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I. Busi
Huawei
A. Guo
Futurewei Technologies
X. Liu
Individual
T. Saad
Cisco Systems Inc.
I. Bryskin
Individual

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Common YANG Data Types for Traffic Engineering
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Abstract

This document defines a collection of commonly used Traffic Engineering (TE) specific 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 that model configuration and state for TE constructs, such as TE Topologies, TE Tunnels, TE Policies, TE Paths, TE Label Switched Paths (LSPs), and TE interfaces.

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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This Internet-Draft will expire on 21 November 2026.

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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 commonly used Traffic Engineering (TE) data types derived from the built-in YANG data types. The derived data types, identities, and groupings form common definitions applicable to modeling TE features in models defined outside of this document. These derived common data types, identities, and groupings are intended to be imported by other modules that model TE constructs, such as TE Topologies, TE Tunnels, TE Policies, TE Paths, TE Label Switched Paths (LSPs), and TE interfaces. Nevertheless, these common definitions can be used by any other module per the guidance in Sections 4.12 and 4.13 of [RFC9907]. An importing module is not required to use all the definitions provided by the types module.

> Note: Some groupings defined in this document do not follow the guidelines of Section 4.13 of [RFC9907] 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].

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. Editorial Note (To be removed by Editors of this document before sending it to the RFC Editor)

> Note to the RFC Editor: This section is to be removed this document is sent to the RFC Editor.

The YANG trees in Appendix A 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.

1.2. Editorial Note (To be removed by the RFC Editor)

> Note to the RFC Editor: This section is to be removed prior to publication.

This document contains placeholder values that need to be replaced with finalized values at the time of publication. This note summarizes all of the substitutions that are needed.

Please apply the following replacements:

* XXXX --> the assigned RFC number for this I-D

* draft-ietf-pce-sid-algo-29, Sections 4.5.1 and 4.5.2 --> the draft version and section number as in the latest version of [I-D.ietf-pce-sid-algo] at the time this document is published as an RFC

* 2026-05-08 --> the actual date of the publication of this document

1.2.1. References to RFCs

This document references a huge number of RFCs only by the RFC number which makes it really hard to follow.

A preference has been expressed to replace the references with the RFC title in the text and just use RFC number as a reference.

For example:

In section 1 change:

> Section 4.12 of [RFC9907] and Section 4.13 of [RFC9907].

to

> Section 4.12 and Section 4.13 of YANG Data Models guidelines document [RFC9907].

It is suggested that the RFC Editor and the tooling team identify a way to expand the references as proposed in a programmatic way.

1.3. 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].

1.4. 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 [RFC9911]
inet	ietf-inet-types	Section 4 of [RFC9911]
rt-types	ietf-routing-types	[RFC8294]
te-types	ietf-te-types	RFC XXXX
te-packet-types	ietf-te-packet-types	RFC XXXX

Table 1: Prefixes and corresponding YANG modules

1.5. Tree Diagrams

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

2. Acronyms and Abbreviations

APS: Automatic Protection Switching [RFC7271]

GMPLS: Generalized Multiprotocol Label Switching [RFC3945]

LER: Label Edge Router [RFC5921]

LSP: Label Switched Path [RFC3031]

Note: in this document, "LSP" refers to a TE LSP or a TE path.

LSR: Label Switching Router [RFC3031]

MPLS: Multiprotocol Label Switching [RFC3031]

NBMA: Non-Broadcast Multi-Access [RFC2328]

PM: Performance Metrics [RFC2330]

RSVP: Resource Reservation Protocol [RFC2205]

SRLG: Shared Risk Link Group [RFC4203]

TE: Traffic Engineering [RFC9522]

WTR: Wait-to-Restore [RFC6378]

3. Overview

This document defines two YANG modules for common TE types: "ietf-te-types" (Section 4) for TE generic types and "ietf-te-packet-types" (Section 5) 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 TE types that are commonly used across multiple TE technology-specific modules.

3.1.1. Identities

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

path-attribute-flags: A base 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 identity for supported link protection types as defined in [RFC4872].

