      container path-srlgs-names {
        description
          "Container for the list of named Shared Risk Link Groups
           (SRLGs).";
```

```
        list path-srlgs-name {
          key "usage";
          description
            "List of named Shared Risk Link Groups (SRLGs) to be
             included or excluded.";
          leaf usage {
            type identityref {
              base route-usage-type;
            }
            description
              "Identifies an entry in a list of named Shared Risk Link
               Groups (SRLGs) to either include or exclude.";
          }
          leaf-list names {
            type string;
            description
              "List of named Shared Risk Link Groups (SRLGs).";
          }
        }
      }
    }

    grouping generic-path-disjointness {
      description
        "Path disjointness grouping.";
      leaf disjointness {
        type te-path-disjointness;
        description
          "The type of resource disjointness.
           When configured for a primary path, the disjointness level
           applies to all secondary LSPs.

           When configured for a secondary path, the disjointness
           level overrides the level configured for the primary path.";
      }
    }

    grouping common-path-constraints-attributes {
      description
        "Common path constraints configuration grouping.";
      uses common-constraints;
      uses generic-path-metric-bounds;
      uses generic-path-affinities;
      uses generic-path-srlgs;
    }

    grouping generic-path-constraints {
      description
```

```
        "Global named path constraints configuration grouping.";
      container path-constraints {
        description
          "TE named path constraints container.";
        uses common-path-constraints-attributes;
        uses generic-path-disjointness;
      }
    }

    grouping generic-path-properties {
      description
        "TE generic path properties grouping.";
      container path-properties {
        config false;
        description
          "The TE path properties.";
        list path-metric {
          key "metric-type";
          description
            "TE path metric type.";
          leaf metric-type {
            type identityref {
              base path-metric-type;
            }
            description
              "TE path metric type.";
          }
          leaf accumulative-value {
            type uint64;
            description
              "TE path metric accumulative value.";
          }
        }
        uses generic-path-affinities;
        uses generic-path-srlgs;
        container path-route-objects {
          description
            "Container for the list of route objects either returned by
             the computation engine or actually used by an LSP.";
          list path-route-object {
            key "index";
            ordered-by user;
            description
              "List of route objects either returned by the computation
               engine or actually used by an LSP.";
            leaf index {
              type uint32;
              description
```

```
                "Route object entry index.

                 The index is used to identify an entry in the list.

                 The order of entries is defined by the user without
                 relying on key values.";
              }
              uses explicit-route-hop;
            }
          }
        }
      }

      grouping encoding-and-switching-type {
        description
          "Common grouping to define the LSP encoding and
           switching types";
        leaf encoding {
          type identityref {
            base te-types:lsp-encoding-types;
          }
          description
            "LSP encoding type.";
          reference
            "RFC 3945: Generalized Multi-Protocol Label Switching (GMPLS)
                       Architecture";
        }
        leaf switching-type {
          type identityref {
            base te-types:switching-capabilities;
          }
          description
            "LSP switching type.";
          reference
            "RFC 3945: Generalized Multi-Protocol Label Switching (GMPLS)
                       Architecture";
        }
      }

      grouping te-generic-node-id {
        description
          "A reusable grouping for a TE generic node identifier.";
        leaf id {
          type union {
            type te-node-id;
            type inet:ip-address;
            type nw:node-id;
          }
```

```
        description
          "The identifier of the node.

           It can be represented as IP address or dotted quad address
           or as an URI.

           The type data node disambiguates the union type.";
      }
      leaf type {
        type enumeration {
          enum ip {
            description
              "IP address representation of the node identifier.";
          }
          enum te-id {
            description
              "TE identifier of the node";
          }
          enum node-id {
            description
              "URI representation of the node identifier.";
          }
        }
        description
          "Type of node identifier representation.";
      }
    }
  }
  <CODE ENDS>
```

Figure 1: TE Types YANG module

5. Packet TE Types YANG Module

The "ietf-te-packet-types" module imports from the "ietf-te-types" module defined in Section 4 of this document.

```
<CODE BEGINS> file "ietf-te-packet-types@2024-11-28.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 ietf-yang-types {
    prefix yang;
    reference
      "RFC 6991: Common YANG Data Types";
  }
```

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

  // RFC Editor: replace XXXX with actual RFC number
  // and remove this note

  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.net@gmail.com>

     Editor:   Rakesh Gandhi
               <mailto:rgandhi@cisco.com>

     Editor:   Vishnu Pavan Beeram
               <mailto:vbeeram@juniper.net>

     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 Packet Traffic Engineering
     (TE).

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

     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 (RFC 2119) (RFC 8174) when, and only when,
     they appear in all capitals, as shown here.

     Copyright (c) 2025 IETF Trust and the persons identified as
     authors of the code.  All rights reserved.

     Redistribution and use in source and binary forms, with or
```

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

        This version of this YANG module is part of RFC XXXX
        (https://www.rfc-editor.org/info/rfcXXXX); see the RFC itself
        for full legal notices.";

      revision 2025-01-24 {
        description
          "This revision adds the following new identities:
           - bandwidth-profile-type;
           - link-metric-delay-variation;
           - link-metric-loss;
           - path-metric-delay-variation;
           - path-metric-loss.

           This revision adds the following new groupings:
           - bandwidth-profile-parameters;
           - te-packet-path-bandwidth;
           - te-packet-link-bandwidth.

           This revision provides also few editorial changes.";
        reference
          "RFC XXXX: Common YANG Data Types for Traffic Engineering";
      }

      // RFC Editor: replace XXXX with actual RFC number, update date
      // information and remove this note

      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 {
    base bandwidth-profile-type;
    description
      "MEF 10 Bandwidth Profile";
    reference
      "MEF 10.3: Ethernet Services Attributes Phase 3";
  }

  identity rfc-2697 {
    base bandwidth-profile-type;
    description
      "RFC 2697 Bandwidth Profile";
    reference
      "RFC 2697: A Single Rate Three Color Marker";
  }

  identity rfc-2698 {
    base bandwidth-profile-type;
    description
      "RFC 2698 Bandwidth Profile";
    reference
      "RFC 2698: A Two Rate Three Color Marker";
  }

  // Derived identities from te-types:link-metric-type

  identity link-metric-delay-variation {
    base te-types:link-metric-type;
    description
      "The Unidirectional Delay Variation Metric,
       measured in units of microseconds.";
    reference
      "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions,
                 Section 4.3
       RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions,
                 Section 4.3";
  }

  identity link-metric-loss {
    base te-types:link-metric-type;
    description
      "The Unidirectional Link Loss Metric,
       measured in units of 0.000003%.";
    reference
      "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions,
                 Section 4.4
       RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions,
                 Section 4.4";
```

```
  }

  // Derived identities from te-types:link-metric-type

  identity path-metric-delay-variation {
    base te-types:path-metric-type;
    description
      "The Path Delay Variation Metric,
       measured in units of microseconds.";
    reference
      "RFC 8233: Extensions to the Path Computation Element
                 Communication Protocol (PCEP) to Compute
                 Service-Aware Label Switched Paths (LSPs),
                 Section 3.1.2";
  }

  identity path-metric-loss {
    base te-types:path-metric-type;
    description
      "The Path Loss Metric, measured in units of 0.000003%.";
    reference
      "RFC 8233: Extensions to the Path Computation Element
                 Communication Protocol (PCEP) to Compute
                 Service-Aware Label Switched Paths (LSPs),
                 Section 3.1.3";
  }

  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";
    }

    /*
     * Typedefs
     */

    typedef te-bandwidth-requested-type {
      type enumeration {
        enum specified-value {
          description
            "Bandwidth value is explicitly specified.";
        }
        enum specified-profile {
          description
            "Bandwidth profile 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 "kilobits per second";
      description
        "Bandwidth values, expressed in kilobits per second.";
    }

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

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

/*
 * Groupings
 */

grouping performance-metrics-attributes-packet {
  description
    "Contains Performance Metrics (PM) information.";
  uses te-types:performance-metrics-attributes {
    augment "performance-metrics-one-way" {
      description
        "Performance Metrics (PM) one-way packet-specific
         augmentation for a generic PM grouping.";
      leaf one-way-min-delay {
        type uint32 {
          range "0..16777215";
        }
        units "microseconds";
        description
          "One-way minimum delay or latency.";
      }
      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";
        }
        units "microseconds";
        description
          "One-way maximum delay or latency.";
      }
      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";
            }
            units "microseconds";
            description
              "One-way delay variation.";
            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 8570: IS-IS Traffic Engineering (TE) Metric
                         Extensions
               RFC 7823: Performance-Based Path Selection for
                         Explicitly Routed Label Switched Paths (LSPs)
                         Using TE Metric Extensions";
          }
          leaf one-way-packet-loss {
            type decimal64 {
              fraction-digits 6;
              range "0..50.331642";
            }
            units "%";
            description
              "One-way packet loss as a percentage of the total traffic
               sent over a configurable interval.

