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Updated Common YANG Data Types for Traffic Engineering

Abstract

This document defines few additional common data types, identities, and groupings in YANG data modeling language to be imported by modules that model Traffic Engineering (TE) configuration and state capabilities.

Editors' note: Copy the text from [[RFC8776](#)] and merge it with the content of this section before WG LC if the RFC8876-bis approach is confirmed.

This document updates RFC 8776 with a new revision of the module ietf-te-types.

Status of This Memo

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1. Introduction

After the publication of [[RFC8776](#)], few additional common data types, identities, and groupings have been defined. Given their broad applicability this document defines them as part of the revised ietf-te-types YANG model.

Editors' note: Copy the text from [[RFC8776](#)] and merge it with the content of this section before WG LC if the RFC8876-bis approach is confirmed.

CHANGE NOTE: These definitions have been developed in [[I-D.ietf-teas-yang-te](#)], [[I-D.ietf-teas-yang-path-computation](#)] and [[I-D.ietf-teas-yang-l3-te-topo](#)] and are quite mature: [[I-D.ietf-teas-yang-te](#)] and [[I-D.ietf-teas-yang-path-computation](#)] in particular are in WG Last Call and some definitions have been moved to this document as part of WG LC comments resolution.

RFC Editor: remove the CHANGE NOTE above and this note

1.1. Requirements Notation

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.

1.2. Terminology

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

1.3. Prefixes in Data Node Names

In this document, names of data nodes and other data model objects are prefixed using the standard prefix associated with the corresponding YANG imported modules, as shown in [Table 1](#).

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

Table 1: Prefixes and corresponding YANG modules

RFC Editor Note: Please replace XXXX with the RFC number assigned to this document.

2. Acronyms and Abbreviations

Editors' note: Copy the text from [[RFC8776](#)] before WG LC if the RFC8876-bis approach is confirmed.

3. Overview

3.1. TE Types Module Contents

Editors' note: Copy the text from [\[RFC8776\]](#) and merge it with the content of this section before WG LC if the RFC8876-bis approach is confirmed.

The module `ietf-te-types` updates the following YANG identities defined in [\[RFC8776\]](#):

`association-type`:

A base YANG identity for supported LSP association types as defined in [\[RFC6780\]](#), [\[RFC4872\]](#), [\[RFC4873\]](#) and [\[RFC8800\]](#)

`objective-function-type`:

A base YANG identity for supported path objective functions, as defined in [\[RFC5541\]](#).

CHANGE NOTE: The `association-type-diversity` identity, defined in [\[RFC8800\]](#) has been added to the `association-type` base identity. The `of-minimize-agg-bandwidth-consumption`, `of-minimize-load-most-loaded-link` and `of-minimize-cost-path-set`, defined in [\[RFC5541\]](#), have been obsoleted because not applicable to paths but to Synchronization VECTOR (SVEC) objects.

RFC Editor: remove the CHANGE NOTE above and this note

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

`bandwidth-scientific-notation`:

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

`lsp-provisioning-error-reason`:

A base YANG identity for reporting LSP provisioning error reasons. No standard LPS provisioning error reasons are defined in this document.

`identity path-computation-error-reason`:

A base YANG identity for reporting path computation error reasons, as defined in [\[RFC5440\]](#), [\[RFC5441\]](#), [\[RFC5520\]](#), [\[RFC5557\]](#), [\[RFC8306\]](#) and [\[RFC8685\]](#).

Editors' Note: how to describe the path computation error reasons defined in this document?

tunnel-actions-type:

A base YANG identity for tunnel actions.

Editors' Note: check whether standard tunnel actions should be defined in this document or not.

protocol-origin-type:

A base YANG identity for the type of protocol origin, as defined in [[RFC5440](#)] and [[RFC5512](#)].

Editors' Note: how to describe the protocol origin types defined in this document?

svec-objective-function-type:

A base YANG identity for supported SVEC objective functions, as defined in [[RFC5541](#)] and [[RFC8685](#)].

svec-metric-type:

A base YANG identity for supported SVEC objective functions, as defined in [[RFC5541](#)].

encoding-and-switching-type:

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

Editors' Note: how to describe the tunnel-admin-auto, which is defined in this document as derived from tunnel-admin-status-type base identity?

3.2. Packet TE Types Module Contents

Editors' note: Copy the text from [[RFC8776](#)] before WG LC if the RFC8876-bis approach is confirmed.

4. TE Types YANG Module

Editors' note: Copy the text from [[RFC8776](#)] and merge it with the content of this section before WG LC if the RFC8876-bis approach is confirmed.

This section provides the updated revision of the "ietf-te-types" YANG module.

CHANGE NOTE: Please focus your review only on the updates to the YANG model: see also [Appendix A.1](#).

RFC Editor: remove the CHANGE NOTE above and this note

```
<CODE BEGINS> file "ietf-te-types@2022-10-21.yang"

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

  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-yang-types {
    prefix yang;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }

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

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

The key words 'MUST', 'MUST NOT', 'REQUIRED', 'SHALL', 'SHALL NOT', 'SHOULD', 'SHOULD NOT', 'RECOMMENDED', 'NOT RECOMMENDED', 'MAY', and 'OPTIONAL' in this document are to be interpreted as described in BCP 14 (RFC 2119) (RFC 8174) when, and only when, they appear in all capitals, as shown here.

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

```
revision 2022-10-21 {
  description
    "Added:
    - typedef bandwidth-scientific-notation;
    - base identity lsp-provisioning-error-reason;
    - identity association-type-diversity;
    - identity tunnel-admin-auto;
    - base identity path-computation-error-reason and
      its derived identities;
    - base identity tunnel-actions-type and its derived
      identities;
    - base identity protocol-origin-type and
      its derived identities;
    - base identity svec-objective-function-type and its derived
      identities;
    - base identity svec-metric-type and its derived identities;
    - grouping encoding-and-switching-type.

    Updated:
    - description of the base identity objective-function-type.

    Obsoleted:
    - identity of-minimize-agg-bandwidth-consumption
    - identity of-minimize-load-most-loaded-link
    - identity of-minimize-cost-path-set";
  reference
    "RFC XXXX: Updated Common YANG Data Types for Traffic
    Engineering";
}
```



```

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

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

/**
 * 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
    "SRLG type.";
reference
    "RFC 4203: OSPF Extensions in Support of Generalized
    Multi-Protocol Label Switching (GMPLS)
    RFC 5307: IS-IS Extensions in Support of Generalized
    Multi-Protocol Label Switching (GMPLS)";
}

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

typedef te-bandwidth {
    type string {

```

```

pattern '0[xX](0((\.0?)?[pP](\+)?0?|(\.0?))|'
+ '1(\.([\da-fA-F]{0,5}[02468aAcCeE]?))?'
+ '[pP](\+)?(12[0-7]|'
+ '1[01]\d|0?\d?\d)?|0[xX][\da-fA-F]{1,8}|\d+'
+ '(, (0[xX](0((\.0?)?[pP](\+)?0?|(\.0?))|'
+ '1(\.([\da-fA-F]{0,5}[02468aAcCeE]?))?'
+ '[pP](\+)?(12[0-7]|'
+ '1[01]\d|0?\d?\d)?|0[xX][\da-fA-F]{1,8}|\d+))*';
}
description
  "This is the generic bandwidth type. It is a string containing
  a list of numbers separated by commas, where each of these
  numbers can be non-negative decimal, hex integer, or
  hex float:

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

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

  For the Optical Transport Network (OTN) switching type,
  a list of integers can be used, such as '0,2,3,1', indicating
  two ODU0s and one ODU3. ('ODU' stands for 'Optical Data
  Unit'.) For Dense Wavelength Division Multiplexing (DWDM),
  a list of pairs of slot numbers and widths can be used,
  such as '0,2,3,3', indicating a frequency slot 0 with
  slot width 2 and a frequency slot 3 with slot width 3.
  Canonically, the string is represented as all lowercase and in
  hex, where the prefix '0x' precedes the hex number.";
reference
  "RFC 8294: Common YANG Data Types for the Routing Area
  ITU-T Recommendation G.709: Interfaces for the
  optical transport network";
}

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

typedef te-global-id {
  type uint32;
}

```

```

description
  "An identifier to uniquely identify an operator, which can be
   either a provider or a client.
   The definition of this type is taken from RFCs 6370 and 5003.
   This attribute type is used solely to provide a globally
   unique context for TE topologies.";
reference
  "RFC 5003: Attachment Individual Identifier (AII) Types for
   Aggregation
   RFC 6370: MPLS Transport Profile (MPLS-TP) Identifiers";
}

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

typedef te-link-access-type {
  type enumeration {
    enum point-to-point {
      description
        "The link is point-to-point.";
    }
    enum multi-access {
      description
        "The link is multi-access, including broadcast and NBMA.";
    }
  }
}
description
  "Defines a type representing the access type of a TE link.";
reference
  "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
   Version 2";
}

typedef te-label-direction {

```

```

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

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

typedef te-metric {
  type uint32;
  description
    "TE metric.";
  reference
    "RFC 3785: Use of Interior Gateway Protocol (IGP) Metric as a
    second MPLS Traffic Engineering (TE) Metric";
}

typedef te-node-id {
  type yang:dotted-quad;
  description
    "A type representing the identifier for a node in a TE
    topology.
    The identifier is represented as 4 octets in dotted-quad
    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, or the TE Router ID TLV described in Section 3.2.1 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
                "SRLG (Shared Risk Link Group) 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 4427: Recovery (Protection and Restoration) Terminology
        for Generalized Multi-Protocol Label Switching (GMPLS)
        RFC 6378: MPLS Transport Profile (MPLS-TP) Linear Protection";
    }

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";
}

// NOTE: The typedef bandwidth-scientific-notation below has been
// added in this module revision
// RFC Editor: remove the note above and this note
typedef bandwidth-scientific-notation {
  type string {
    pattern
      '0(\.0?)?([eE](\+)?0?)?|'
      + '[1-9](\.[0-9]{0,6})?[eE](\+)?(9[0-6]|[1-8][0-9]|0?[0-9])?';
  }
}

```

```

units "bps";
description
    "Bandwidth values, expressed using the scientific notation
    in bits per second.
    The encoding format is the external decimal-significant
    character sequences specified in IEEE 754 and ISO/IEC C99
    for 32-bit decimal floating-point numbers:
    (-1)**(S) * 10**(Exponent) * (Significant),
    where Significant uses 7 digits.
    An implementation for this representation may use decimal32
    or binary32. The range of the Exponent is from -95 to +96
    for decimal32, and from -38 to +38 for binary32.
    As a bandwidth value, the format is restricted to be
    normalized, non-negative, and non-fraction:
    n.dddddde{+}dd, N.DDDDDDE{+}DD, 0e0 or 0E0,
    where 'd' and 'D' are decimal digits; 'n' and 'N' are
    non-zero decimal digits; 'e' and 'E' indicate a power of ten.
    Some examples are 0e0, 1e10, and 9.953e9.";
reference
    "IEEE Std 754-2008: IEEE Standard for Floating-Point
    Arithmetic.
    ISO/IEC C99: Information technology - Programming
    Languages - C.";
}

/* TE 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 SRLG groups.";
}

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
 */

// NOTE: The base identity lsp-provisioning-error-reason has been
// added in this module revision
// RFC Editor: remove the note above and this note
identity lsp-provisioning-error-reason {
    description
        "Base identity for LSP provisioning errors.";
}

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

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

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

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

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

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

identity path-reevaluation-request {
  base session-attributes-flags;
  description
    "This flag indicates that a path re-evaluation (of the
    current path in use) is requested. Note that this does
    not trigger any LSP reroutes but instead just signals a
```

```

        request to evaluate whether a preferable path exists.";
reference
    "RFC 4736: Reoptimization of Multiprotocol Label Switching
    (MPLS) Traffic Engineering (TE) Loosely Routed Label Switched
    Path (LSP)";
}

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

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

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

identity boundary-rerouting-desired {
    base lsp-attributes-flags;
description
    "Indicates boundary rerouting behavior for an LSP undergoing
    establishment. This MAY also be used to specify
    segment-based LSP recovery through nested crankback for
    established LSPs. The boundary Area Border Router (ABR) /
    Autonomous System Border Router (ASBR) can decide to forward
    the PathErr message upstream to either an upstream boundary
    ABR/ASBR or the ingress LSR. Alternatively, it can try to
    select another egress boundary LSR.";
reference

```

```
    "RFC 4920: Crankback Signaling Extensions for MPLS and GMPLS
    RSVP-TE
    RFC 5420: Encoding of Attributes for MPLS LSP Establishment
    Using Resource Reservation Protocol Traffic Engineering
    (RSVP-TE)
    RFC 7570: Label Switched Path (LSP) Attribute in the Explicit
    Route Object (ERO)";
}
```

```
identity segment-based-rerouting-desired {
    base lsp-attributes-flags;
    description
        "Indicates segment-based rerouting behavior for an LSP
        undergoing establishment. This MAY also be used to specify
        segment-based LSP recovery for established LSPs.";
    reference
        "RFC 4920: Crankback Signaling Extensions for MPLS and GMPLS
        RSVP-TE
        RFC 5420: Encoding of Attributes for MPLS LSP Establishment
        Using Resource Reservation Protocol Traffic Engineering
        (RSVP-TE)
        RFC 7570: Label Switched Path (LSP) Attribute in the Explicit
        Route Object (ERO)";
}
```

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

```
identity contiguous-lsp-desired {
    base lsp-attributes-flags;
    description
        "Indicates that a contiguous LSP is desired.";
    reference
        "RFC 5151: Inter-Domain MPLS and GMPLS Traffic Engineering --
        Resource Reservation Protocol-Traffic Engineering (RSVP-TE)
        Extensions
        RFC 7570: Label Switched Path (LSP) Attribute in the Explicit
        Route Object (ERO)";
}
```

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

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

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