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

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

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

objective-function-type: A base identity for supported path objective functions as defined in [RFC5541].

te-tunnel-type: A base identity for supported TE tunnel types as

defined in [RFC3209] and [RFC4875].

lsp-encoding-types: A base identity for supported LSP encoding types as defined in [RFC3471], [RFC4328], and [RFC6004]. These defined identities includes also technology-specific LSP encoding types for backward compatibility with [RFC8776].

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

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

switching-capabilities: A base identity for supported interface switching capabilities as defined in [RFC3471], [RFC6002], [RFC6004], [RFC7074], and [RFC7138]. These defined identities includes also technology-specific interface switching capabilities for backward compatibility with [RFC8776].

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

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

The unit of the path metric value is interpreted in the context of the path metric type. The derived identities MUST 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 identity for indicating LSP provisioning error reasons. No standard LSP provisioning error reasons are defined in this document.

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

protocol-origin-type: A base identity for the type of protocol

origin as defined in Section 3.1.1.2.

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

svec-metric-type: A base identity for supported SVEC metric types 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 the following path computation error reasons:

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

path-computation-error-no-dependent-server: A base 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, as defined in [RFC5441], or a child PCE, as defined in [RFC8685].

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 modules and not to PCEP environments (e.g., path-computation-error-no-topology);

2. technology-specific which are better defined in technology-specific YANG modules;

3. match more than one PCEP number 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 protocol origin identifies the protocol or mechanism a controller uses to instantiate a TE tunnel. To model this, the "ietf-te-types" module provides a set of reusable YANG identities. In addition to identities for protocols like PCEP [RFC5440] and BGP [RFC9012], the module defines the following identity for tunnels created via an Application Programmable Interface (API):

protocol-origin-api: A YANG identity used when the TE tunnel is instantiated through an 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-octet in dotted-quad notation or as 16-octet in an [RFC5952] 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 administrative groups, as defined in [RFC3630] and [RFC5305], or extended administrative groups, as defined in [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 status 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 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 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 grouping that defines one-way and two-way measured Performance Metrics (PM) and indications of anomalies on links or the path as defined in [RFC7471], [RFC8570], [RFC7823], [RFC7679] and [RFC2681].

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

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

explicit-route-hop-with-srlg: A grouping that augments the 'explicit-route-hop' to specify also SRLG hops.

encoding-and-switching-type: A grouping that defines 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 identity for supported protection types that a backup or bypass tunnel can provide as defined in [RFC4090].

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

bandwidth-profile-type: A base identity for various bandwidth profiles, also known as traffic profiles in Section 2.3.2 of [RFC2475], that may be used to specify the temporal properties of a packet stream (e.g., MPLS-TE LSPs), e.g., as specified in [MEF_10.3], [RFC2697] and [RFC2698].

3.2.2. Data Types

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

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 grouping that contains the generic performance metrics and additional packet-specific metrics.

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

te-packet-path-bandwidth: A 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 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 the following modules:

* "ietf-yang-types" and "ietf-inet-types" as defined in [RFC9911]

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

* "ietf-network" and "ietf-network-topology" as defined in [RFC8345]

