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MPLS Transport Profile (MPLS-TP) Traffic Engineering (TE)
Management Information Base (MIB)

Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes additional managed objects and textual conventions for tunnels, identifiers, and Label Switching Routers to support Multiprotocol Label Switching (MPLS) MIB modules for transport networks.

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes additional textual conventions and managed objects for tunnels, identifiers, and Label Switching Routers to support Multiprotocol Label Switching (MPLS) MIB modules for transport networks. MIB modules defined in this document extend the existing MPLS MIB objects in such a way that they support the MPLS Transport Profile (MPLS-TP) but also other MPLS networks. Hence, "MPLS-TP" is not included in the MIB module names.

As described in the MPLS Traffic Engineering (TE) MIB definition [RFC3812], MPLS traffic engineering is concerned with the creation and management of MPLS tunnels. This term is a shorthand for a combination of one or more LSPs linking an ingress and an egress LSR. Several types of point-to-point MPLS tunnels may be constructed between a pair of LSRs A and B:

- Unidirectional with a single LSP (say, from A to B).
- Associated bidirectional consisting of two separately routed LSPs, one linking A to B and the other linking B to A. Together, the pair provides a single logical bidirectional transport path.
- Co-routed bidirectional consisting of an associated bidirectional tunnel but with the second LSP from B to A following the reverse of the path of the LSP from A to B, in terms of both nodes and links.

Tunnels may be either statically configured by management action or dynamically created using an LSP management protocol.

The existing MPLS TE MIB [RFC3812] and the GMPLS TE MIB [RFC4802] address only a subset of the combinations of statically and dynamically configured tunnel types, catering to statically configured unidirectional tunnels together with dynamically configured unidirectional and co-routed bidirectional tunnels. They are also restricted to two endpoint LSRs identified by IP addresses.

The MPLS-TP TE MIB defined in this document extends the MIB modules defined in [RFC3812] to cover all six combinations (that is, adding support for statically configured associated and co-routed bidirectional plus dynamically configured associated bidirectional tunnels). It also extends support to endpoints that have identifiers other than IP addresses.

This support is provided by a suite of four MIB modules that are to be used in conjunction with the MIB modules defined in [RFC3812] and the companion document [RFC3813] for MPLS-TP tunnel management.

At the time of writing, SNMP SET is no longer recommended as a way to configure MPLS networks as described in [RFC3812]. However, since the MIB modules specified in this document extend and are intended to work in parallel with the MIB modules for MPLS specified in [RFC3812], certain objects defined here are specified with MAX-ACCESS of read-write or read-create so that specifications of the base tables in [RFC3812] and the extensions in this document are consistent. Although the examples described in Section 9 specify means to configure MPLS-TP Tunnels in a similar way to the examples in [RFC3812], this should be seen as indicating how the MIB values would be returned if the specified circumstances were configured by alternative means.

2. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of RFC 3410 [RFC3410].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIV2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].

3. Overview

3.1. Conventions Used in This Document

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 [RFC2119].

3.2. Terminology

This document uses terminology from the "Multiprotocol Label Switching Architecture" [RFC3031], "Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB)" [RFC3812], "Multiprotocol Label Switching (MPLS) Label Switching Router (LSR) Management Information Base (MIB)" [RFC3813], and "MPLS Transport Profile (MPLS-TP) Identifiers" [RFC6370].

3.3. Acronyms

CC: Country Code
ICC: ITU Carrier Code
LSP: Label Switched Path
LSR: Label Switching Router
MPLS-TP: MPLS Transport Profile
TE: Traffic Engineering
TP: Transport Profile

4. Motivations

"Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB)" [RFC3812] provides support for Traffic Engineering tunnels. In MPLS, the actual transport of packets is provided by Label Switched Paths (LSPs). A transport service may be composed of multiple LSPs. In order to clearly identify the MPLS-TP service, as defined in [RFC6370], we use the term "MPLS-TP Tunnel" or simply "tunnel". However, with MPLS-TP, the characteristics of the tunnels were enhanced. For example, MPLS-TP Tunnels are bidirectional in nature and could be used with non-IP identifiers for the tunnel endpoints. As the existing MPLS-TE-STD-MIB and GMPLS-TE-STD-MIB were defined mainly to support unidirectional tunnels and signaled co-routed bidirectional tunnel definitions, respectively, these existing MIB modules are not sufficient to capture all the characteristics of the tunnels. Hence, enhancing the MIB modules to support MPLS-TP Tunnels is required. As most of the attributes of MPLS Traffic Engineering tunnels are also applicable to MPLS-TP Tunnels, it is optimal to reuse and extend the existing MIB module definition instead of defining a new MIB module.