                The finest precision is 0.000003%.";
            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 8570: IS-IS Traffic Engineering (TE) Metric
```

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

```
          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 8570: IS-IS Traffic Engineering (TE) Metric
                         Extensions
               RFC 7823: Performance-Based Path Selection for
                         Explicitly Routed Label Switched Paths (LSPs)
                         Using TE Metric Extensions";
          }
          leaf two-way-delay-variation {
            type uint32 {
              range "0..16777215";
            }
            units "microseconds";
            default "0";
            description
              "Two-way delay variation.";
            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 8570: IS-IS Traffic Engineering (TE) Metric
                         Extensions
               RFC 7823: Performance-Based Path Selection for
                         Explicitly Routed Label Switched Paths (LSPs)
                         Using TE Metric Extensions";
          }
          leaf two-way-packet-loss {
            type decimal64 {
              fraction-digits 6;
              range "0..50.331642";
            }
            units "%";
            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.";
          }
        }
      }
    }

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

```
          range "0..50.331642";
        }
        units "%";
        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 one-way-performance-metrics-gauge-packet {
      description
        "One-way packet Performance Metrics (PM) throttle grouping.

         This grouping is used to report the same metrics defined in
         the one-way-performance-metrics-packet grouping, using gauges
         instead of uint32 data types and referencing IPPM RFCs
         instead of IGP-TE RFCs.";
      leaf one-way-min-delay {
        type yang:gauge64;
        units "microseconds";
        description
          "One-way minimum delay or latency.";
      }
      leaf one-way-max-delay {
        type yang:gauge64;
        units "microseconds";
        description
          "One-way maximum delay or latency.";
        reference
          "RFC 7679: A One-Way Delay Metric for IP Performance
                     Metrics (IPPM)";
      }
      leaf one-way-delay-variation {
        type yang:gauge64;
        units "microseconds";
        description
          "One-way delay variation.";
        reference
          "RFC 3393: IP Packet Delay Variation Metric for IP
                     Performance Metrics (IPPM)";
      }
      leaf one-way-packet-loss {
        type decimal64 {
          fraction-digits 5;
          range "0..100";
```

```
        }
        description
          "The ratio of packets dropped to packets transmitted between
           two endpoints.";
        reference
          "RFC 7680: A One-Way Loss Metric for IP Performance
                     Metrics (IPPM)";
      }
    }

    grouping two-way-performance-metrics-packet {
      description
        "Two-way packet Performance Metrics (PM) throttle grouping.";
      leaf two-way-min-delay {
        type uint32 {
          range "0..16777215";
        }
        units "microseconds";
        default "0";
        description
          "Two-way minimum delay or latency.";
      }
      leaf two-way-max-delay {
        type uint32 {
          range "0..16777215";
        }
        units "microseconds";
        default "0";
        description
          "Two-way maximum delay or latency.";
      }
      leaf two-way-delay-variation {
        type uint32 {
          range "0..16777215";
        }
        units "microseconds";
        default "0";
        description
          "Two-way delay variation.";
      }
      leaf two-way-packet-loss {
        type decimal64 {
          fraction-digits 6;
          range "0..50.331642";
        }
        units "%";
        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 two-way-performance-metrics-gauge-packet {
      description
        "Two-way packet Performance Metrics (PM) throttle grouping.

         This grouping is used to report the same metrics defined in
         the two-way-performance-metrics-packet grouping, using gauges
         instead of uint32 data types and referencing IPPM RFCs
         instead of IGP-TE RFCs.";
      leaf two-way-min-delay {
        type yang:gauge64;
        units "microseconds";
        description
          "Two-way minimum delay or latency.";
        reference
          "RFC 2681: A Round-trip Delay Metric for IPPM";
      }
      leaf two-way-max-delay {
        type yang:gauge64;
        units "microseconds";
        description
          "Two-way maximum delay or latency.";
        reference
          "RFC 2681: A Round-trip Delay Metric for IPPM";
      }
      leaf two-way-delay-variation {
        type yang:gauge64;
        units "microseconds";
        description
          "Two-way delay variation.";
        reference
          "RFC 5481: Packet Delay Variation Applicability Statement";
      }
      leaf two-way-packet-loss {
        type decimal64 {
          fraction-digits 5;
          range "0..100";
        }
        description
          "The ratio of packets dropped to packets transmitted between
           two endpoints.";
      }
```

```
  }

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

  grouping bandwidth-profile-parameters {
    description
      "Common parameters to define bandwidth profiles in packet
       networks.";
    leaf cir {
      type uint64;
      units "bits per second";
      description
        "Committed Information Rate (CIR).";
    }
    leaf cbs {
      type uint64;
      units "bytes";
      description
        "Committed Burst Size (CBS).";
    }
    leaf eir {
      type uint64;
```

```
        units "bits per second";
        description
          "Excess Information Rate (EIR).";
      }
      leaf ebs {
        type uint64;
        units "bytes";
        description
          "Excess Burst Size (EBS).";
      }
      leaf pir {
        type uint64;
        units "bits per second";
        description
          "Peak Information Rate (PIR).";
      }
      leaf pbs {
        type uint64;
        units "bytes";
        description
          "Peak Burst Size (PBS).";
      }
    }

    grouping te-packet-path-bandwidth {
      description
        "Bandwidth attributes for TE Packet paths.";
      container packet-bandwidth {
        description
          "Bandwidth attributes for TE Packet paths.";
        leaf specification-type {
          type te-bandwidth-requested-type;
          description
            "The bandwidth specification type, either explicitly
             specified or automatically computed.";
        }
        leaf set-bandwidth {
          when "../specification-type = 'specified-value'" {
            description
              "When the bandwidth value is explicitly specified.";
          }
          type bandwidth-kbps;
          description
            "Set the bandwidth value explicitly, e.g., using offline
             calculation.";
        }
        container bandwidth-profile {
          when "../specification-type = 'specified-profile'" {
```

```
            description
              "When the bandwidth profile is explicitly specified.";
          }
          description
            "Set the bandwidth profile attributes explicitly.";
          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.";
          }
          uses bandwidth-profile-parameters;
        }
        leaf class-type {
          type te-types:te-ds-class;
          description
            "The Class-Type of traffic transported by the LSP.";
          reference
            "RFC 4124: Protocol Extensions for Support of
                       Diffserv-aware MPLS Traffic Engineering,
                       Section 4.3.1";
        }
        leaf signaled-bandwidth {
          type te-packet-types:bandwidth-kbps;
          config false;
          description
            "The currently signaled bandwidth of the LSP.

             In the case where the bandwidth is specified
             explicitly, then this will match the value of the
             set-bandwidth leaf.

             In the cases where the bandwidth is dynamically
             computed by the system, the current value of the
             bandwidth should be reflected.";
        }
      }
    }

    grouping te-packet-link-bandwidth {
      description
        "Bandwidth attributes for Packet TE links.";
```

```
      leaf packet-bandwidth {
        type uint64;
        units "bits per second";
        description
          "Bandwidth value for Packet TE links.";
      }
    }
  }
  <CODE ENDS>
```

Figure 2: Packet TE Types YANG module

6. IANA Considerations

This document requests IANA to update the following URIs in the "IETF XML Registry" [RFC3688] to refer to this document:

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

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

This document requests IANA to register the following YANG modules in the "YANG Module Names" registry [RFC6020] within the "YANG Parameters" registry group.

```
      name:      ietf-te-types
      Maintained by IANA?  N
      namespace: urn:ietf:params:xml:ns:yang:ietf-te-types
      prefix:    te-types
      reference: RFC XXXX

      name:      ietf-te-packet-types
      Maintained by IANA?  N
      namespace: urn:ietf:params:xml:ns:yang:ietf-te-packet-types
      prefix:    te-packet-types
      reference: RFC XXXX
```

7. Security Considerations

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

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

The Network Configuration Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

The YANG modules define a set of identities, types, and groupings. These nodes are intended to be reused by other YANG modules. The modules by themselves do not expose any data nodes that are writable, data nodes that contain read-only state, or RPCs. As such, there are no additional security issues related to the YANG module that need to be considered.

Modules that use the groupings that are defined in this document should identify the corresponding security considerations. For example using 'explicit-route-hop', 'record-route-state' or 'te-topology-identifier' (which includes the 'client-id') groupings may expose sensitive topology information.

8. References

8.1. Normative References

[ITU-T_G.709]
International Telecommunication Union, "Interfaces for the optical transport network", ITU-T G.709 , June 2020, <https://www.itu.int/rec/T-REC-G.709>.

[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/rfc/rfc2119>.

[RFC3209] Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP Tunnels", RFC 3209, DOI 10.17487/RFC3209, December 2001, <https://www.rfc-editor.org/rfc/rfc3209>.

[RFC3471] Berger, L., Ed., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description", RFC 3471, DOI 10.17487/RFC3471, January 2003, <https://www.rfc-editor.org/rfc/rfc3471>.

[RFC3477] Kompella, K. and Y. Rekhter, "Signalling Unnumbered Links in Resource ReSerVation Protocol - Traffic Engineering (RSVP-TE)", RFC 3477, DOI 10.17487/RFC3477, January 2003, <https://www.rfc-editor.org/rfc/rfc3477>.

[RFC3630] Katz, D., Kompella, K., and D. Yeung, "Traffic Engineering (TE) Extensions to OSPF Version 2", RFC 3630, DOI 10.17487/RFC3630, September 2003, <https://www.rfc-editor.org/rfc/rfc3630>.

[RFC3785] Le Faucheur, F., Uppili, R., Vedrenne, A., Merckx, P., and T. Telkamp, "Use of Interior Gateway Protocol (IGP) Metric as a second MPLS Traffic Engineering (TE) Metric", BCP 87, RFC 3785, DOI 10.17487/RFC3785, May 2004, <https://www.rfc-editor.org/rfc/rfc3785>.

[RFC4090] Pan, P., Ed., Swallow, G., Ed., and A. Atlas, Ed., "Fast Reroute Extensions to RSVP-TE for LSP Tunnels", RFC 4090, DOI 10.17487/RFC4090, May 2005, <https://www.rfc-editor.org/rfc/rfc4090>.

[RFC4124] Le Faucheur, F., Ed., "Protocol Extensions for Support of Diffserv-aware MPLS Traffic Engineering", RFC 4124, DOI 10.17487/RFC4124, June 2005, <https://www.rfc-editor.org/rfc/rfc4124>.

[RFC4202] Kompella, K., Ed. and Y. Rekhter, Ed., "Routing Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS)", RFC 4202, DOI 10.17487/RFC4202, October 2005, <https://www.rfc-editor.org/rfc/rfc4202>.

[RFC4203] Kompella, K., Ed. and Y. Rekhter, Ed., "OSPF Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS)", RFC 4203, DOI 10.17487/RFC4203, October 2005, <https://www.rfc-editor.org/rfc/rfc4203>.

[RFC4328] Papadimitriou, D., Ed., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Extensions for G.709 Optical Transport Networks Control", RFC 4328, DOI 10.17487/RFC4328, January 2006, <https://www.rfc-editor.org/rfc/rfc4328>.

[RFC4561] Vasseur, J.-P., Ed., Ali, Z., and S. Sivabalan, "Definition of a Record Route Object (RRO) Node-Id Sub-Object", RFC 4561, DOI 10.17487/RFC4561, June 2006, <https://www.rfc-editor.org/rfc/rfc4561>.