In addition to importing [RFC9911] and [RFC8294], this module references the following documents in defining its types and groupings: [RFC9522], [RFC4090], [RFC4202], [RFC4328], [RFC4561], [RFC4657], [RFC4736], [RFC6004], [RFC6378], [RFC6511], [RFC7139], [RFC7271], [RFC7308], [RFC7551], [RFC7571], [RFC7579], and [ISOIEC_9899]. Importantly, even where the definition of a type or grouping references a technology-specific document, this does not preclude its use for other technologies.

```
<CODE BEGINS> file "ietf-te-types@2026-05-08.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 9911: Common YANG Data Types, Section 4";
  }
  import ietf-yang-types {
    prefix yang;
    reference
      "RFC 9911: Common YANG Data Types, Section 3";
  }
  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
               <mailto:tsaad.net@gmail.com>

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

     Editor:   Vishnu Pavan Beeram
               <mailto:vishnupavan.ietf@gmail.com>
```

```
        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 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.

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

         All revisions of IETF published modules can be found
         at the YANG Parameters registry group
         (https://www.iana.org/assignments/yang-parameters).

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

      revision 2026-05-08 {
        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";
    }
    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
      "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
          "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.";
    reference
      "RFC 4202: Routing Extensions in Support of Generalized
                 Multi-Protocol Label Switching (GMPLS),
                 section 2.2
       RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description, section 7";
  }

  identity link-protection-unprotected {
    base link-protection-type;
    description
      "'Unprotected' link protection type.";
    reference
      "RFC 4202: Routing Extensions in Support of Generalized
                 Multi-Protocol Label Switching (GMPLS),
                 section 2.2
       RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description, section 7";
  }

  identity link-protection-extra-traffic {
    base link-protection-type;
    description
      "'Extra-Traffic' link protection type.";
    reference
      "RFC 4202: Routing Extensions in Support of Generalized
                 Multi-Protocol Label Switching (GMPLS),
                 section 2.2
       RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description, section 7";
  }

  identity link-protection-shared {
    base link-protection-type;
    description
      "'Shared' link protection type.";
    reference
      "RFC 4202: Routing Extensions in Support of Generalized
                 Multi-Protocol Label Switching (GMPLS),
                 section 2.2
       RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                 Signaling Functional Description, section 7";
  }

  identity link-protection-1-for-1 {
```

```
      base link-protection-type;
      description
        "'Dedicated 1:1' link protection type.";
      reference
        "RFC 4202: Routing Extensions in Support of Generalized
                   Multi-Protocol Label Switching (GMPLS),
                   section 2.2
         RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description, section 7";
    }

    identity link-protection-1-plus-1 {
      base link-protection-type;
      description
        "'Dedicated 1+1' link protection type.";
      reference
        "RFC 4202: Routing Extensions in Support of Generalized
                   Multi-Protocol Label Switching (GMPLS),
                   section 2.2
         RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description, section 7";
    }

    identity link-protection-enhanced {
      base link-protection-type;
      description
        "'Enhanced' link protection type.";
      reference
        "RFC 4202: Routing Extensions in Support of Generalized
                   Multi-Protocol Label Switching (GMPLS),
                   section 2.2
         RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
                   Signaling Functional Description, section 7";
    }

    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, section 11";
  }

  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
       precomputed 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, section 11";
  }
```

```
  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, section 8";
  }

  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' or
       'restoration-scheme-precomputed' identity SHOULD be used
       instead.";
    reference
      "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                 Generalized Multi-Protocol Label Switching (GMPLS)
                 Recovery, section 11";
  }
```

```
    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-presignaled' identity SHOULD be used
         instead.";
      reference
        "RFC 4872: RSVP-TE Extensions in Support of End-to-End
                   Generalized Multi-Protocol Label Switching (GMPLS)
                   Recovery, section 8";
    }

    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, section 7.3";
    }

    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, section 7";
    }

    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, section 5";
    }

    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, section 6";
    }

    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, section 7";
    }

    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.";
    reference
      "RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels,
                 Section 4.3.2
       RFC 5440: Path Computation Element (PCE) Communication
                 Protocol (PCEP), Section 7.12
       RFC 7896: Update to the Include Route Object (IRO)
                 Specification in the Path Computation Element
                 Communication Protocol (PCEP)";
  }

  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-29,
                                Sections 4.5.1 and 4.5.2";
    }

    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, as defined in
         ISO/IEC 9899:

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

         For the packet-switching type, the string encoding MUST 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
        "ISO/IEC 9899:2024: Information Technology - Programming
                            Languages - C, Section 6.4.4.2
         RFC 8294: Common YANG Data Types for the Routing Area";
    }

    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
        "The access types 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, also known as Unidirectional Link
           Delay.";
        reference
          "RFC 7679: A One-Way Delay Metric for IP Performance
                     Metrics (IPPM)";
      }
      leaf one-way-delay-normality {
        type te-types:performance-metrics-normality;