This document defines four additional MIB modules, namely, MPLS-TE-EXT-STD-MIB, MPLS-TC-EXT-STD-MIB, MPLS-ID-STD-MIB, and MPLS-LSR-EXT-STD-MIB. As these additional MIB modules are required for MPLS-TP functionality, these are all defined in this document, instead of being documented separately.

5. Feature List

The MIBs in this document satisfy the following requirements and constraints:

The MIB modules, taken together, support statically configured and dynamically signaled point-to-point, co-routed bidirectional and associated bidirectional tunnels.

- The MPLS tunnels need not be interfaces, but it is possible to configure an MPLS-TP Tunnel as an interface. The same ifType 150, as defined in Section 8 of [RFC3812], will be used for MPLS-TP Tunnels as well.
- The `mplsTunnelTable` [RFC3812] is also to be used for MPLS-TP Tunnels.
- New MPLS-TP-specific textual conventions and identifiers are required.
- The `mplsTunnelTable` is sparsely extended to support objects specific to MPLS-TP Tunnels.
- A node configuration table (`mplsTunnelExtNodeConfigTable`), as detailed in Section 6.2.1, below, is used to translate the `Global_ID::Node_ID` or `ICC_Operator_ID::Node_ID` to the local identifier in order to index the `mplsTunnelTable`.
- The `mplsXCTable` is sparsely extended to support objects specific to MPLS-TP XC (Cross Connect).
- The MIB module supports persistent, as well as non-persistent, tunnels.

6. Outline

Traffic Engineering support for the MPLS-TP Tunnels requires the setup of the co-routed or associated bidirectional tunnel. The tables and MIB modules that are mentioned in the below subsections support the functionality described in [RFC5654] and [RFC6370]. These tables support both IP-compatible and ICC-based tunnel configurations.

Figure 1, below, depicts how the table references are followed in this MIB.

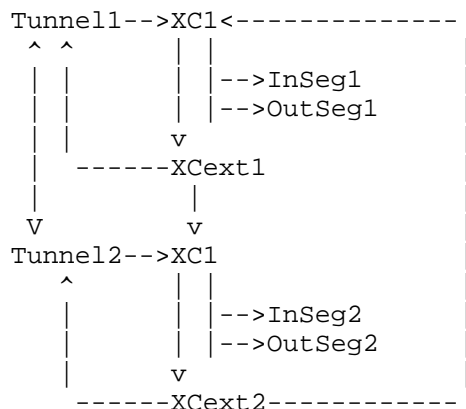


Figure 1: Table References of MIB Modules

6.1. MIB Module Extensions

Four MIB modules are extended to support MPLS-TP Tunnels, namely, MPLS-TE-EXT-STD-MIB, MPLS-TC-EXT-STD-MIB, MPLS-ID-STD-MIB, and MPLS-LSR-EXT-STD-MIB. The following section provides the summary of changes.

6.1.1. Summary of MIB Module Changes

- Node configuration table (mplsTunnelExtNodeConfigTable) for setting the local identifier for Tunnel Ingress and Egress identifiers.
- Node IP map table (mplsTunnelExtNodeIpMapTable) for querying the local identifier for a given Global_ID and Node_ID.
- Node ICC map table (mplsTunnelExtNodeIccMapTable) for querying the local identifier for a given ICC_Operator_ID and Node_ID.
- Tunnel extension table (mplsTunnelExtTable) for setting up MPLS-TP Tunnels with sparse extension of mplsTunnelTable.
- Textual conventions and object definitions for MPLS-TP Tunnels.
- Cross-connect extension table (mplsXCExtTable) for setting up the MPLS-TP LSPs.

These tables are described in the subsequent sections.

6.2. MPLS-TE-EXT-STD-MIB

The TE MIB module extensions and details of the tables are described in the following sections.

6.2.1. mplstunnelExtNodeConfigTable

The `mplstunnelExtNodeConfigTable` is used to assign a local identifier for a given `ICC_Operator_ID::Node_ID` or `Global_ID::Node_ID` combination as defined in [RFC6923] and [RFC6370], respectively. The CC is a string of two characters, each being an uppercase Basic Latin alphabetic (i.e., A-Z). The ICC is a string of one to six characters, each an uppercase Basic Latin alphabetic (i.e., A-Z) or numeric (i.e., 0-9). All of the characters are encoded using [T.50] as described in [RFC6370].