[RFC4872] Lang, J.P., Ed., Rekhter, Y., Ed., and D. Papadimitriou, Ed., "RSVP-TE Extensions in Support of End-to-End Generalized Multi-Protocol Label Switching (GMPLS) Recovery", RFC 4872, DOI 10.17487/RFC4872, May 2007, <https://www.rfc-editor.org/rfc/rfc4872>.

[RFC4873] Berger, L., Bryskin, I., Papadimitriou, D., and A. Farrel, "GMPLS Segment Recovery", RFC 4873, DOI 10.17487/RFC4873, May 2007, <https://www.rfc-editor.org/rfc/rfc4873>.

[RFC4875] Aggarwal, R., Ed., Papadimitriou, D., Ed., and S. Yasukawa, Ed., "Extensions to Resource Reservation Protocol - Traffic Engineering (RSVP-TE) for Point-to-Multipoint TE Label Switched Paths (LSPs)", RFC 4875, DOI 10.17487/RFC4875, May 2007, <https://www.rfc-editor.org/rfc/rfc4875>.

[RFC4920] Farrel, A., Ed., Satyanarayana, A., Iwata, A., Fujita, N., and G. Ash, "Crankback Signaling Extensions for MPLS and GMPLS RSVP-TE", RFC 4920, DOI 10.17487/RFC4920, July 2007, <https://www.rfc-editor.org/rfc/rfc4920>.

[RFC5003] Metz, C., Martini, L., Balus, F., and J. Sugimoto, "Attachment Individual Identifier (AII) Types for Aggregation", RFC 5003, DOI 10.17487/RFC5003, September 2007, <https://www.rfc-editor.org/rfc/rfc5003>.

[RFC5150] Ayyangar, A., Kompella, K., Vasseur, JP., and A. Farrel, "Label Switched Path Stitching with Generalized Multiprotocol Label Switching Traffic Engineering (GMPLS TE)", RFC 5150, DOI 10.17487/RFC5150, February 2008, <https://www.rfc-editor.org/rfc/rfc5150>.

[RFC5151] Farrel, A., Ed., Ayyangar, A., and JP. Vasseur, "Inter-Domain MPLS and GMPLS Traffic Engineering -- Resource Reservation Protocol-Traffic Engineering (RSVP-TE) Extensions", RFC 5151, DOI 10.17487/RFC5151, February 2008, <https://www.rfc-editor.org/rfc/rfc5151>.

[RFC5305] Li, T. and H. Smit, "IS-IS Extensions for Traffic Engineering", RFC 5305, DOI 10.17487/RFC5305, October 2008, <https://www.rfc-editor.org/rfc/rfc5305>.

[RFC5307] Kompella, K., Ed. and Y. Rekhter, Ed., "IS-IS Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS)", RFC 5307, DOI 10.17487/RFC5307, October 2008, <https://www.rfc-editor.org/rfc/rfc5307>.

[RFC5420] Farrel, A., Ed., Papadimitriou, D., Vasseur, JP., and A. Ayyangar, "Encoding of Attributes for MPLS LSP Establishment Using Resource Reservation Protocol Traffic Engineering (RSVP-TE)", RFC 5420, DOI 10.17487/RFC5420, February 2009, <https://www.rfc-editor.org/rfc/rfc5420>.

[RFC5440] Vasseur, JP., Ed. and JL. Le Roux, Ed., "Path Computation Element (PCE) Communication Protocol (PCEP)", RFC 5440, DOI 10.17487/RFC5440, March 2009, <https://www.rfc-editor.org/rfc/rfc5440>.

[RFC5441] Vasseur, JP., Ed., Zhang, R., Bitar, N., and JL. Le Roux, "A Backward-Recursive PCE-Based Computation (BRPC) Procedure to Compute Shortest Constrained Inter-Domain Traffic Engineering Label Switched Paths", RFC 5441, DOI 10.17487/RFC5441, April 2009, <https://www.rfc-editor.org/rfc/rfc5441>.

[RFC5520] Bradford, R., Ed., Vasseur, JP., and A. Farrel, "Preserving Topology Confidentiality in Inter-Domain Path Computation Using a Path-Key-Based Mechanism", RFC 5520, DOI 10.17487/RFC5520, April 2009, <https://www.rfc-editor.org/rfc/rfc5520>.

[RFC5541] Le Roux, JL., Vasseur, JP., and Y. Lee, "Encoding of Objective Functions in the Path Computation Element Communication Protocol (PCEP)", RFC 5541, DOI 10.17487/RFC5541, June 2009, <https://www.rfc-editor.org/rfc/rfc5541>.

[RFC5557] Lee, Y., Le Roux, JL., King, D., and E. Oki, "Path Computation Element Communication Protocol (PCEP) Requirements and Protocol Extensions in Support of Global Concurrent Optimization", RFC 5557, DOI 10.17487/RFC5557, July 2009, <https://www.rfc-editor.org/rfc/rfc5557>.

[RFC5712] Meyer, M., Ed. and JP. Vasseur, Ed., "MPLS Traffic Engineering Soft Preemption", RFC 5712, DOI 10.17487/RFC5712, January 2010, <https://www.rfc-editor.org/rfc/rfc5712>.

[RFC6001] Papadimitriou, D., Vigoureux, M., Shiomoto, K., Brungard, D., and JL. Le Roux, "Generalized MPLS (GMPLS) Protocol Extensions for Multi-Layer and Multi-Region Networks (MLN/MRN)", RFC 6001, DOI 10.17487/RFC6001, October 2010, <https://www.rfc-editor.org/rfc/rfc6001>.

[RFC6002] Berger, L. and D. Fedyk, "Generalized MPLS (GMPLS) Data Channel Switching Capable (DCSC) and Channel Set Label Extensions", RFC 6002, DOI 10.17487/RFC6002, October 2010, <https://www.rfc-editor.org/rfc/rfc6002>.

[RFC6004] Berger, L. and D. Fedyk, "Generalized MPLS (GMPLS) Support for Metro Ethernet Forum and G.8011 Ethernet Service Switching", RFC 6004, DOI 10.17487/RFC6004, October 2010, <https://www.rfc-editor.org/rfc/rfc6004>.

[RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <https://www.rfc-editor.org/rfc/rfc6020>.

[RFC6119] Harrison, J., Berger, J., and M. Bartlett, "IPv6 Traffic Engineering in IS-IS", RFC 6119, DOI 10.17487/RFC6119, February 2011, <https://www.rfc-editor.org/rfc/rfc6119>.

[RFC6368] Marques, P., Raszuk, R., Patel, K., Kumaki, K., and T. Yamagata, "Internal BGP as the Provider/Customer Edge Protocol for BGP/MPLS IP Virtual Private Networks (VPNs)", RFC 6368, DOI 10.17487/RFC6368, September 2011, <https://www.rfc-editor.org/rfc/rfc6368>.

[RFC6370] Bocci, M., Swallow, G., and E. Gray, "MPLS Transport Profile (MPLS-TP) Identifiers", RFC 6370, DOI 10.17487/RFC6370, September 2011, <https://www.rfc-editor.org/rfc/rfc6370>.

[RFC6378] Weingarten, Y., Ed., Bryant, S., Osborne, E., Sprecher, N., and A. Fulignoli, Ed., "MPLS Transport Profile (MPLS-TP) Linear Protection", RFC 6378, DOI 10.17487/RFC6378, October 2011, <https://www.rfc-editor.org/rfc/rfc6378>.

[RFC6511] Ali, Z., Swallow, G., and R. Aggarwal, "Non-Penultimate Hop Popping Behavior and Out-of-Band Mapping for RSVP-TE Label Switched Paths", RFC 6511, DOI 10.17487/RFC6511, February 2012, <https://www.rfc-editor.org/rfc/rfc6511>.

[RFC6780] Berger, L., Le Faucheur, F., and A. Narayanan, "RSVP ASSOCIATION Object Extensions", RFC 6780, DOI 10.17487/RFC6780, October 2012, <https://www.rfc-editor.org/rfc/rfc6780>.

[RFC6790] Kompella, K., Drake, J., Amante, S., Henderickx, W., and L. Yong, "The Use of Entropy Labels in MPLS Forwarding", RFC 6790, DOI 10.17487/RFC6790, November 2012, <https://www.rfc-editor.org/rfc/rfc6790>.

[RFC6827] Malis, A., Ed., Lindem, A., Ed., and D. Papadimitriou, Ed., "Automatically Switched Optical Network (ASON) Routing for OSPFv2 Protocols", RFC 6827, DOI 10.17487/RFC6827, January 2013, <https://www.rfc-editor.org/rfc/rfc6827>.

[RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <https://www.rfc-editor.org/rfc/rfc6991>.

[RFC7074] Berger, L. and J. Meuric, "Revised Definition of the GMPLS Switching Capability and Type Fields", RFC 7074, DOI 10.17487/RFC7074, November 2013, <https://www.rfc-editor.org/rfc/rfc7074>.

[RFC7138] Ceccarelli, D., Ed., Zhang, F., Belotti, S., Rao, R., and J. Drake, "Traffic Engineering Extensions to OSPF for GMPLS Control of Evolving G.709 Optical Transport Networks", RFC 7138, DOI 10.17487/RFC7138, March 2014, <https://www.rfc-editor.org/rfc/rfc7138>.

[RFC7139] Zhang, F., Ed., Zhang, G., Belotti, S., Ceccarelli, D., and K. Pithewan, "GMPLS Signaling Extensions for Control of Evolving G.709 Optical Transport Networks", RFC 7139, DOI 10.17487/RFC7139, March 2014, <https://www.rfc-editor.org/rfc/rfc7139>.

[RFC7260] Takacs, A., Fedyk, D., and J. He, "GMPLS RSVP-TE Extensions for Operations, Administration, and Maintenance (OAM) Configuration", RFC 7260, DOI 10.17487/RFC7260, June 2014, <https://www.rfc-editor.org/rfc/rfc7260>.

[RFC7271] Ryoo, J., Ed., Gray, E., Ed., van Helvoort, H., D'Alessandro, A., Cheung, T., and E. Osborne, "MPLS Transport Profile (MPLS-TP) Linear Protection to Match the Operational Expectations of Synchronous Digital Hierarchy, Optical Transport Network, and Ethernet Transport Network Operators", RFC 7271, DOI 10.17487/RFC7271, June 2014, <https://www.rfc-editor.org/rfc/rfc7271>.