        description
          "The normality of the 'one-way-delay' metric.";
        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";
      }
    }

    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.";
      leaf two-way-delay {
        type uint32 {
          range "0..16777215";
        }
        units "microseconds";
        description
          "Two-way delay or latency, also known as Roudn-trip Delay.";
        reference
          "RFC 2681: A Round-trip Delay Metric for IPPM";
      }
      leaf two-way-delay-normality {
        type te-types:performance-metrics-normality;
        description
          "The normality of the 'two-way-delay' metric.";
        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";
      }
    }

    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.";
        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";
          default "0";
          description
            "One-way delay or latency, also known as Unidirectional Link
             Delay.";
          reference
            "RFC 7679: A One-Way Delay Metric for IP Performance
                       Metrics (IPPM)";
        }
        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.";
        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";
          default "0";
          description
            "Two-way delay or latency, also known as Roudn-trip Delay.";
          reference
            "RFC 2681: A Round-trip Delay Metric for IPPM";
        }
      }

      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
              "Autonomous System (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 {
            refine "type/numbered-node-hop/numbered-node-hop"
                 + "/hop-type" {
              must '. = "strict"' {
                description
                  "Loose hops can only be used for 'include' route
                   objects.";
                reference
                  "RFC 4874: Exclude Routes - Extension to Resource
                             ReserVation Protocol-Traffic Engineering
                             (RSVP-TE), Section 3.1";
              }
```

```
            }
          }
        }
        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 {
            refine "type/numbered-node-hop/numbered-node-hop"
                 + "/hop-type" {
              must '(. = "strict") or '
                 + 'derived-from-or-self(../../explicit-route-usage,'
                 + '"te-types:route-include-object")' {
                description
                  "Loose hops can only be used for 'include' route
                   objects.";
                reference
                  "RFC 4874: Exclude Routes - Extension to Resource
                             ReserVation Protocol-Traffic Engineering
                             (RSVP-TE), Section 3.1";
              }
            }
          }
        }
      }
```

```
    }

    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 a 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 the following modules:

* "ietf-yang-types" as defined in [RFC9911]

* "ietf-te-types" as defined in Section 4 of this document

<CODE BEGINS> file "ietf-te-packet-types@2026-05-08.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 9911: Common YANG Data Types";
  }
  import ietf-te-types {
    prefix te-types;
    reference
      "RFC XXXX: Common YANG Data Types for Traffic Engineering";
  }

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

     Editor:   Tarek Saad
               <mailto:tsaad.net@gmail.com>

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

     Editor:   Vishnu Pavan Beeram
               <mailto:vishnupavan.ietf@gmail.com>

     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 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) 2026 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).

      All revisions of IETF published modules can be found
      at the YANG Parameters registry group
      (https://www.iana.org/assignments/yang-parameters).

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

    revision 2026-05-08 {
      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";
    }
    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:path-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.";
      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 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 "percent";
            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 "percent";
            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 "percent";
        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 "percent";
          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, also known as
       traffic profiles in RFC 2475, that may be used to specify the
       temporal properties of a packet stream (e.g., MPLS-TE LSPs),
       e.g., as specified in MEF 10, RFC 2697 or RFC 2698.";
    reference
      "RFC 2475: An Architecture for Differentiated Services
       MEF 10.3: Ethernet Services Attributes Phase 3
       RFC 2697: A Single Rate Three Color Marker
       RFC 2698: A Two Rate Three Color Marker";
    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][RFC9890] 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 [RFC9907].

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 YANG-based management protocols (1) have to use a secure transport layer (e.g., SSH [RFC4252], TLS [RFC8446], and QUIC [RFC9000]) and (2) 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

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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.

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.

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:

* node-id or node-id-uri;

* 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:

* node-id or node-id-uri;

* 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 has 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 data models since this grouping has not yet been used by any YANG data 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 has 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 (the 'svec-of-minimize-agg-bandwidth-consumption' identity should be used instead);

* of-minimize-load-most-loaded-link (the 'svec-of-minimize-load-most-loaded-link' identity should be used instead);

* of-minimize-cost-path-set (the 'svec-of-minimize-cost-path-set' identity should be used instead);

* lsp-protection-reroute-extra (the 'restoration-scheme-rerouting' identity should be used instead);

* lsp-protection-reroute (the 'restoration-scheme-rerouting' identity should be used instead).

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Contributors

Vishnu Pavan Beeram
HPE
Email: vishnupavan.ietf@gmail.com

Rakesh Gandhi
Cisco Systems, Inc.
Email: rgandhi@cisco.com

Authors' Addresses

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

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

Xufeng Liu
Individual
Email: xufeng.liu.ietf@gmail.com

Tarek Saad
Cisco Systems Inc.
Email: tsaad.net@gmail.com

Igor Bryskin
Individual
Email: i_bryskin@yahoo.com