In the IP-compatible mode, `Global_ID::Node_ID`, is used to uniquely identify a node. For each `ICC_Operator_ID::Node_ID` or `Global_ID::Node_ID`, there is a unique entry in the table representing a node. As the regular TE tunnels use the IP address as the LSR ID, the local identifier should be below the first valid IP address, which is 16777216[1.0.0.0]. Every node is assigned a local identifier within a range of 0 to 16777215. This local identifier is used for indexing into `mplstunnelTable` as `mplstunnelIngressLSRId` and `mplstunnelEgressLSRId`.

For IP-compatible environments, an MPLS-TP Tunnel is indexed by Tunnel Index, Tunnel Instance, Source `Global_ID`, Source `Node_ID`, Destination `Global_ID`, and Destination `Node_ID`.

For ICC-based environments, an MPLS-TP Tunnel is indexed by Tunnel Index, Tunnel Instance, Source CC, Source ICC, Source `Node_ID`, Destination CC, Destination ICC, and Destination `Node_ID`.

As `mplstunnelTable` is indexed by `mplstunnelIndex`, `mplstunnelInstance`, `mplstunnelIngressLSRId`, and `mplstunnelEgressLSRId`, the MPLS-TP tunnel identifiers cannot be used directly.

The `mplstunnelExtNodeConfigTable` will be used to store an entry for `ICC_Operator_ID::Node_ID` or `Global_ID::Node_ID` with a local identifier to be used as the LSR ID in `mplstunnelTable`.

6.2.2. mplstunnelExtNodeIpMapTable

The read-only `mplstunnelExtNodeIpMapTable` is used to query the local identifier assigned and stored in `mplstunnelExtNodeConfigTable` for a given `Global_ID::Node_ID`. In order to query the local identifier, in

the IP-compatible mode, this table is indexed with Global_ID::Node_ID. In the IP-compatible mode for a TP tunnel, Global_ID::Node_ID is used.

A separate query is made to get the local identifier of both Ingress and Egress Global_ID::Node_ID identifiers. These local identifiers are used as mplstunnelIngressLSRId and mplstunnelEgressLSRId when indexing mplstunnelTable.

6.2.3. mplstunnelExtNodeIccMapTable

The read-only mplstunnelExtNodeIccMapTable is used to query the local identifier assigned and stored in the mplstunnelExtNodeConfigTable for a given ICC_Operator_ID::Node_ID.

A separate query is made to get the local identifier of both Ingress and Egress ICC_Operator_ID::Node_ID. These local identifiers are used as mplstunnelIngressLSRId and mplstunnelEgressLSRId when indexing mplstunnelTable.

6.2.4. mplstunnelExtTable

This table sparsely extends the mplstunnelTable in order to support MPLS-TP Tunnels with additional objects. All the additional attributes specific to supporting a TP tunnel are contained in this extended table and could be accessed with the mplstunnelTable indices.

The gmplstunnelReversePerfTable [RFC4802] should be used to provide per-tunnel packet performance information for the reverse direction of a bidirectional tunnel. It can be seen as supplementing the mplstunnelPerfTable, which augments the mplstunnelTable.

6.3. MPLS-TC-EXT-STD-MIB

This MIB module contains textual conventions for LSPs of MPLS-based transport networks.

6.4. MPLS-ID-STD-MIB

This MIB module contains identifier object definitions for MPLS Traffic Engineering in transport networks.

6.5. MPLS-LSR-EXT-STD-MIB

This MIB module contains generic object definitions (including the `mplsXCExtTable` -- cross-connect extension table -- for setting up the MPLS-TP LSPs with sparse extension of `mplsXCTable`) for MPLS LSRs in transport networks.

6.6. The Use of RowPointer

This document follows the RowPointer usage as described in Section 10 of [RFC3812].

A new RowPointer object, `mplsTunnelExtOppositeDirPtr`, is added to `mplsTunnelExtTable` of MPLS-TE-EXT-STD-MIB module. This RowPointer object points to the tunnel entry in the opposite direction.

Two additional RowPointers objects, `mplsXCExtTunnelPointer` and `mplsXCExtOppositeDirXCPtr`, are added to the `mplsXCExtTable` of MPLS-LSR-EXT-STD-MIB. The RowPointer `mplsXCExtTunnelPointer` is a read-only object used to indicate the back pointer to the tunnel entry. The RowPointer `mplsXCExtOppositeDirXCPtr` object points to the opposite-direction XC entry.

If either of these RowPointers return `zeroDotZero`, it implies that there is no entry associated with the RowPointer object.