[RFC7308] Osborne, E., "Extended Administrative Groups in MPLS Traffic Engineering (MPLS-TE)", RFC 7308, DOI 10.17487/RFC7308, July 2014, <https://www.rfc-editor.org/rfc/rfc7308>.

[RFC7471] Giacalone, S., Ward, D., Drake, J., Atlas, A., and S. Previdi, "OSPF Traffic Engineering (TE) Metric Extensions", RFC 7471, DOI 10.17487/RFC7471, March 2015, <https://www.rfc-editor.org/rfc/rfc7471>.

[RFC7551] Zhang, F., Ed., Jing, R., and R. Gandhi, Ed., "RSVP-TE Extensions for Associated Bidirectional Label Switched Paths (LSPs)", RFC 7551, DOI 10.17487/RFC7551, May 2015, <https://www.rfc-editor.org/rfc/rfc7551>.

[RFC7570] Margaria, C., Ed., Martinelli, G., Balls, S., and B. Wright, "Label Switched Path (LSP) Attribute in the Explicit Route Object (ERO)", RFC 7570, DOI 10.17487/RFC7570, July 2015, <https://www.rfc-editor.org/rfc/rfc7570>.

[RFC7571] Dong, J., Chen, M., Li, Z., and D. Ceccarelli, "GMPLS RSVP-TE Extensions for Lock Instruct and Loopback", RFC 7571, DOI 10.17487/RFC7571, July 2015, <https://www.rfc-editor.org/rfc/rfc7571>.

[RFC7579] Bernstein, G., Ed., Lee, Y., Ed., Li, D., Imajuku, W., and J. Han, "General Network Element Constraint Encoding for GMPLS-Controlled Networks", RFC 7579, DOI 10.17487/RFC7579, June 2015, <https://www.rfc-editor.org/rfc/rfc7579>.

[RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <https://www.rfc-editor.org/rfc/rfc7950>.

[RFC8001] Zhang, F., Ed., Gonzalez de Dios, O., Ed., Margaria, C., Hartley, M., and Z. Ali, "RSVP-TE Extensions for Collecting Shared Risk Link Group (SRLG) Information", RFC 8001, DOI 10.17487/RFC8001, January 2017, <https://www.rfc-editor.org/rfc/rfc8001>.

[RFC8149] Saad, T., Ed., Gandhi, R., Ed., Ali, Z., Venator, R., and Y. Kamite, "RSVP Extensions for Reoptimization of Loosely Routed Point-to-Multipoint Traffic Engineering Label Switched Paths (LSPs)", RFC 8149, DOI 10.17487/RFC8149, April 2017, <https://www.rfc-editor.org/rfc/rfc8149>.

[RFC8169] Mirsky, G., Ruffini, S., Gray, E., Drake, J., Bryant, S., and A. Vainshtein, "Residence Time Measurement in MPLS Networks", RFC 8169, DOI 10.17487/RFC8169, May 2017, <https://www.rfc-editor.org/rfc/rfc8169>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/rfc/rfc8174>.

[RFC8233] Dhody, D., Wu, Q., Manral, V., Ali, Z., and K. Kumaki, "Extensions to the Path Computation Element Communication Protocol (PCEP) to Compute Service-Aware Label Switched Paths (LSPs)", RFC 8233, DOI 10.17487/RFC8233, September 2017, <https://www.rfc-editor.org/rfc/rfc8233>.

[RFC8294] Liu, X., Qu, Y., Lindem, A., Hopps, C., and L. Berger, "Common YANG Data Types for the Routing Area", RFC 8294, DOI 10.17487/RFC8294, December 2017, <https://www.rfc-editor.org/rfc/rfc8294>.

[RFC8306] Zhao, Q., Dhody, D., Ed., Palleti, R., and D. King, "Extensions to the Path Computation Element Communication Protocol (PCEP) for Point-to-Multipoint Traffic Engineering Label Switched Paths", RFC 8306, DOI 10.17487/RFC8306, November 2017, <https://www.rfc-editor.org/rfc/rfc8306>.

[RFC8341] Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <https://www.rfc-editor.org/rfc/rfc8341>.

[RFC8342] Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture (NMDA)", RFC 8342, DOI 10.17487/RFC8342, March 2018, <https://www.rfc-editor.org/rfc/rfc8342>.

[RFC8345] Clemm, A., Medved, J., Varga, R., Bahadur, N., Ananthakrishnan, H., and X. Liu, "A YANG Data Model for Network Topologies", RFC 8345, DOI 10.17487/RFC8345, March 2018, <https://www.rfc-editor.org/rfc/rfc8345>.

[RFC8570] Ginsberg, L., Ed., Previdi, S., Ed., Giacalone, S., Ward, D., Drake, J., and Q. Wu, "IS-IS Traffic Engineering (TE) Metric Extensions", RFC 8570, DOI 10.17487/RFC8570, March 2019, <https://www.rfc-editor.org/rfc/rfc8570>.

[RFC8685] Zhang, F., Zhao, Q., Gonzalez de Dios, O., Casellas, R., and D. King, "Path Computation Element Communication Protocol (PCEP) Extensions for the Hierarchical Path Computation Element (H-PCE) Architecture", RFC 8685, DOI 10.17487/RFC8685, December 2019, <https://www.rfc-editor.org/rfc/rfc8685>.

[RFC8776] Saad, T., Gandhi, R., Liu, X., Beeram, V., and I. Bryskin, "Common YANG Data Types for Traffic Engineering", RFC 8776, DOI 10.17487/RFC8776, June 2020, <https://www.rfc-editor.org/rfc/rfc8776>.

[RFC8800] Litkowski, S., Sivabalan, S., Barth, C., and M. Negi, "Path Computation Element Communication Protocol (PCEP) Extension for Label Switched Path (LSP) Diversity Constraint Signaling", RFC 8800, DOI 10.17487/RFC8800, July 2020, <https://www.rfc-editor.org/rfc/rfc8800>.

[RFC9012] Patel, K., Van de Velde, G., Sangli, S., and J. Scudder, "The BGP Tunnel Encapsulation Attribute", RFC 9012, DOI 10.17487/RFC9012, April 2021, <https://www.rfc-editor.org/rfc/rfc9012>.

8.2. Informative References

[I-D.ietf-netmod-rfc8407bis]
Bierman, A., Boucadair, M., and Q. Wu, "Guidelines for Authors and Reviewers of Documents Containing YANG Data Models", Work in Progress, Internet-Draft, draft-ietf-netmod-rfc8407bis-28, 5 June 2025, <https://datatracker.ietf.org/doc/html/draft-ietf-netmod-rfc8407bis-28>.

[I-D.ietf-pce-sid-algo-14]
Sidor, S., Rose, Z., Peng, S., Peng, S., and A. Stone, "Carrying SR-Algorithm Information in PCE-based Networks.", Work in Progress, Internet-Draft, draft-ietf-pce-sid-algo-14, 25 September 2024, <https://datatracker.ietf.org/doc/html/draft-ietf-pce-sid-algo-14>.

[MEF_10.3] MEF, "Ethernet Services Attributes Phase 3", MEF 10.3 , October 2013, <https://www.mef.net/Assets/Technical_Specifications/PDF/MEF_10.pdf>.

[RFC2697] Heinanen, J. and R. Guerin, "A Single Rate Three Color Marker", RFC 2697, DOI 10.17487/RFC2697, September 1999, <https://www.rfc-editor.org/rfc/rfc2697>.

[RFC2698] Heinanen, J. and R. Guerin, "A Two Rate Three Color Marker", RFC 2698, DOI 10.17487/RFC2698, September 1999, <https://www.rfc-editor.org/rfc/rfc2698>.

[RFC2702] Awduche, D., Malcolm, J., Agogbua, J., O'Dell, M., and J. McManus, "Requirements for Traffic Engineering Over MPLS", RFC 2702, DOI 10.17487/RFC2702, September 1999, <https://www.rfc-editor.org/rfc/rfc2702>.

[RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <https://www.rfc-editor.org/rfc/rfc3688>.

[RFC4125] Le Faucheur, F. and W. Lai, "Maximum Allocation Bandwidth Constraints Model for Diffserv-aware MPLS Traffic Engineering", RFC 4125, DOI 10.17487/RFC4125, June 2005, <https://www.rfc-editor.org/rfc/rfc4125>.

[RFC4126] Ash, J., "Max Allocation with Reservation Bandwidth Constraints Model for Diffserv-aware MPLS Traffic Engineering & Performance Comparisons", RFC 4126, DOI 10.17487/RFC4126, June 2005, <https://www.rfc-editor.org/rfc/rfc4126>.

[RFC4127] Le Faucheur, F., Ed., "Russian Dolls Bandwidth Constraints Model for Diffserv-aware MPLS Traffic Engineering", RFC 4127, DOI 10.17487/RFC4127, June 2005, <https://www.rfc-editor.org/rfc/rfc4127>.

[RFC4252] Ylonen, T. and C. Lonvick, Ed., "The Secure Shell (SSH) Authentication Protocol", RFC 4252, DOI 10.17487/RFC4252, January 2006, <https://www.rfc-editor.org/rfc/rfc4252>.

[RFC4427] Mannie, E., Ed. and D. Papadimitriou, Ed., "Recovery (Protection and Restoration) Terminology for Generalized Multi-Protocol Label Switching (GMPLS)", RFC 4427, DOI 10.17487/RFC4427, March 2006, <https://www.rfc-editor.org/rfc/rfc4427>.

[RFC4657] Ash, J., Ed. and J.L. Le Roux, Ed., "Path Computation Element (PCE) Communication Protocol Generic Requirements", RFC 4657, DOI 10.17487/RFC4657, September 2006, <https://www.rfc-editor.org/rfc/rfc4657>.

[RFC4736] Vasseur, JP., Ed., Ikejiri, Y., and R. Zhang, "Reoptimization of Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Loosely Routed Label Switched Path (LSP)", RFC 4736, DOI 10.17487/RFC4736, November 2006, <https://www.rfc-editor.org/rfc/rfc4736>.

[RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <https://www.rfc-editor.org/rfc/rfc6241>.