```
identity oob-mapping-flag {
  base lsp-attributes-flags;
  description
    "Indicates that signaling of the egress binding information is
    out of band (e.g., via the Border Gateway Protocol (BGP)).";
  reference
    "RFC 6511: Non-Penultimate Hop Popping Behavior and Out-of-Band
    Mapping for RSVP-TE Label Switched Paths
    RFC 7570: Label Switched Path (LSP) Attribute in the Explicit
    Route Object (ERO)";
}
```

```
identity entropy-label-capability {
  base lsp-attributes-flags;
```



```

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

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

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

identity srlg-collection-desired {
  base lsp-attributes-flags;
  description
    "SRLG collection desired.";
  reference
    "RFC 7570: Label Switched Path (LSP) Attribute in the Explicit
    Route Object (ERO)
    RFC 8001: RSVP-TE Extensions for Collecting Shared Risk
    Link Group (SRLG) Information";
}

identity loopback-desired {
  base lsp-attributes-flags;
  description
    "This flag indicates that a particular node on the LSP is
    required to enter loopback mode. This can also be
    used to specify the loopback state of the node.";
  reference
    "RFC 7571: GMPLS RSVP-TE Extensions for Lock Instruct and
    Loopback";
}

```

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

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

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

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

identity link-protection-extra-traffic {
  base link-protection-type;
  description
    "Extra-Traffic protected link type.";
  reference
    "RFC 4427: Recovery (Protection and Restoration) Terminology
    for Generalized Multi-Protocol Label Switching (GMPLS)";
}

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

```

}

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

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

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

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

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

identity association-type-resource-sharing {
  base association-type;
  description
    "Association type for resource sharing, used to enable
      resource sharing during make-before-break.";
  reference

```

```

    "RFC 4873: GMPLS Segment Recovery
    RFC 6780: RSVP ASSOCIATION Object Extensions";
}

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

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

// NOTE: The identity association-type-diversity below has been
// added in this module revision
// RFC Editor: remove the note above and this note
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
        "RFC8800: Path Computation Element Communication Protocol
        (PCEP) Extension for Label Switched Path (LSP) Diversity
        Constraint Signaling";
}

// NOTE: The description of the base identity
// objective-function-type has been updated
// in this module revision
// RFC Editor: remove the note above and this note
identity objective-function-type {
    description
        "Base identity for path objective function type.";
}

```

```

}

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)";
}

// NOTE: The identity of-minimize-agg-bandwidth-consumption
// below has been obsoleted in this module revision
// RFC Editor: remove the note above and this note
identity of-minimize-agg-bandwidth-consumption {
    base objective-function-type;
    status obsolete;
    description
        "Objective function for minimizing aggregate bandwidth
        consumption.";
    reference
        "RFC 5541: Encoding of Objective Functions in the Path
        Computation Element Communication Protocol (PCEP)";
}

// NOTE: The identity of-minimize-load-most-loaded-link
// below has been obsoleted in this module revision
// RFC Editor: remove the note above and this note
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.";
reference
  "RFC 5541: Encoding of Objective Functions in the Path
  Computation Element Communication Protocol (PCEP)";
}

// NOTE: The identity of-minimize-cost-path-set
// below has been obsoleted in this module revision
// RFC Editor: remove the note above and this note
identity of-minimize-cost-path-set {
  base objective-function-type;
  status obsolete;
  description
    "Objective function for minimizing the cost on a path set.";
  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 3272: Overview and Principles of Internet Traffic
    Engineering, Section 5.4";
}

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 3272: 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 3272: 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.";
}

// NOTE: The identity tunnel-admin-auto below has been
// added in this module revision
// RFC Editor: remove the note above and this note
```

```
identity tunnel-admin-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-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-preconfigured {
  base restoration-scheme-type;
  description
    "Restoration LSP is preconfigured prior to the failure.";
  reference
    "RFC 4427: Recovery (Protection and Restoration) Terminology
    for Generalized Multi-Protocol Label Switching (GMPLS)";
}

identity restoration-scheme-precomputed {
  base restoration-scheme-type;
  description
    "Restoration LSP is precomputed prior to the failure.";
  reference
    "RFC 4427: Recovery (Protection and Restoration) Terminology
    for Generalized Multi-Protocol Label Switching (GMPLS)";
}
```

```

identity restoration-scheme-presignaled {
  base restoration-scheme-type;
  description
    "Restoration LSP is presignaled prior to the failure.";
  reference
    "RFC 4427: Recovery (Protection and Restoration) Terminology
    for Generalized Multi-Protocol Label Switching (GMPLS)";
}

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;
  description
    "'(Full) Rerouting' 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 {
  base lsp-protection-type;
  description
    "'Rerouting without Extra-Traffic' LSP protection type.";
  reference
    "RFC 4872: RSVP-TE Extensions in Support of End-to-End
    Generalized Multi-Protocol Label Switching (GMPLS) Recovery";
}

identity lsp-protection-1-for-n {
  base lsp-protection-type;
  description
    "'1:N Protection with Extra-Traffic' LSP protection type.";
}

```

```

reference
  "RFC 4872: RSVP-TE Extensions in Support of End-to-End
    Generalized Multi-Protocol Label Switching (GMPLS) Recovery";
}

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

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

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

identity lsp-protection-extra-traffic {
  base lsp-protection-type;
  description
    "Extra-Traffic LSP protection type.";
  reference
    "RFC 4427: Recovery (Protection and Restoration) Terminology
      for Generalized Multi-Protocol Label Switching (GMPLS)";
}

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

identity normal {
  base lsp-protection-state;
  description

```

```
    "Normal state.";
}

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 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 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 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 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 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 4427: Recovery (Protection and Restoration) Terminology
        for Generalized Multi-Protocol Label Switching (GMPLS)";
}

identity wait-to-restore {
    base lsp-protection-state;
    description
        "A WTR timer is running.";
    reference
        "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 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 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 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 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 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 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 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 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 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 APS communication  
    is operating correctly. It is of lower priority than any  
    other state or command."  
  reference  
    "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, WTR state,  
    or exercise command."  
  reference  
    "RFC 4427: Recovery (Protection and Restoration) Terminology  
    for Generalized Multi-Protocol Label Switching (GMPLS)";  
}
```

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

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

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

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

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

identity switching-otn {
  base switching-capabilities;
  description
    "OTN-TDM capable.";
  reference
```

```

    "RFC 7138: Traffic Engineering Extensions to OSPF for GMPLS
    Control of Evolving G.709 Optical Transport Networks";
}

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

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

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

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

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

identity lsp-encoding-ethernet {

```

```

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

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

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

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

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

identity lsp-encoding-fiber {
  base lsp-encoding-types;
  description
    "Fiber LSP encoding.";
  reference

```

```

    "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
    Signaling Functional Description";
}

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

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

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

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

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

identity path-setup-static {

```

```
    base path-signaling-type;
    description
        "Static LSP provisioning path setup.";
}

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

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

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

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

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

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

identity route-include-object {
    base route-usage-type;
    description
```

```

    "'Include route' object.";
}

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

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

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

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

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

identity path-metric-hop {
    base path-metric-type;
    description
        "Hop path metric.";
}