7. MIB Modules' Interdependencies

This section provides an overview of the relationships between the MPLS-TP TE MIB module and other MPLS MIB modules.

The arrows in the following diagram show a "depends on" relationship. A relationship of "MIB module A depends on MIB module B" means that MIB module A uses an object, object identifier, or textual convention defined in MIB module B, or that MIB module A contains a pointer (index or RowPointer) to an object in MIB module B.

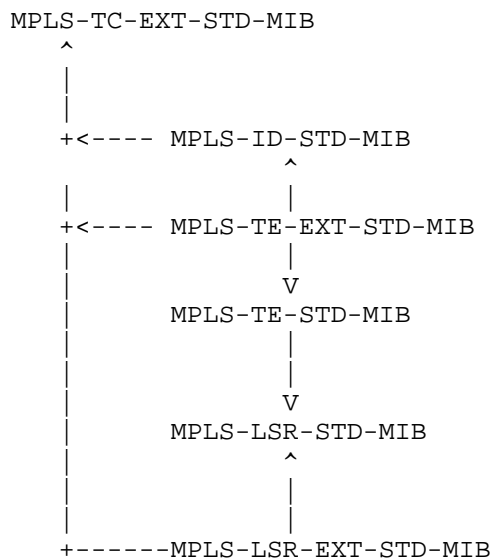


Figure 2: MIB Modules' Interdependencies

Thus:

- All the new MPLS extension MIB modules depend on MPLS-TC-EXT-STD-MIB.
- MPLS-ID-STD-MIB contains references to objects in MPLS-TE-STD-MIB [RFC3812].
- MPLS-TE-EXT-STD-MIB contains references to objects in MPLS-TE-STD-MIB [RFC3812].
- MPLS-LSR-EXT-STD-MIB contains references to objects in MPLS-LSR-STD-MIB [RFC3813].

The `mplsTunnelExtTable` sparsely extends the `mplsTunnelTable` of MPLS-TE-STD-MIB [RFC3812]. This helps in associating the reverse-direction tunnel information.

The `mplsXCExtTable` sparsely extends the `mplsXCTable` of MPLS-LSR-STD-MIB [RFC3813]. This helps in pointing back to the tunnel entry for easy tunnel access from the XC entry.

Note that all of the MIB modules shown above in the figure also have a dependency on MPLS-TC-STD-MIB.

8. Dependencies between MIB Module Tables

The tables in MPLS-TE-EXT-STD-MIB are related as shown on the diagram below. The arrows indicate a reference from one table to another.

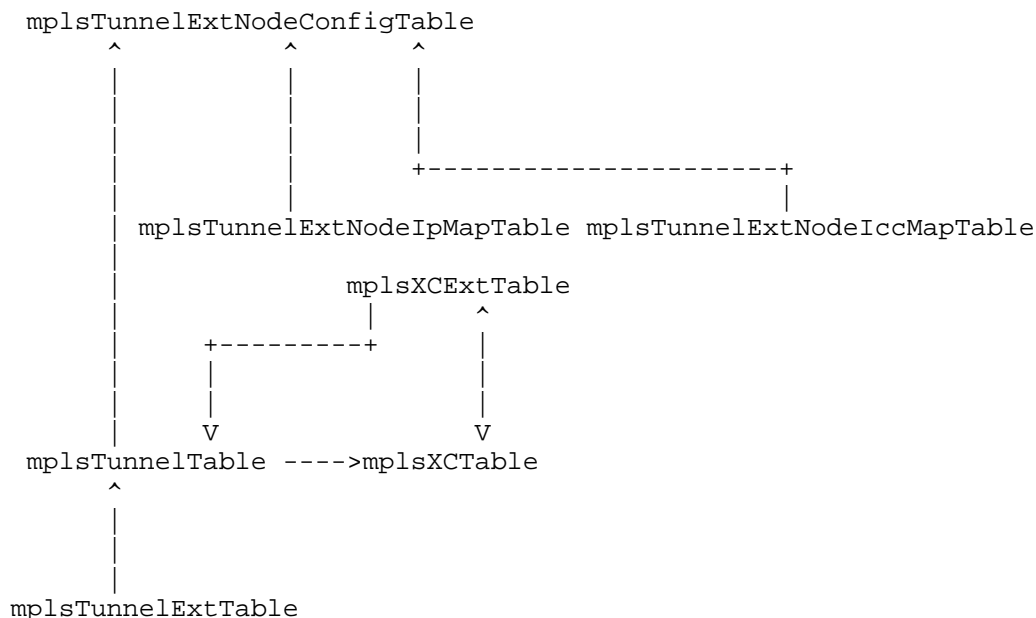


Figure 3: Dependencies between MIB Module Tables

An existing `mplstunnelTable` uses the `mplstunnelExtNodeConfigTable` table to map the `Global_ID::Node_ID` and/or `ICC_Operator_ID::Node_ID` with the local number in order to accommodate in the existing tunnel table's ingress/egress LSR ID.