[RFC7823] Atlas, A., Drake, J., Giacalone, S., and S. Previdi, "Performance-Based Path Selection for Explicitly Routed Label Switched Paths (LSPs) Using TE Metric Extensions", RFC 7823, DOI 10.17487/RFC7823, May 2016, <https://www.rfc-editor.org/rfc/rfc7823>.

[RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <https://www.rfc-editor.org/rfc/rfc8040>.

[RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <https://www.rfc-editor.org/rfc/rfc8340>.

[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/rfc/rfc8446>.

[RFC9000] Iyengar, J., Ed. and M. Thomson, Ed., "QUIC: A UDP-Based Multiplexed and Secure Transport", RFC 9000, DOI 10.17487/RFC9000, May 2021, <https://www.rfc-editor.org/rfc/rfc9000>.

[RFC9522] Farrel, A., Ed., "Overview and Principles of Internet Traffic Engineering", RFC 9522, DOI 10.17487/RFC9522, January 2024, <https://www.rfc-editor.org/rfc/rfc9522>.

Appendix A. The Complete Schema Trees

This appendix presents the complete tree of the TE and Packet TE types data model. See [RFC8340] for an explanation of the symbols used. The data type of every leaf node is shown near the right end of the corresponding line.

> Editors' Note: The YANG trees have been generated by pyang and have some bugs to be fixed before publication. Please manually fix the YANG tree before sending the document to the RFC EDITOR.

A.1. TE Types Schema Tree

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

   module: ietf-te-types

     grouping te-bandwidth:
       +-- te-bandwidth
          +-- (technology)?
             +--:(generic)
                +-- generic?   te-bandwidth
     grouping te-label:
       +-- te-label
          +-- (technology)?
          |  +--:(generic)
          |     +-- generic?   rt-types:generalized-label
          +-- direction?       te-label-direction
     grouping te-topology-identifier:
       +-- te-topology-identifier
          +-- provider-id?   te-global-id
          +-- client-id?     te-global-id
          +-- topology-id?   te-topology-id
     grouping performance-metrics-one-way-delay-loss:
       +-- one-way-delay?             uint32
       +-- one-way-delay-normality?
               te-types:performance-metrics-normality
     grouping performance-metrics-two-way-delay-loss:
       +-- two-way-delay?             uint32
       +-- two-way-delay-normality?
               te-types:performance-metrics-normality
     grouping performance-metrics-one-way-bandwidth:
       +-- one-way-residual-bandwidth?
       |       rt-types:bandwidth-ieee-float32
       +-- one-way-residual-bandwidth-normality?
       |       te-types:performance-metrics-normality
       +-- one-way-available-bandwidth?
       |       rt-types:bandwidth-ieee-float32
       +-- one-way-available-bandwidth-normality?
       |       te-types:performance-metrics-normality
       +-- one-way-utilized-bandwidth?
       |       rt-types:bandwidth-ieee-float32
       +-- one-way-utilized-bandwidth-normality?
               te-types:performance-metrics-normality
     grouping one-way-performance-metrics:
       +-- one-way-delay?                 uint32
       +-- one-way-residual-bandwidth?
       |       rt-types:bandwidth-ieee-float32
       +-- one-way-available-bandwidth?
```

```
       |       rt-types:bandwidth-ieee-float32
       +-- one-way-utilized-bandwidth?
               rt-types:bandwidth-ieee-float32
     grouping two-way-performance-metrics:
       +-- two-way-delay?   uint32
     grouping performance-metrics-thresholds:
       +-- one-way-delay?                 uint32
       +-- one-way-residual-bandwidth?
       |       rt-types:bandwidth-ieee-float32
       +-- one-way-available-bandwidth?
       |       rt-types:bandwidth-ieee-float32
       +-- one-way-utilized-bandwidth?
       |       rt-types:bandwidth-ieee-float32
       +-- two-way-delay?                 uint32
     grouping performance-metrics-attributes:
       +-- performance-metrics-one-way
       |  +-- one-way-delay?                            uint32
       |  +-- one-way-delay-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-residual-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +-- one-way-residual-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-available-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +-- one-way-available-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-utilized-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +-- one-way-utilized-bandwidth-normality?
       |          te-types:performance-metrics-normality
       +-- performance-metrics-two-way
          +-- two-way-delay?             uint32
          +-- two-way-delay-normality?
                  te-types:performance-metrics-normality
     grouping performance-metrics-throttle-container:
       +-- throttle
          +-- one-way-delay-offset?                  uint32
          +-- measure-interval?                      uint32
          +-- advertisement-interval?                uint32
          +-- suppression-interval?                  uint32
          +-- threshold-out
          |  +-- one-way-delay?                 uint32
          |  +-- one-way-residual-bandwidth?
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- one-way-available-bandwidth?
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- one-way-utilized-bandwidth?
```

```
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- two-way-delay?                 uint32
          +-- threshold-in
          |  +-- one-way-delay?                 uint32
          |  +-- one-way-residual-bandwidth?
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- one-way-available-bandwidth?
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- one-way-utilized-bandwidth?
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- two-way-delay?                 uint32
          +-- threshold-accelerated-advertisement
             +-- one-way-delay?                 uint32
             +-- one-way-residual-bandwidth?
             |       rt-types:bandwidth-ieee-float32
             +-- one-way-available-bandwidth?
             |       rt-types:bandwidth-ieee-float32
             +-- one-way-utilized-bandwidth?
             |       rt-types:bandwidth-ieee-float32
             +-- two-way-delay?                 uint32
     grouping explicit-route-hop:
       +-- (type)?
          +--:(numbered-node-hop)
          |  +-- numbered-node-hop
          |     +-- node-id-uri?   nw:node-id
          |     +-- node-id?       te-node-id
          |     +-- hop-type?      te-hop-type
          +--:(numbered-link-hop)
          |  +-- numbered-link-hop
          |     +-- link-tp-id    te-tp-id
          |     +-- hop-type?     te-hop-type
          |     +-- direction?    te-link-direction
          +--:(unnumbered-link-hop)
          |  +-- unnumbered-link-hop
          |     +-- link-tp-id-uri?   nt:tp-id
          |     +-- link-tp-id?       te-tp-id
          |     +-- node-id-uri?      nw:node-id
          |     +-- node-id?          te-node-id
          |     +-- hop-type?         te-hop-type
          |     +-- direction?        te-link-direction
          +--:(as-number)
          |  +-- as-number-hop
          |     +-- as-number    inet:as-number
          |     +-- hop-type?    te-hop-type
          +--:(label)
             +-- label-hop
                +-- te-label
                   +-- (technology)?
```

```
                |  +--:(generic)
                |     +-- generic?   rt-types:generalized-label
                +-- direction?       te-label-direction
     grouping explicit-route-hop-with-srlg:
       +-- (type)?
          +--:(numbered-node-hop)
          |  +-- numbered-node-hop
          |     +-- node-id-uri?   nw:node-id
          |     +-- node-id?       te-node-id
          |     +-- hop-type?      te-hop-type
          +--:(numbered-link-hop)
          |  +-- numbered-link-hop
          |     +-- link-tp-id    te-tp-id
          |     +-- hop-type?     te-hop-type
          |     +-- direction?    te-link-direction
          +--:(unnumbered-link-hop)
          |  +-- unnumbered-link-hop
          |     +-- link-tp-id-uri?   nt:tp-id
          |     +-- link-tp-id?       te-tp-id
          |     +-- node-id-uri?      nw:node-id
          |     +-- node-id?          te-node-id
          |     +-- hop-type?         te-hop-type
          |     +-- direction?        te-link-direction
          +--:(as-number)
          |  +-- as-number-hop
          |     +-- as-number    inet:as-number
          |     +-- hop-type?    te-hop-type
          +--:(label)
          |  +-- label-hop
          |     +-- te-label
          |        +-- (technology)?
          |        |  +--:(generic)
          |        |     +-- generic?   rt-types:generalized-label
          |        +-- direction?       te-label-direction
          +--:(srlg)
             +-- srlg
                +-- srlg?   uint32
     grouping record-route-state:
       +-- index?                       uint32
       +-- (type)?
          +--:(numbered-node-hop)
          |  +-- numbered-node-hop
          |     +-- node-id-uri?   nw:node-id
          |     +-- node-id?       te-node-id
          |     +-- flags*         path-attribute-flags
          +--:(numbered-link-hop)
          |  +-- numbered-link-hop
          |     +-- link-tp-id    te-tp-id
```

```
          |     +-- flags*        path-attribute-flags
          +--:(unnumbered-link-hop)
          |  +-- unnumbered-link-hop
          |     +-- link-tp-id-uri?   nt:tp-id
          |     +-- link-tp-id?       te-tp-id
          |     +-- node-id-uri?      nw:node-id
          |     +-- node-id?          te-node-id
          |     +-- flags*            path-attribute-flags
          +--:(label)
             +-- label-hop
                +-- te-label
                |  +-- (technology)?
                |  |  +--:(generic)
                |  |     +-- generic?   rt-types:generalized-label
                |  +-- direction?       te-label-direction
                +-- flags*      path-attribute-flags
     grouping label-restriction-info:
       +-- restriction?    enumeration
       +-- index?          uint32
       +-- label-start
       |  +-- te-label
       |     +-- (technology)?
       |     |  +--:(generic)
       |     |     +-- generic?   rt-types:generalized-label
       |     +-- direction?       te-label-direction
       +-- label-end
       |  +-- te-label
       |     +-- (technology)?
       |     |  +--:(generic)
       |     |     +-- generic?   rt-types:generalized-label
       |     +-- direction?       te-label-direction
       +-- label-step
       |  +-- (technology)?
       |     +--:(generic)
       |        +-- generic?   int32
       +-- range-bitmap?   yang:hex-string
     grouping label-set-info:
       +-- label-restrictions
          +-- label-restriction* [index]
             +-- restriction?    enumeration
             +-- index?          uint32
             +-- label-start
             |  +-- te-label
             |     +-- (technology)?
             |     |  +--:(generic)
             |     |     +-- generic?   rt-types:generalized-label
             |     +-- direction?       te-label-direction
             +-- label-end
```