```



```
identity path-metric-delay-average {
  base path-metric-type;
  description
    "Average unidirectional link delay.";
  reference
    "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions";
}
```

```
identity path-metric-delay-minimum {
  base path-metric-type;
  description
    "Minimum unidirectional link delay.";
  reference
    "RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions";
}
```

```
identity path-metric-residual-bandwidth {
  base path-metric-type;
  description
    "Unidirectional Residual Bandwidth, which is defined to be
    Maximum Bandwidth (RFC 3630) minus the bandwidth currently
    allocated to LSPs.";
  reference
    "RFC 3630: Traffic Engineering (TE) Extensions to OSPF
    Version 2
    RFC 7471: OSPF Traffic Engineering (TE) Metric Extensions";
}
```

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

```
identity path-metric-optimize-excludes {
  base path-metric-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.";
}

identity path-tiebreaker-maxfill {
  base path-tiebreaker-type;
  description
    "Max-Fill LSP path placement.";
}

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 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 2702: Requirements for Traffic Engineering Over MPLS
    RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels";
}

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 2702: Requirements for Traffic Engineering Over MPLS
    RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels";
}

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 2702: Requirements for Traffic Engineering Over MPLS
    RFC 3209: RSVP-TE: Extensions to RSVP for LSP Tunnels";
}

identity te-optimization-criterion {
    description
        "Base identity for the TE optimization criteria.";
reference
    "RFC 3272: 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 SRLG path computation.";
}

identity srlg-ignore {
    base path-computation-srlg-type;
    description
        "Ignores SRLGs in the path computation.";
}

```

```

identity srlg-strict {
    base path-computation-srlg-type;
    description
        "Includes a strict SRLG check in the path computation.";
}

identity srlg-preferred {
    base path-computation-srlg-type;
    description
        "Includes a preferred SRLG check in the path computation.";
}

identity srlg-weighted {
    base path-computation-srlg-type;
    description
        "Includes a weighted SRLG check in the path computation.";
}

// NOTE: The base identity path-computation-error-reason and
// its derived identities below have been
// added in this module revision
// RFC Editor: remove the note above and this note
identity path-computation-error-reason {
    description
        "Base identity for path computation error reasons.";
}

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
        "RFC5441, RFC8685";
}

identity path-computation-error-pce-unavailable {
    base path-computation-error-reason;

```

```
description
  "Path computation has failed because PCE is not available.";
reference
  "RFC5440";
}

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.";
  reference
    "RFC8685";
}

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.";
  reference
    "RFC8685";
}

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.";
  reference
    "RFC8685";
}

identity path-computation-error-child-pce-unresponsive {
  base path-computation-error-reason;
  description
    "Path computation has failed because child PCE is not
    responsive.";
  reference
    "RFC8685";
}

identity path-computation-error-destination-domain-unknown {
  base path-computation-error-reason;
  description
    "Path computation has failed because the destination domain
    was unknown.";
  reference
    "RFC8685";
}
```

```
}
```

```
identity path-computation-error-p2mp {  
  base path-computation-error-reason;  
  description  
    "Path computation has failed because of P2MP reachability  
    problem.";  
  reference  
    "RFC8306";  
}
```

```
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.";  
  reference  
    "RFC5557";  
}
```

```
identity path-computation-error-no-gco-solution {  
  base path-computation-error-reason;  
  description  
    "Path computation has failed because of no GCO solution  
    found.";  
  reference  
    "RFC5557";  
}
```

```
identity path-computation-error-path-not-found {  
  base path-computation-error-reason;  
  description  
    "Path computation no path found error reason.";  
  reference  
    "RFC5440";  
}
```

```
identity path-computation-error-pks-expansion {  
  base path-computation-error-reason;  
  description  
    "Path computation has failed because of Path-Key Subobject  
    (PKS) expansion failure.";  
  reference  
    "RFC5520";  
}
```

```
identity path-computation-error-brpc-chain-unavailable {  
  base path-computation-error-reason;  
  description
```

```

        "Path computation has failed because PCE BRPC chain
        unavailable.";
    reference
        "RFC5441";
}

identity path-computation-error-source-unknown {
    base path-computation-error-reason;
    description
        "Path computation has failed because source node is
        unknown.";
    reference
        "RFC5440";
}

identity path-computation-error-destination-unknown {
    base path-computation-error-reason;
    description
        "Path computation has failed because destination node is
        unknown.";
    reference
        "RFC5440";
}

identity path-computation-error-no-server {
    base path-computation-error-reason;
    description
        "Path computation has failed because path computation
        server is unavailable.";
    reference
        "RFC5440";
}

// NOTE: The base identity tunnel-actions-type and
// its derived identities below have been
// added in this module revision
// RFC Editor: remove the note above and this note
identity tunnel-actions-type {
    description
        "TE tunnel actions type.";
}

// NOTE: The base identity protocol-origin-type and
// its derived identities below have been
// added in this module revision
// RFC Editor: remove the note above and this note
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 Programmable Interface
        (API).";
}

identity protocol-origin-pcep {
    base protocol-origin-type;
    description
        "Protocol origin is Path Computation Engine Protocol
        (PCEP).";
    reference "RFC5440";
}

identity protocol-origin-bgp {
    base protocol-origin-type;
    description
        "Protocol origin is Border Gateway Protocol (BGP).";
    reference "RFC5512";
}

// NOTE: The base identity svec-objective-function-type and
// its derived identities below have been
// added in this module revision
// RFC Editor: remove the note above and this note
identity svec-objective-function-type {
    description
        "Base identity for SVEC objective function type.";
    reference
        "RFC5541: 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
        "RFC5541: 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
    "RFC5541: 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
    "RFC5541: 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
    "RFC8685: 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
    "RFC8685: 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
    "RFC8685: 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
    "RFC8685: Path Computation Element Communication Protocol
    (PCEP) Extensions for the Hierarchical Path Computation
    Element (H-PCE) Architecture.";
}

// NOTE: The base identity svec-metric-type and
// its derived identities below have been
// added in this module revision
// RFC Editor: remove the note above and this note
identity svec-metric-type {
  description
    "Base identity for SVEC metric type.";
  reference
    "RFC5541: Encoding of Objective Functions in the Path
    Computation Element Communication Protocol (PCEP).";
}

identity svec-metric-cumul-te {
  base svec-metric-type;
  description
    "Cumulative TE cost.";
  reference
    "RFC5541: Encoding of Objective Functions in the Path
    Computation Element Communication Protocol (PCEP).";
}

identity svec-metric-cumul-igp {
  base svec-metric-type;
  description
    "Cumulative IGP cost.";
  reference
    "RFC5541: Encoding of Objective Functions in the Path
    Computation Element Communication Protocol (PCEP).";
}

identity svec-metric-cumul-hop {
  base svec-metric-type;
  description
    "Cumulative Hop path metric.";
  reference
    "RFC5541: 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
    "RFC5541: 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
    "RFC5541: Encoding of Objective Functions in the Path
    Computation Element Communication Protocol (PCEP).";
}

/**
 * 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 7823: Performance-Based Path Selection for Explicitly
        Routed Label Switched Paths (LSPs) Using TE Metric
        Extensions
        RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions";
    leaf one-way-delay {
        type uint32 {
            range "0..16777215";
        }
        description
            "One-way delay or latency in microseconds.";
    }
    leaf one-way-delay-normality {
        type te-types:performance-metrics-normality;
        description
            "One-way delay normality.";
    }
}