```
            |  +-- te-label
            |     +-- (technology)?
            |     |  +--:(generic)
            |     |     +-- generic?   rt-types:generalized-label
            |     +-- direction?       te-label-direction
            +-- label-step
            |  +-- (technology)?
            |     +--:(generic)
            |        +-- generic?   int32
            +-- range-bitmap?   yang:hex-string
      grouping optimization-metric-entry:
        +-- metric-type?                       identityref
        +-- weight?                            uint8
        +-- explicit-route-exclude-objects
        |  +-- route-object-exclude-object* [index]
        |     +-- index?                        uint32
        |     +-- (type)?
        |        +--:(numbered-node-hop)
        |        |  +-- numbered-node-hop
        |        |     +-- node-id-uri?   nw:node-id
        |        |     +-- node-id?       te-node-id
        |        |     +-- hop-type?      te-hop-type
        |        +--:(numbered-link-hop)
        |        |  +-- numbered-link-hop
        |        |     +-- link-tp-id    te-tp-id
        |        |     +-- hop-type?     te-hop-type
        |        |     +-- direction?    te-link-direction
        |        +--:(unnumbered-link-hop)
        |        |  +-- unnumbered-link-hop
        |        |     +-- link-tp-id-uri?   nt:tp-id
        |        |     +-- link-tp-id?       te-tp-id
        |        |     +-- node-id-uri?      nw:node-id
        |        |     +-- node-id?          te-node-id
        |        |     +-- hop-type?         te-hop-type
        |        |     +-- direction?        te-link-direction
        |        +--:(as-number)
        |        |  +-- as-number-hop
        |        |     +-- as-number    inet:as-number
        |        |     +-- hop-type?    te-hop-type
        |        +--:(label)
        |        |  +-- label-hop
        |        |     +-- te-label
        |        |        +-- (technology)?
        |        |        |  +--:(generic)
        |        |        |     +-- generic?   rt-types:generalized-label
        |        |        +-- direction?       te-label-direction
        |        +--:(srlg)
        |           +-- srlg
```

```
       |              +-- srlg?   uint32
       +-- explicit-route-include-objects
          +-- route-object-include-object* [index]
             +-- index?                       uint32
             +-- (type)?
                +--:(numbered-node-hop)
                |  +-- numbered-node-hop
                |     +-- node-id-uri?   nw:node-id
                |     +-- node-id?       te-node-id
                |     +-- hop-type?      te-hop-type
                +--:(numbered-link-hop)
                |  +-- numbered-link-hop
                |     +-- link-tp-id    te-tp-id
                |     +-- hop-type?     te-hop-type
                |     +-- direction?    te-link-direction
                +--:(unnumbered-link-hop)
                |  +-- unnumbered-link-hop
                |     +-- link-tp-id-uri?   nt:tp-id
                |     +-- link-tp-id?       te-tp-id
                |     +-- node-id-uri?      nw:node-id
                |     +-- node-id?          te-node-id
                |     +-- hop-type?         te-hop-type
                |     +-- direction?        te-link-direction
                +--:(as-number)
                |  +-- as-number-hop
                |     +-- as-number    inet:as-number
                |     +-- hop-type?    te-hop-type
                +--:(label)
                   +-- label-hop
                      +-- te-label
                         +-- (technology)?
                         |  +--:(generic)
                         |     +-- generic?   rt-types:generalized-label
                         +-- direction?       te-label-direction
     grouping common-constraints:
       +-- te-bandwidth
       |  +-- (technology)?
       |     +--:(generic)
       |        +-- generic?   te-bandwidth
       +-- link-protection?   identityref
       +-- setup-priority?    uint8
       +-- hold-priority?     uint8
       +-- signaling-type?    identityref
     grouping tunnel-constraints:
       +-- network-id?               nw:network-id
       +-- te-topology-identifier
       |  +-- provider-id?   te-global-id
       |  +-- client-id?     te-global-id
```

```
       |  +-- topology-id?   te-topology-id
       +-- te-bandwidth
       |  +-- (technology)?
       |     +--:(generic)
       |        +-- generic?   te-bandwidth
       +-- link-protection?          identityref
       +-- setup-priority?           uint8
       +-- hold-priority?            uint8
       +-- signaling-type?           identityref
     grouping path-constraints-route-objects:
       +-- explicit-route-objects
          +-- route-object-exclude-always* [index]
          |  +-- index?                       uint32
          |  +-- (type)?
          |     +--:(numbered-node-hop)
          |     |  +-- numbered-node-hop
          |     |     +-- node-id-uri?   nw:node-id
          |     |     +-- node-id?       te-node-id
          |     |     +-- hop-type?      te-hop-type
          |     +--:(numbered-link-hop)
          |     |  +-- numbered-link-hop
          |     |     +-- link-tp-id    te-tp-id
          |     |     +-- hop-type?     te-hop-type
          |     |     +-- direction?    te-link-direction
          |     +--:(unnumbered-link-hop)
          |     |  +-- unnumbered-link-hop
          |     |     +-- link-tp-id-uri?   nt:tp-id
          |     |     +-- link-tp-id?       te-tp-id
          |     |     +-- node-id-uri?      nw:node-id
          |     |     +-- node-id?          te-node-id
          |     |     +-- hop-type?         te-hop-type
          |     |     +-- direction?        te-link-direction
          |     +--:(as-number)
          |     |  +-- as-number-hop
          |     |     +-- as-number    inet:as-number
          |     |     +-- hop-type?    te-hop-type
          |     +--:(label)
          |        +-- label-hop
          |           +-- te-label
          |              +-- (technology)?
          |              |  +--:(generic)
          |              |     +-- generic?   rt-types:generalized-label
          |              +-- direction?       te-label-direction
          +-- route-object-include-exclude* [index]
             +-- explicit-route-usage?        identityref
             +-- index?                       uint32
             +-- (type)?
                +--:(numbered-node-hop)
```

```
               |  +-- numbered-node-hop
               |     +-- node-id-uri?   nw:node-id
               |     +-- node-id?       te-node-id
               |     +-- hop-type?      te-hop-type
               +--:(numbered-link-hop)
               |  +-- numbered-link-hop
               |     +-- link-tp-id    te-tp-id
               |     +-- hop-type?     te-hop-type
               |     +-- direction?    te-link-direction
               +--:(unnumbered-link-hop)
               |  +-- unnumbered-link-hop
               |     +-- link-tp-id-uri?   nt:tp-id
               |     +-- link-tp-id?       te-tp-id
               |     +-- node-id-uri?      nw:node-id
               |     +-- node-id?          te-node-id
               |     +-- hop-type?         te-hop-type
               |     +-- direction?        te-link-direction
               +--:(as-number)
               |  +-- as-number-hop
               |     +-- as-number    inet:as-number
               |     +-- hop-type?    te-hop-type
               +--:(label)
               |  +-- label-hop
               |     +-- te-label
               |        +-- (technology)?
               |        |  +--:(generic)
               |        |     +-- generic?   rt-types:generalized-label
               |        +-- direction?       te-label-direction
               +--:(srlg)
                  +-- srlg
                     +-- srlg?   uint32
     grouping path-route-include-objects:
       +-- route-object-include-object* [index]
          +-- index?                       uint32
          +-- (type)?
             +--:(numbered-node-hop)
             |  +-- numbered-node-hop
             |     +-- node-id-uri?   nw:node-id
             |     +-- node-id?       te-node-id
             |     +-- hop-type?      te-hop-type
             +--:(numbered-link-hop)
             |  +-- numbered-link-hop
             |     +-- link-tp-id    te-tp-id
             |     +-- hop-type?     te-hop-type
             |     +-- direction?    te-link-direction
             +--:(unnumbered-link-hop)
             |  +-- unnumbered-link-hop
             |     +-- link-tp-id-uri?   nt:tp-id
```

```
            |     +-- link-tp-id?       te-tp-id
            |     +-- node-id-uri?      nw:node-id
            |     +-- node-id?          te-node-id
            |     +-- hop-type?         te-hop-type
            |     +-- direction?        te-link-direction
            +--:(as-number)
            |  +-- as-number-hop
            |     +-- as-number    inet:as-number
            |     +-- hop-type?    te-hop-type
            +--:(label)
               +-- label-hop
                  +-- te-label
                     +-- (technology)?
                     |  +--:(generic)
                     |     +-- generic?   rt-types:generalized-label
                     +-- direction?       te-label-direction
    grouping path-route-exclude-objects:
      +-- route-object-exclude-object* [index]
         +-- index?                       uint32
         +-- (type)?
            +--:(numbered-node-hop)
            |  +-- numbered-node-hop
            |     +-- node-id-uri?   nw:node-id
            |     +-- node-id?       te-node-id
            |     +-- hop-type?      te-hop-type
            +--:(numbered-link-hop)
            |  +-- numbered-link-hop
            |     +-- link-tp-id    te-tp-id
            |     +-- hop-type?     te-hop-type
            |     +-- direction?    te-link-direction
            +--:(unnumbered-link-hop)
            |  +-- unnumbered-link-hop
            |     +-- link-tp-id-uri?   nt:tp-id
            |     +-- link-tp-id?       te-tp-id
            |     +-- node-id-uri?      nw:node-id
            |     +-- node-id?          te-node-id
            |     +-- hop-type?         te-hop-type
            |     +-- direction?        te-link-direction
            +--:(as-number)
            |  +-- as-number-hop
            |     +-- as-number    inet:as-number
            |     +-- hop-type?    te-hop-type
            +--:(label)
            |  +-- label-hop
            |     +-- te-label
            |        +-- (technology)?
            |        |  +--:(generic)
            |        |     +-- generic?   rt-types:generalized-label
```

```
          |        +-- direction?       te-label-direction
          +--:(srlg)
             +-- srlg
                +-- srlg?   uint32
    grouping generic-path-metric-bounds:
      +-- path-metric-bounds
         +-- path-metric-bound* [metric-type]
            +-- metric-type?   identityref
            +-- upper-bound?   uint64
    grouping generic-path-optimization:
      +-- optimizations
      |  +-- (algorithm)?
      |     +--:(metric) {path-optimization-metric}?
      |     |  +-- optimization-metric* [metric-type]
      |     |  |  +-- metric-type?                      identityref
      |     |  |  +-- weight?                           uint8
      |     |  |  +-- explicit-route-exclude-objects
      |     |  |  |  +-- route-object-exclude-object* [index]
      |     |  |  |     +-- index?                        uint32
      |     |  |  |     +-- (type)?
      |     |  |  |        +--:(numbered-node-hop)
      |     |  |  |        |  +-- numbered-node-hop
      |     |  |  |        |     +-- node-id-uri?   nw:node-id
      |     |  |  |        |     +-- node-id?       te-node-id
      |     |  |  |        |     +-- hop-type?      te-hop-type
      |     |  |  |        +--:(numbered-link-hop)
      |     |  |  |        |  +-- numbered-link-hop
      |     |  |  |        |     +-- link-tp-id    te-tp-id
      |     |  |  |        |     +-- hop-type?     te-hop-type
      |     |  |  |        |     +-- direction?    te-link-direction
      |     |  |  |        +--:(unnumbered-link-hop)
      |     |  |  |        |  +-- unnumbered-link-hop
      |     |  |  |        |     +-- link-tp-id-uri?   nt:tp-id
      |     |  |  |        |     +-- link-tp-id?       te-tp-id
      |     |  |  |        |     +-- node-id-uri?      nw:node-id
      |     |  |  |        |     +-- node-id?          te-node-id
      |     |  |  |        |     +-- hop-type?         te-hop-type
      |     |  |  |        |     +-- direction?
      |     |  |  |        |              te-link-direction
      |     |  |  |        +--:(as-number)
      |     |  |  |        |  +-- as-number-hop
      |     |  |  |        |     +-- as-number    inet:as-number
      |     |  |  |        |     +-- hop-type?    te-hop-type
      |     |  |  |        +--:(label)
      |     |  |  |        |  +-- label-hop
      |     |  |  |        |     +-- te-label
      |     |  |  |        |        +-- (technology)?
      |     |  |  |        |        |  +--:(generic)
```

```
        |     |  |  |        |        |     +-- generic?
        |     |  |  |        |        |             rt-types:generalized\
                                                          -label
        |     |  |  |        |        +-- direction?
        |     |  |  |        |                 te-label-direction
        |     |  |  |        +--:(srlg)
        |     |  |  |           +-- srlg
        |     |  |  |              +-- srlg?   uint32
        |     |  |  +-- explicit-route-include-objects
        |     |  |     +-- route-object-include-object* [index]
        |     |  |        +-- index?                      uint32
        |     |  |        +-- (type)?
        |     |  |           +--:(numbered-node-hop)
        |     |  |           |  +-- numbered-node-hop
        |     |  |           |     +-- node-id-uri?   nw:node-id
        |     |  |           |     +-- node-id?       te-node-id
        |     |  |           |     +-- hop-type?      te-hop-type
        |     |  |           +--:(numbered-link-hop)
        |     |  |           |  +-- numbered-link-hop
        |     |  |           |     +-- link-tp-id    te-tp-id
        |     |  |           |     +-- hop-type?     te-hop-type
        |     |  |           |     +-- direction?    te-link-direction
        |     |  |           +--:(unnumbered-link-hop)
        |     |  |           |  +-- unnumbered-link-hop
        |     |  |           |     +-- link-tp-id-uri?   nt:tp-id
        |     |  |           |     +-- link-tp-id?       te-tp-id
        |     |  |           |     +-- node-id-uri?      nw:node-id
        |     |  |           |     +-- node-id?          te-node-id
        |     |  |           |     +-- hop-type?         te-hop-type
        |     |  |           |     +-- direction?
        |     |  |           |              te-link-direction
        |     |  |           +--:(as-number)
        |     |  |           |  +-- as-number-hop
        |     |  |           |     +-- as-number    inet:as-number
        |     |  |           |     +-- hop-type?    te-hop-type
        |     |  |           +--:(label)
        |     |  |              +-- label-hop
        |     |  |                 +-- te-label
        |     |  |                    +-- (technology)?
        |     |  |                    |  +--:(generic)
        |     |  |                    |     +-- generic?
        |     |  |                    |             rt-types:generalized\
                                                          -label
        |     |  |                    +-- direction?
        |     |  |                            te-label-direction
        |     |  x-- tiebreakers
        |     |     x-- tiebreaker* [tiebreaker-type]
        |     |        x-- tiebreaker-type?   identityref
```

```
       |     +--:(objective-function)
       |              {path-optimization-objective-function}?
       |        +-- objective-function
       |           +-- objective-function-type?   identityref
       +-- tiebreaker?      identityref
     grouping generic-path-affinities:
       +-- path-affinities-values
       |  +-- path-affinities-value* [usage]
       |     +-- usage?   identityref
       |     +-- value?   admin-groups
       +-- path-affinity-names
          +-- path-affinity-name* [usage]
             +-- usage?           identityref
             +-- affinity-name* [name]
                +-- name?   string
     grouping generic-path-srlgs:
       +-- path-srlgs-lists
       |  +-- path-srlgs-list* [usage]
       |     +-- usage?    identityref
       |     +-- values*   srlg
       +-- path-srlgs-names
          +-- path-srlgs-name* [usage]
             +-- usage?   identityref
             +-- names*   string
     grouping generic-path-disjointness:
       +-- disjointness?   te-path-disjointness
     grouping common-path-constraints-attributes:
       +-- te-bandwidth
       |  +-- (technology)?
       |     +--:(generic)
       |        +-- generic?   te-bandwidth
       +-- link-protection?          identityref
       +-- setup-priority?           uint8
       +-- hold-priority?            uint8
       +-- signaling-type?           identityref
       +-- path-metric-bounds
       |  +-- path-metric-bound* [metric-type]
       |     +-- metric-type?   identityref
       |     +-- upper-bound?   uint64
       +-- path-affinities-values
       |  +-- path-affinities-value* [usage]
       |     +-- usage?   identityref
       |     +-- value?   admin-groups
       +-- path-affinity-names
       |  +-- path-affinity-name* [usage]
       |     +-- usage?           identityref
       |     +-- affinity-name* [name]
       |        +-- name?   string
```

```
       +-- path-srlgs-lists
       |  +-- path-srlgs-list* [usage]
       |     +-- usage?    identityref
       |     +-- values*   srlg
       +-- path-srlgs-names
          +-- path-srlgs-name* [usage]
             +-- usage?   identityref
             +-- names*   string
     grouping generic-path-constraints:
       +-- path-constraints
          +-- te-bandwidth
          |  +-- (technology)?
          |     +--:(generic)
          |        +-- generic?   te-bandwidth
          +-- link-protection?          identityref
          +-- setup-priority?           uint8
          +-- hold-priority?            uint8
          +-- signaling-type?           identityref
          +-- path-metric-bounds
          |  +-- path-metric-bound* [metric-type]
          |     +-- metric-type?   identityref
          |     +-- upper-bound?   uint64
          +-- path-affinities-values
          |  +-- path-affinities-value* [usage]
          |     +-- usage?   identityref
          |     +-- value?   admin-groups
          +-- path-affinity-names
          |  +-- path-affinity-name* [usage]
          |     +-- usage?           identityref
          |     +-- affinity-name* [name]
          |        +-- name?   string
          +-- path-srlgs-lists
          |  +-- path-srlgs-list* [usage]
          |     +-- usage?    identityref
          |     +-- values*   srlg
          +-- path-srlgs-names
          |  +-- path-srlgs-name* [usage]
          |     +-- usage?   identityref
          |     +-- names*   string
          +-- disjointness?             te-path-disjointness
     grouping generic-path-properties:
       +--ro path-properties
          +--ro path-metric* [metric-type]
          |  +--ro metric-type?          identityref
          |  +--ro accumulative-value?   uint64
          +--ro path-affinities-values
          |  +--ro path-affinities-value* [usage]
          |     +--ro usage?   identityref
```

```
|     +--ro value?   admin-groups
+--ro path-affinity-names
|  +--ro path-affinity-name* [usage]
|     +--ro usage?           identityref
|     +--ro affinity-name* [name]
|        +--ro name?   string
+--ro path-srlgs-lists
|  +--ro path-srlgs-list* [usage]
|     +--ro usage?    identityref
|     +--ro values*   srlg
+--ro path-srlgs-names
|  +--ro path-srlgs-name* [usage]
|     +--ro usage?   identityref
|     +--ro names*   string
+--ro path-route-objects
   +--ro path-route-object* [index]
      +--ro index?                        uint32
      +--ro (type)?
         +--:(numbered-node-hop)
         |  +--ro numbered-node-hop
         |     +--ro node-id-uri?   nw:node-id
         |     +--ro node-id?       te-node-id
         |     +--ro hop-type?      te-hop-type
         +--:(numbered-link-hop)
         |  +--ro numbered-link-hop
         |     +--ro link-tp-id    te-tp-id
         |     +--ro hop-type?     te-hop-type
         |     +--ro direction?    te-link-direction
         +--:(unnumbered-link-hop)
         |  +--ro unnumbered-link-hop
         |     +--ro link-tp-id-uri?   nt:tp-id
         |     +--ro link-tp-id?       te-tp-id
         |     +--ro node-id-uri?      nw:node-id
         |     +--ro node-id?          te-node-id
         |     +--ro hop-type?         te-hop-type
         |     +--ro direction?        te-link-direction
         +--:(as-number)
         |  +--ro as-number-hop
         |     +--ro as-number    inet:as-number
         |     +--ro hop-type?    te-hop-type
         +--:(label)
            +--ro label-hop
               +--ro te-label
                  +--ro (technology)?
                  |  +--:(generic)
                  |     +--ro generic?
                  |             rt-types:generalized-label
                  +--ro direction?       te-label-direction
```

```
     grouping encoding-and-switching-type:
       +-- encoding?         identityref
       +-- switching-type?   identityref
     grouping te-generic-node-id:
       +-- id?     union
       +-- type?   enumeration
```

A.2. Packet TE Types Schema Tree