```

```

}

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

```

```

grouping performance-metrics-one-way-bandwidth {
  description
    "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 7823: Performance-Based Path Selection for Explicitly
    Routed Label Switched Paths (LSPs) Using TE Metric
    Extensions
    RFC 8570: IS-IS Traffic Engineering (TE) Metric Extensions";
  leaf one-way-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 PM throttle grouping.";
    leaf one-way-delay {
        type uint32 {
            range "0..16777215";
        }
    }
}

```

```

    default "0";
    description
        "One-way delay or latency in microseconds.";
}
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 PM throttle grouping.";
    leaf two-way-delay {
        type uint32 {
            range "0..16777215";
        }
        default "0";
        description
            "Two-way delay or latency in microseconds.";
    }
}

```



```

    }
}

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

```

```

container threshold-in {
  uses performance-metrics-thresholds;
  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.";
}
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 {
        leaf node-id {
          type te-node-id;
          mandatory true;
          description
            "The identifier of a node in the TE topology.";
        }
        leaf hop-type {
          type te-hop-type;
          default "strict";
          description
            "Strict or loose hop.";
        }
      }
    }
    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)";
    }
}
case numbered-link-hop {
    container numbered-link-hop {
        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.";
        }
        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)";
    }
}
case unnumbered-link-hop {
    container unnumbered-link-hop {
        leaf link-tp-id {
            type te-tp-id;
            mandatory true;
            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 {
            type te-node-id;
            mandatory true;
            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.";
}
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)";
}
}
case as-number {
    container as-number-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.";
        }
        description
            "AS explicit route hop.";
    }
}
case label {
    container label-hop {
        description
            "Label hop type.";
        uses te-label;
    }
    description
        "The label explicit route hop type.";
}
}
}

```

```

}

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 {
      container numbered-node-hop {
        description
          "Numbered node route hop container.";
        leaf node-id {
          type te-node-id;
          mandatory true;
          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";
        }
      }
    }
    description
      "Numbered node route hop.";
  }
  case numbered-link-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";
    }
  }
  description
    "Numbered link route hop.";
}
case unnumbered-link-hop {
  container unnumbered-link-hop {
    leaf link-tp-id {
      type te-tp-id;
      mandatory true;
      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 {
      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";
  }
  description
    "Unnumbered link Record Route hop.";
  reference
    "RFC 3477: Signalling Unnumbered Links in Resource
    ReSerVation Protocol - Traffic Engineering (RSVP-TE)";
}
description

```

```

        "Unnumbered link route hop.";
    }
    case label {
        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";
            }
        }
    }
    description
        "The label Record Route entry types.";
}
}
}

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 will have to 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'.
    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-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.";
  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-always {
    description
      "Container for the 'exclude route' object list.";
    list route-object-exclude-always {
      key "index";
      ordered-by user;
      description
        "List of route objects to always exclude from the path
        computation.";
      leaf index {
        type uint32;
        description
          "Explicit Route Object index. The index is used to
          identify an entry in the list. The order of entries
          is defined by the user without relying on key values.";
      }
      uses explicit-route-hop;
    }
  }
  list route-object-include-exclude {
    key "index";
    ordered-by user;
    description
      "List of route objects to include or exclude in the path
      computation.";
    leaf explicit-route-usage {
      type identityref {
        base route-usage-type;
      }
      default "te-types:route-include-object";
      description
        "Indicates whether to include or exclude the
        route object. The default is to include it.";
    }
    leaf index {
      type uint32;
      description
        "Route object include-exclude index. The index is used
        to identify an entry in the list. The order of entries
        is defined by the user without relying on key values.";
    }
  }
  uses explicit-route-hop {
    augment "type" {
      case srlg {
        container srlg {
          description

```

```
        "SRLG container.";
        leaf srlg {
            type uint32;
            description
                "SRLG value.";
        }
    }
    description
        "An SRLG value to be included or excluded.";
}
description
    "Augmentation for a generic explicit route for SRLG
    exclusion.";
}
}
}
}
```

```
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 {
  augment "type" {
    case srlg {
      container srlg {
        description
          "SRLG container.";
        leaf srlg {
          type uint32;
          description
            "SRLG value.";
        }
      }
    }
    description
      "An SRLG value to be included or excluded.";
  }
  description
    "Augmentation for a generic explicit route for SRLG
    exclusion.";
}
}
}
}

grouping generic-path-metric-bounds {
  description
    "TE path metric bounds grouping.";
  container path-metric-bounds {
    description
      "TE path metric bounds container.";
    list path-metric-bound {
      key "metric-type";
      description
        "List of TE path metric bounds.";
      leaf metric-type {
        type identityref {
          base 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 end-to-end TE path metric. A zero
        indicates an unbounded upper limit for the specific
        'metric-type'.";
}
}
}
}

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 {
                    description
                        "Container for the list of tiebreakers.";
                    list tiebreaker {
                        key "tiebreaker-type";
                        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;
                            }
                            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.";
      }
    }
  }
}

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";
      leaf name {
        type string;
        description
          "Identifies a named affinity entry.";
      }
      description
        "List of named affinities.";
    }
  }
}

```

```

grouping generic-path-srlgs {
  description
    "Path SRLG grouping.";
  container path-srlgs-lists {
    description
      "Path SRLG properties container.";
    list path-srlgs-list {
      key "usage";
      description
        "List of SRLG values to be included or excluded.";
      leaf usage {
        type identityref {
          base route-usage-type;
        }
        description
          "Identifies an entry in a list of SRLGs to either
          include or exclude.";
      }
      leaf-list values {
        type srlg;
      }
    }
  }
}

```

```

        description
            "List of SRLG values.";
    }
}
}
container path-srlgs-names {
    description
        "Container for the list of named SRLGs.";
    list path-srlgs-name {
        key "usage";
        description
            "List of named SRLGs to be included or excluded.";
        leaf usage {
            type identityref {
                base route-usage-type;
            }
            description
                "Identifies an entry in a list of named SRLGs to either
                include or exclude.";
        }
        leaf-list names {
            type string;
            description
                "List of named 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;
}
}
}
}

// NOTE: The grouping encoding-and-switching-type below has been
// added in this module revision
// RFC Editor: remove the note above and this note
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
            "RFC3945";
    }
    leaf switching-type {
        type identityref {
            base te-types:switching-capabilities;
        }
        description
            "LSP switching type.";
        reference
            "RFC3945";
    }
}
}
}

<CODE ENDS>

```

Figure 1: TE Types YANG module

5. Packet TE Types YANG Module

Editors' note: Copy the text from [[RFC8776](#)] before WG LC if the RFC8876-bis approach is confirmed.

6. IANA Considerations

For the following URIs in the "IETF XML Registry" [[RFC3688](#)], IANA has updated the reference field 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 also adds updated YANG modules to the "YANG Module Names" registry [[RFC7950](#)]:

```
name:      ietf-te-types
namespace: urn:ietf:params:xml:ns:yang:ietf-te-types
prefix:    te-types
reference: RFC XXXX
```

```
name:      ietf-te-packet-types
namespace: urn:ietf:params:xml:ns:yang:ietf-te-packet-types
prefix:    te-packet-types
reference: RFC XXXX
```

RFC Editor Note: Please replace XXXX with the RFC number assigned to this document.

7. Security Considerations

Editors' note: Copy the text from [[RFC8776](#)] before WG LC if the RFC8876-bis approach is confirmed.

The security considerations defined in section 7 of [[RFC8776](#)] applies to the revision of the ietf-te-types YANG module.

This document just adds new typedefs and groupings to the YANG modules defined in [[RFC8776](#)] and therefore it does not introduce additional considerations.

8. References

8.1. Normative References

- [RFC2119]** Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC4872]** Lang, J.P., Ed., Rekhter, Y., Ed., and D. Papadimitriou, Ed., "RSVP-TE Extensions in Support of End-to-End Generalized Multi-Protocol Label Switching (GMPLS) Recovery", RFC 4872, DOI 10.17487/RFC4872, May 2007, <<https://www.rfc-editor.org/info/rfc4872>>.
- [RFC4873]** Berger, L., Bryskin, I., Papadimitriou, D., and A. Farrel, "GMPLS Segment Recovery", RFC 4873, DOI 10.17487/RFC4873, May 2007, <<https://www.rfc-editor.org/info/rfc4873>>.
- [RFC5440]** Vasseur, JP., Ed. and JL. Le Roux, Ed., "Path Computation Element (PCE) Communication Protocol (PCEP)", RFC 5440, DOI 10.17487/RFC5440, March 2009, <<https://www.rfc-editor.org/info/rfc5440>>.
- [RFC5441]** Vasseur, JP., Ed., Zhang, R., Bitar, N., and JL. Le Roux, "A Backward-Recursive PCE-Based Computation (BRPC) Procedure to Compute Shortest Constrained Inter-Domain Traffic Engineering Label Switched Paths", RFC 5441, DOI 10.17487/RFC5441, April 2009, <<https://www.rfc-editor.org/info/rfc5441>>.
- [RFC5512]** Mohapatra, P. and E. Rosen, "The BGP Encapsulation Subsequent Address Family Identifier (SAFI) and the BGP Tunnel Encapsulation Attribute", RFC 5512, DOI 10.17487/RFC5512, April 2009, <<https://www.rfc-editor.org/info/rfc5512>>.
- [RFC5520]** Bradford, R., Ed., Vasseur, JP., and A. Farrel, "Preserving Topology Confidentiality in Inter-Domain Path Computation Using a Path-Key-Based Mechanism", RFC 5520, DOI 10.17487/RFC5520, April 2009, <<https://www.rfc-editor.org/info/rfc5520>>.
- [RFC5541]** Le Roux, JL., Vasseur, JP., and Y. Lee, "Encoding of Objective Functions in the Path Computation Element Communication Protocol (PCEP)", RFC 5541, DOI 10.17487/RFC5541, June 2009, <<https://www.rfc-editor.org/info/rfc5541>>.
- [RFC5557]** Lee, Y., Le Roux, JL., King, D., and E. Oki, "Path Computation Element Communication Protocol (PCEP) Requirements and Protocol Extensions in Support of Global

Concurrent Optimization", RFC 5557, DOI 10.17487/RFC5557, July 2009, <<https://www.rfc-editor.org/info/rfc5557>>.

- [RFC6780] Berger, L., Le Faucheur, F., and A. Narayanan, "RSVP ASSOCIATION Object Extensions", RFC 6780, DOI 10.17487/RFC6780, October 2012, <<https://www.rfc-editor.org/info/rfc6780>>.
- [RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <<https://www.rfc-editor.org/info/rfc6991>>.
- [RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <<https://www.rfc-editor.org/info/rfc7950>>.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.
- [RFC8294] Liu, X., Qu, Y., Lindem, A., Hopps, C., and L. Berger, "Common YANG Data Types for the Routing Area", RFC 8294, DOI 10.17487/RFC8294, December 2017, <<https://www.rfc-editor.org/info/rfc8294>>.
- [RFC8306] Zhao, Q., Dhody, D., Ed., Palleti, R., and D. King, "Extensions to the Path Computation Element Communication Protocol (PCEP) for Point-to-Multipoint Traffic Engineering Label Switched Paths", RFC 8306, DOI 10.17487/RFC8306, November 2017, <<https://www.rfc-editor.org/info/rfc8306>>.
- [RFC8685] Zhang, F., Zhao, Q., Gonzalez de Dios, O., Casellas, R., and D. King, "Path Computation Element Communication Protocol (PCEP) Extensions for the Hierarchical Path Computation Element (H-PCE) Architecture", RFC 8685, DOI 10.17487/RFC8685, December 2019, <<https://www.rfc-editor.org/info/rfc8685>>.
- [RFC8776] Saad, T., Gandhi, R., Liu, X., Beeram, V., and I. Bryskin, "Common YANG Data Types for Traffic Engineering", RFC 8776, DOI 10.17487/RFC8776, June 2020, <<https://www.rfc-editor.org/info/rfc8776>>.
- [RFC8800] Litkowski, S., Sivabalan, S., Barth, C., and M. Negi, "Path Computation Element Communication Protocol (PCEP) Extension for Label Switched Path (LSP) Diversity Constraint Signaling", RFC 8800, DOI 10.17487/RFC8800, July 2020, <<https://www.rfc-editor.org/info/rfc8800>>.

8.2. Informative References

- [I-D.ietf-teas-yang-l3-te-topo] Liu, X., Bryskin, I., Beeram, V. P., Saad, T., Shah, H. C., and O. G. de Dios, "YANG Data Model for Layer 3 TE Topologies", Work in Progress, Internet-Draft, draft-ietf-teas-yang-l3-te-topo-13, 10 July 2022, <<https://www.ietf.org/archive/id/draft-ietf-teas-yang-l3-te-topo-13.txt>>.
- [I-D.ietf-teas-yang-path-computation] Busi, I., Belotti, S., de Dios, O. G., Sharma, A., and D. Ceccarelli, "A YANG Data Model for requesting path computation", Work in Progress, Internet-Draft, draft-ietf-teas-yang-path-computation-18, 22 March 2022, <<https://www.ietf.org/archive/id/draft-ietf-teas-yang-path-computation-18.txt>>.
- [I-D.ietf-teas-yang-te] Saad, T., Gandhi, R., Liu, X., Beeram, V. P., Bryskin, I., and O. G. de Dios, "A YANG Data Model for Traffic Engineering Tunnels, Label Switched Paths and Interfaces", Work in Progress, Internet-Draft, draft-ietf-teas-yang-te-31, 24 October 2022, <<https://www.ietf.org/archive/id/draft-ietf-teas-yang-te-31.txt>>.
- [RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <<https://www.rfc-editor.org/info/rfc3688>>.
- [RFC9314] Jethanandani, M., Ed., Rahman, R., Ed., Zheng, L., Ed., Pallagatti, S., and G. Mirsky, "YANG Data Model for Bidirectional Forwarding Detection (BFD)", RFC 9314, DOI 10.17487/RFC9314, September 2022, <<https://www.rfc-editor.org/info/rfc9314>>.