```
   module: ietf-te-packet-types

     grouping performance-metrics-attributes-packet:
       +-- performance-metrics-one-way
       |  +-- one-way-delay?                            uint32
       |  +-- one-way-delay-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-residual-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +-- one-way-residual-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-available-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +-- one-way-available-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-utilized-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +-- one-way-utilized-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-min-delay?                        uint32
       |  +-- one-way-min-delay-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-max-delay?                        uint32
       |  +-- one-way-max-delay-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-delay-variation?                  uint32
       |  +-- one-way-delay-variation-normality?
       |  |       te-types:performance-metrics-normality
       |  +-- one-way-packet-loss?                      decimal64
       |  +-- one-way-packet-loss-normality?
       |          te-types:performance-metrics-normality
       +-- performance-metrics-two-way
          +-- two-way-delay?                      uint32
          +-- two-way-delay-normality?
          |       te-types:performance-metrics-normality
          +-- two-way-min-delay?                  uint32
          +-- two-way-min-delay-normality?
          |       te-types:performance-metrics-normality
          +-- two-way-max-delay?                  uint32
```

```
        +-- two-way-max-delay-normality?
        |       te-types:performance-metrics-normality
        +-- two-way-delay-variation?             uint32
        +-- two-way-delay-variation-normality?
        |       te-types:performance-metrics-normality
        +-- two-way-packet-loss?                 decimal64
        +-- two-way-packet-loss-normality?
                te-types:performance-metrics-normality
    grouping one-way-performance-metrics-packet:
      +-- one-way-min-delay?         uint32
      +-- one-way-max-delay?         uint32
      +-- one-way-delay-variation?   uint32
      +-- one-way-packet-loss?       decimal64
    grouping one-way-performance-metrics-gauge-packet:
      +-- one-way-min-delay?         yang:gauge64
      +-- one-way-max-delay?         yang:gauge64
      +-- one-way-delay-variation?   yang:gauge64
      +-- one-way-packet-loss?       decimal64
    grouping two-way-performance-metrics-packet:
      +-- two-way-min-delay?         uint32
      +-- two-way-max-delay?         uint32
      +-- two-way-delay-variation?   uint32
      +-- two-way-packet-loss?       decimal64
    grouping two-way-performance-metrics-gauge-packet:
      +-- two-way-min-delay?         yang:gauge64
      +-- two-way-max-delay?         yang:gauge64
      +-- two-way-delay-variation?   yang:gauge64
      +-- two-way-packet-loss?       decimal64
    grouping performance-metrics-throttle-container-packet:
      +-- throttle
         +-- one-way-delay-offset?                  uint32
         +-- measure-interval?                      uint32
         +-- advertisement-interval?                uint32
         +-- suppression-interval?                  uint32
         +-- threshold-out
         |  +-- one-way-delay?                 uint32
         |  +-- one-way-residual-bandwidth?
         |  |       rt-types:bandwidth-ieee-float32
         |  +-- one-way-available-bandwidth?
         |  |       rt-types:bandwidth-ieee-float32
         |  +-- one-way-utilized-bandwidth?
         |  |       rt-types:bandwidth-ieee-float32
         |  +-- two-way-delay?                 uint32
         |  +-- one-way-min-delay?             uint32
         |  +-- one-way-max-delay?             uint32
         |  +-- one-way-delay-variation?       uint32
         |  +-- one-way-packet-loss?           decimal64
         |  +-- two-way-min-delay?             uint32
```

```
          |  +-- two-way-max-delay?             uint32
          |  +-- two-way-delay-variation?       uint32
          |  +-- two-way-packet-loss?           decimal64
          +-- threshold-in
          |  +-- one-way-delay?                 uint32
          |  +-- one-way-residual-bandwidth?
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- one-way-available-bandwidth?
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- one-way-utilized-bandwidth?
          |  |       rt-types:bandwidth-ieee-float32
          |  +-- two-way-delay?                 uint32
          |  +-- one-way-min-delay?             uint32
          |  +-- one-way-max-delay?             uint32
          |  +-- one-way-delay-variation?       uint32
          |  +-- one-way-packet-loss?           decimal64
          |  +-- two-way-min-delay?             uint32
          |  +-- two-way-max-delay?             uint32
          |  +-- two-way-delay-variation?       uint32
          |  +-- two-way-packet-loss?           decimal64
          +-- threshold-accelerated-advertisement
             +-- one-way-delay?                 uint32
             +-- one-way-residual-bandwidth?
             |       rt-types:bandwidth-ieee-float32
             +-- one-way-available-bandwidth?
             |       rt-types:bandwidth-ieee-float32
             +-- one-way-utilized-bandwidth?
             |       rt-types:bandwidth-ieee-float32
             +-- two-way-delay?                 uint32
             +-- one-way-min-delay?             uint32
             +-- one-way-max-delay?             uint32
             +-- one-way-delay-variation?       uint32
             +-- one-way-packet-loss?           decimal64
             +-- two-way-min-delay?             uint32
             +-- two-way-max-delay?             uint32
             +-- two-way-delay-variation?       uint32
             +-- two-way-packet-loss?           decimal64
     grouping bandwidth-profile-parameters:
       +-- cir?   uint64
       +-- cbs?   uint64
       +-- eir?   uint64
       +-- ebs?   uint64
       +-- pir?   uint64
       +-- pbs?   uint64
     grouping te-packet-path-bandwidth:
       +-- packet-bandwidth
          +-- specification-type?   te-bandwidth-requested-type
          +-- set-bandwidth?        bandwidth-kbps
```

```
          +-- bandwidth-profile
          |  +-- bandwidth-profile-name?   string
          |  +-- bandwidth-profile-type?   identityref
          |  +-- cir?                      uint64
          |  +-- cbs?                      uint64
          |  +-- eir?                      uint64
          |  +-- ebs?                      uint64
          |  +-- pir?                      uint64
          |  +-- pbs?                      uint64
          +-- class-type?           te-types:te-ds-class
          +--ro signaled-bandwidth?   te-packet-types:bandwidth-kbps
     grouping te-packet-link-bandwidth:
       +-- packet-bandwidth?   uint64
```

Appendix B. Changes from RFC 8776

This version adds new common data types, identities, and groupings to the YANG modules. It also updates some of the existing data types, identities, and groupings in the YANG modules and fixes few bugs in [RFC8776].

The following new identities have been added to the ’ietf-te-types’ module:

* lsp-provisioning-error-reason;

* association-type-diversity;

* tunnel-admin-state-auto;

* lsp-restoration-restore-none;

* restoration-scheme-rerouting;

* path-metric-optimization-type;

* link-path-metric-type;

* link-metric-type and its derived identities;

* path-computation-error-reason and its derived identities;

* protocol-origin-type and its derived identities;

* svec-objective-function-type and its derived identities;

* svec-metric-type and its derived identities.

The following new data types have been added to the 'ietf-te-types' module:

* path-type;

* te-gen-node-id.

The following new groupings have been added to the 'ietf-te-types' module:

* explicit-route-hop-with-srlg;

* encoding-and-switching-type;

* te-generic-node-id.

The following new identities have been added to the 'ietf-te-packet-types' module:

* bandwidth-profile-type;

* link-metric-delay-variation;

* link-metric-loss;

* path-metric-delay-variation;

* path-metric-loss.

The following new groupings have been added to the 'ietf-te-packet-types' module:

* te-packet-path-bandwidth;

* te-packet-link-bandwidth.

The following identities, already defined in [RFC8776], have been updated in the 'ietf-te-types' module:

* objective-function-type (editorial);

* action-exercise (bug fix);

* path-metric-type:

  new base identities have been added;

* path-metric-te (bug fix);

* path-metric-igp (bug fix);

* path-metric-hop (bug fix);

* path-metric-delay-average (bug fix);

* path-metric-delay-minimum (bug fix);

* path-metric-residual-bandwidth (bug fix);

* path-metric-optimize-includes (bug fix);

* path-metric-optimize-excludes (bug fix);

* te-optimization-criterion (editorial).

The following data type, already defined in [RFC8776], has been updated in the 'ietf-te-types' module:

* te-node-id;

  The data type has been changed to be a union.

The following groupings, already defined in [RFC8776], have been updated in the 'ietf-te-types' module:

* explicit-route-hop

  The following new leaves have been added to the 'explicit-route-hop' grouping:

  - node-id-uri;

  - link-tp-id-uri;

  The following leaves, already defined in [RFC8776], have been updated in the 'explicit-route-hop':

  - node-id;

  - link-tp-id.

    The mandatory true statements for the node-id and link-tp-id have been replaced by must statements that requires at least the presence of:

    o node-id or node-id-uri;

o link-tp-id or link-tp-id-uri.

* explicit-route-hop

The following new leaves have been added to the 'explicit-route-hop' grouping:

- node-id-uri;

- link-tp-id-uri;

The following leaves, already defined in [RFC8776], have been updated in the 'explicit-route-hop':

- node-id;

- link-tp-id.

The mandatory true statements for the node-id and link-tp-id have been replaced by must statements that requires at least the presence of:

o node-id or node-id-uri;

o link-tp-id or link-tp-id-uri.

* optimization-metric-entry:

The following leaves, already defined in [RFC8776], have been updated in the 'optimization-metric-entry':

- metric-type;

The base identity has been updated without impacting the set of derived identities that are allowed.

* tunnel-constraints;

The following new leaf have been added to the 'tunnel-constraints' grouping:

- network-id;

* path-constraints-route-objects:

The following container, already defined in [RFC8776], has been updated in the 'path-constraints-route-objects':

- explicit-route-objects-always;

  The container has been renamed as 'explicit-route-objects'. This change is not affecting any IETF standard YANG models since this grouping has not yet been used by any YANG model defined in existing IETF RFCs.

* generic-path-metric-bounds:

  The following leaves, already defined in [RFC8776], have been updated in the 'optimization-metric-entry':

  - metric-type;

    The base identity has been updated to:

    o increase the set of derived identities that are allowed and;

    o remove from this set the 'path-metric-optimize-includes' and the 'path-metric-optimize-excludes' identities (bug fixing)

* generic-path-optimization

  The following new leaf have been added to the 'generic-path-optimization' grouping:

  - tiebreaker;

  The following container, already defined in [RFC8776], has been deprecated:

  - tiebreakers.

The following identities, already defined in [RFC8776], have been obsoleted in the 'ietf-te-types' module for bug fixing:

* of-minimize-agg-bandwidth-consumption;

* of-minimize-load-most-loaded-link;

* of-minimize-cost-path-set;

* lsp-protection-reroute-extra;

* lsp-protection-reroute.

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