Appendix A. Changes from RFC 8776

To be added in a future revision of this draft.

A.1. TE Types YANG Diffs

RFC Editor Note: please remove this appendix before publication.

This section provides the diff between the YANG module in section 3.1 of [RFC8776] and the YANG model revision in [Section 4](#).

The intention of this appendix is to facilitate focusing the review of the YANG model in [Section 4](#) to the changes compared with the YANG model in [RFC8776].

This diff has been generated using the following UNIX commands to compare the YANG module revisions in section 3.1 of [[RFC8776](#)] and in [Section 4](#):

```
diff ietf-te-types@2020-06-10.yang ietf-te-types.yang > model-diff.txt
sed 's/^/ /' model-diff.txt > model-diff-spaces.txt
sed 's/^ > / > /' model-diff-spaces.txt > model-updates.txt
```

The output (model-updates.txt) is reported here:

```
30c30
<          <mailto:tsaad@juniper.net>
---
>          <mailto:tsaad.net@gmail.com>
55c55
< Copyright (c) 2020 IETF Trust and the persons identified as
---
> Copyright (c) 2022 IETF Trust and the persons identified as
60c60
< the license terms contained in, the Simplified BSD License set
---
> the license terms contained in, the Revised BSD License set
65,66c65,99
< This version of this YANG module is part of RFC 8776; see the
< RFC itself for full legal notices.";
---
> This version of this YANG module is part of RFC XXXX
> (https://www.rfc-editor.org/info/rfcXXXX); see the RFC itself
> for full legal notices.";
>
> revision 2022-10-21 {
>   description
>     "Added:
>     - typedef bandwidth-scientific-notation;
>     - base identity lsp-provisioning-error-reason;
>     - identity association-type-diversity;
>     - identity tunnel-admin-auto;
>     - base identity path-computation-error-reason and
>       its derived identities;
>     - base identity tunnel-actions-type and its derived
>       identities;
>     - base identity protocol-origin-type and
>       its derived identities;
>     - base identity svec-objective-function-type and its derived
>       identities;
>     - base identity svec-metric-type and its derived identities;
>     - grouping encoding-and-switching-type.
>
>     Updated:
>     - description of the base identity objective-function-type.
>
>     Obsoleted:
>     - identity of-minimize-agg-bandwidth-consumption
>     - identity of-minimize-load-most-loaded-link
>     - identity of-minimize-cost-path-set";
>   reference
>     "RFC XXXX: Updated Common YANG Data Types for Traffic
>     Engineering";
> }
```

```

> // RFC Editor: replace XXXX with actual RFC number, update date
> // information and remove this note
545a579,612
> // NOTE: The typedef bandwidth-scientific-notation below has been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> typedef bandwidth-scientific-notation {
>     type string {
>         pattern
>             '0(\.0?)?([eE](\+)?0?)?|'
>             + '[1-9](\.[0-9]{0,6})?[eE](\+)?(9[0-6]|1-8)[0-9]|0?[0-9]?';
>     }
>     units "bps";
>     description
>         "Bandwidth values, expressed using the scientific notation
>         in bits per second.
>         The encoding format is the external decimal-significant
>         character sequences specified in IEEE 754 and ISO/IEC C99
>         for 32-bit decimal floating-point numbers:
>         (-1)**(S) * 10**(Exponent) * (Significant),
>         where Significant uses 7 digits.
>         An implementation for this representation may use decimal32
>         or binary32. The range of the Exponent is from -95 to +96
>         for decimal32, and from -38 to +38 for binary32.
>         As a bandwidth value, the format is restricted to be
>         normalized, non-negative, and non-fraction:
>         n.dddddde{+}dd, N.DDDDDDE{+}DD, 0e0 or 0E0,
>         where 'd' and 'D' are decimal digits; 'n' and 'N' are
>         non-zero decimal digits; 'e' and 'E' indicate a power of ten.
>         Some examples are 0e0, 1e10, and 9.953e9.";
>     reference
>         "IEEE Std 754-2008: IEEE Standard for Floating-Point
>         Arithmetic.
>         ISO/IEC C99: Information technology - Programming
>         Languages - C.";
> }
>
606a674,681
> // NOTE: The base identity lsp-provisioning-error-reason has been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> identity lsp-provisioning-error-reason {
>     description
>         "Base identity for LSP provisioning errors.";
> }
>
982a1058,1073
> // NOTE: The identity association-type-diversity below has been
> // added in this module revision

```

```
> // RFC Editor: remove the note above and this note
> 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
>     "RFC8800";
> }
>
> // NOTE: The description of the base identity
> // objective-function-type has been updated
> // in this module revision
> // RFC Editor: remove the note above and this note
985c1076
<   "Base objective function type.";
---
>   "Base identity for path objective function type.";
1015a1107,1109
> // NOTE: The identity of-minimize-agg-bandwidth-consumption
> // below has been obsoleted in this module revision
> // RFC Editor: remove the note above and this note
1017a1112
>   status obsolete;
1020c1115
<   consumption.";
---
>   consumption.";
1023c1118
<   Computation Element Communication Protocol (PCEP)";
---
>   Computation Element Communication Protocol (PCEP)";
1025a1121,1123
> // NOTE: The identity of-minimize-load-most-loaded-link
> // below has been obsoleted in this module revision
> // RFC Editor: remove the note above and this note
1027a1126
>   status obsolete;
1030c1129
<   is carrying the highest load.";
---
>   is carrying the highest load.";
1033c1132
<   Computation Element Communication Protocol (PCEP)";
---
>   Computation Element Communication Protocol (PCEP)";
1035a1135,1137
> // NOTE: The identity of-minimize-cost-path-set
> // below has been obsoleted in this module revision
```

```
> // RFC Editor: remove the note above and this note
1037a1140
> status obsolete;
1216a1320,1331
> // NOTE: The identity tunnel-admin-auto below has been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> identity tunnel-admin-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.";
> }
>
2110a2226,2569
> // NOTE: The base identity path-computation-error-reason and
> // its derived identities below have been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> identity path-computation-error-reason {
> description
> "Base identity for path computation error reasons.";
> }
>
> 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
> "RFC5441, RFC8685";
> }
>
> identity path-computation-error-pce-unavailable {
> base path-computation-error-reason;
> description
> "Path computation has failed because PCE is not available.";
```

```
>     reference
>         "RFC5440";
>     }
>
>     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.";
>         reference
>             "RFC8685";
>     }
>
>     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.";
>         reference
>             "RFC8685";
>     }
>
>     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.";
>         reference
>             "RFC8685";
>     }
>
>     identity path-computation-error-child-pce-unresponsive {
>         base path-computation-error-reason;
>         description
>             "Path computation has failed because child PCE is not
>             responsive.";
>         reference
>             "RFC8685";
>     }
>
>     identity path-computation-error-destination-domain-unknown {
>         base path-computation-error-reason;
>         description
>             "Path computation has failed because the destination domain
>             was unknown.";
>         reference
>             "RFC8685";
>     }
>
```

```
> identity path-computation-error-p2mp {
>   base path-computation-error-reason;
>   description
>     "Path computation has failed because of P2MP reachability
>     problem.";
>   reference
>     "RFC8306";
> }
>
> 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.";
>   reference
>     "RFC5557";
> }
>
> identity path-computation-error-no-gco-solution {
>   base path-computation-error-reason;
>   description
>     "Path computation has failed because of no GCO solution
>     found.";
>   reference
>     "RFC5557";
> }
>
> identity path-computation-error-path-not-found {
>   base path-computation-error-reason;
>   description
>     "Path computation no path found error reason.";
>   reference
>     "RFC5440";
> }
>
> identity path-computation-error-pks-expansion {
>   base path-computation-error-reason;
>   description
>     "Path computation has failed because of Path-Key Subobject
>     (PKS) expansion failure.";
>   reference
>     "RFC5520";
> }
>
> identity path-computation-error-brpc-chain-unavailable {
>   base path-computation-error-reason;
>   description
>     "Path computation has failed because PCE BRPC chain
>     unavailable.";
```



```
>     reference
>     "RFC5441";
> }
>
> identity path-computation-error-source-unknown {
>     base path-computation-error-reason;
>     description
>     "Path computation has failed because source node is
>     unknown.";
>     reference
>     "RFC5440";
> }
>
> identity path-computation-error-destination-unknown {
>     base path-computation-error-reason;
>     description
>     "Path computation has failed because destination node is
>     unknown.";
>     reference
>     "RFC5440";
> }
>
> identity path-computation-error-no-server {
>     base path-computation-error-reason;
>     description
>     "Path computation has failed because path computation
>     server is unavailable.";
>     reference
>     "RFC5440";
> }
>
> // NOTE: The base identity tunnel-actions-type and
> // its derived identities below have been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> identity tunnel-actions-type {
>     description
>     "TE tunnel actions type.";
> }
>
> // NOTE: The base identity protocol-origin-type and
> // its derived identities below have been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> 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 Programmable Interface
>     (API).";
> }
>
> identity protocol-origin-pcep {
>   base protocol-origin-type;
>   description
>     "Protocol origin is Path Computation Engine Protocol
>     (PCEP).";
>   reference "RFC5440";
> }
>
> identity protocol-origin-bgp {
>   base protocol-origin-type;
>   description
>     "Protocol origin is Border Gateway Protocol (BGP).";
>   reference "RFC5512";
> }
>
> // NOTE: The base identity svec-objective-function-type and
> // its derived identities below have been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> identity svec-objective-function-type {
>   description
>     "Base identity for SVEC objective function type.";
>   reference
>     "RFC5541: 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
>     "RFC5541: 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
>         "RFC5541: 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
>             "RFC5541: 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
>             "RFC8685: 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
>             "RFC8685: 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
>             "RFC8685: 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
>         "RFC8685: Path Computation Element Communication Protocol
>         (PCEP) Extensions for the Hierarchical Path Computation
>         Element (H-PCE) Architecture.";
> }
>
> // NOTE: The base identity svec-metric-type and
> // its derived identities below have been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> identity svec-metric-type {
>     description
>         "Base identity for SVEC metric type.";
>     reference
>         "RFC5541: Encoding of Objective Functions in the Path
>         Computation Element Communication Protocol (PCEP).";
> }
>
> identity svec-metric-cumul-te {
>     base svec-metric-type;
>     description
>         "Cumulative TE cost.";
>     reference
>         "RFC5541: Encoding of Objective Functions in the Path
>         Computation Element Communication Protocol (PCEP).";
> }
>
> identity svec-metric-cumul-igp {
>     base svec-metric-type;
>     description
>         "Cumulative IGP cost.";
>     reference
>         "RFC5541: Encoding of Objective Functions in the Path
>         Computation Element Communication Protocol (PCEP).";
> }
>
> identity svec-metric-cumul-hop {
>     base svec-metric-type;
>     description
>         "Cumulative Hop path metric.";
>     reference
>         "RFC5541: 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
>     "RFC5541: 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
>     "RFC5541: Encoding of Objective Functions in the Path
>     Computation Element Communication Protocol (PCEP).";
> }
>
3379c3838,3865
< }
\ No newline at end of file
---
>
> // NOTE: The grouping encoding-and-switching-type below has been
> // added in this module revision
> // RFC Editor: remove the note above and this note
> 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
>       "RFC3945";
>   }
>   leaf switching-type {
>     type identityref {
>       base te-types:switching-capabilities;
>     }
>     description
>       "LSP switching type.";
>     reference
>       "RFC3945";
>   }
}

```

```
> }  
> }
```

Appendix B. Option Considered for updating RFC8776

RFC Editor Note: please remove this appendix before publication.

The concern is how to be able to update the ietf-te-types YANG module published in [[RFC8776](#)] without delaying too much the progress of the mature WG documents.

Three possible options have been identified to address this concern.

One option is to keep these definitions in the YANG modules where they have initially been defined: other YANG modules can still import them. The drawback of this approach is that it defeating the value of common YANG modules like ietf-te-types since common definitions will be spread around multiple specific YANG modules.

A second option is to define them in a new common YANG module (e.g., ietf-te-types-ext). The drawback of this approach is that it will increase the number of YANG modules providing tiny updates to the ietf-te-types YANG module.

A third option is to develop a revision of the ietf-te-types YANG module within an RFC8776-bis. The drawback of this approach is that the process for developing a big RFC8776-bis just for a tiny update is too high. Moreover, as suggested during IETF 113 Netmod WG discussion, a new revision of the ietf-te-packet-types YANG module, which is also defined in [[RFC8776](#)] but it does not need to be revised, needs to be published just to change its reference to RFC8776-bis (see [[RFC9314](#)]).

A fourth option, considered in the -00 WG version, was to:

- *describe within the document only the updates to the ietf-te-types YANG module proposed by this document;
- *include the whole updated YANG model within the main body;
- *add some notes, to be removed before publication, within updated YANG model to focus the review only to the updates to the ietf-te-types YANG module proposed by this document.

Based on the feedbacks from IETF 114 discussion, this version has been restructured to become an RFC8776-bis, with some notes, to be removed before publication, to focus the review only to the updates to the ietf-te-types YANG module proposed by this document.

During the Netmod WG session at IETF 114, an alternative process has been introduced:

<https://datatracker.ietf.org/meeting/114/materials/slides-114-netmod-ad-topic-managing-the-evolution-of-ietf-yang-modules-00.pdf>

Future updates of this document could align with the proposed approach.

Therefore, in order to avoid useless editorial work, this version of the document has been structured to become an RFC8776-bis but not all the existing text in [[RFC8776](#)] has been copied: some editors' notes has been inserted instead. These editors' note will be removed and replaced by actual text copied from [[RFC8776](#)] before WG LC if the RFC8776-bis approach is confirmed.

Acknowledgements

The authors would like to thank Robert Wilton, Lou Berger, Mahesh Jethanandani and Jeff Haas for their valuable input to the discussion about the process to follow to provide tiny updates to a YANG module already published as an RFC.

This document was prepared using kramdown.

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