The new `mplstunnelExtTable` provides the reverse-direction LSP information for the existing tunnel table so that bidirectional LSPs can be created.

The `mplsxExtTable` sparsely extends the `mplsLsrXCTable` to provide backward reference to tunnel entry.

9. Example of MPLS-TP Tunnel Setup

In this section, we provide an example of configuring MPLS-TP bidirectional tunnels with IP tunnel identifiers. This example provides the usage of the MPLS-TP Tunnel MIB along with the extended MIB modules introduced in this document.

Do note that a MPLS-TP Tunnel could be set up statically as well as signaled via the control plane. This example considers accessing MIB objects on a head-end for static and signaled MPLS-TP Tunnels. This section shows the configuration of the forward- and reverse-direction MPLS-TP LSPs that run between East and West, and vice versa. Only objects relevant to MPLS-TP Tunnels are illustrated here.

In `mplsTunnelExtNodeConfigTable`:

```
{
-- Non-IP Ingress LSR_ID (Index to the table)

mplsTunnelExtNodeConfigLocalId          = 1,

mplsTunnelExtNodeConfigGlobalId         = 1234,
mplsTunnelExtNodeConfigNodeId           = 10,
-- Mandatory parameters needed to activate the row go here
mplsTunnelExtNodeConfigRowStatus        = createAndGo (4)

-- Non-IP Egress LSR ID (Index to the table)
mplsTunnelExtNodeConfigLocalId          = 2,
mplsTunnelExtNodeConfigGlobalId         = 1234,
mplsTunnelExtNodeConfigNodeId           = 20,
-- Mandatory parameters needed to activate the row go here
mplsTunnelExtNodeConfigRowStatus        = createAndGo (4)
}
```

This will create an entry in the `mplsTunnelExtNodeConfigTable` for a `Global_ID::Node_ID`. The Ingress and Egress LSR are represented by separate entries.

The following read-only `mplsTunnelExtNodeIpMapTable` table is populated automatically upon creating an entry in `mplsTunnelExtNodeConfigTable`, and this table is used to retrieve the local identifier for the given `Global_ID::Node_ID`.

In `mplsTunnelExtNodeIpMapTable`:

```
{
-- Global_ID (Index to the table)
mplsTunnelExtNodeIpMapGlobalId          = 1234,
-- Node Identifier (Index to the table)
mplsTunnelExtNodeIpMapNodeId            = 10,
mplsTunnelExtNodeIpMapLocalId           = 1

-- Global_ID (Index to the table)
mplsTunnelExtNodeIpMapGlobalId          = 1234,
```

```
-- Node Identifier (Index to the table)
mplsTunnelExtNodeIpMapNodeId      = 20,
mplsTunnelExtNodeIpMapLocalId    = 2
}
```

9.1. Example of MPLS-TP Static Co-routed Bidirectional Tunnel Setup

The following denotes the co-routed bidirectional tunnel "head" entry.

9.1.1. mplsTunnelEntry

In mplsTunnelTable:

```
{
  mplsTunnelIndex          = 1,
  mplsTunnelInstance       = 1,
  -- Local map number created in mplsTunnelExtNodeConfigTable for
  -- Ingress LSR ID
  mplsTunnelIngressLSRId   = 1,

  -- Local map number created in mplsTunnelExtNodeConfigTable for
  -- Egress LSR ID
  mplsTunnelEgressLSRId    = 2,
  mplsTunnelName           = "TP co-routed bidirectional LSP",
  mplsTunnelDescr          = "East to West",
  mplsTunnelIsIf           = true (1),
  -- RowPointer MUST point to the first accessible column
  mplsTunnelXCPointer      =
                                mplsXCLspId.4.0.0.0.1.1.0.4.0.0.0.1,
  mplsTunnelSignallingProto = none (1),
  mplsTunnelSetupPrio      = 0,
  mplsTunnelHoldingPrio    = 0,
  mplsTunnelSessionAttributes = 0,
  mplsTunnelLocalProtectInUse = false (0),
  -- RowPointer MUST point to the first accessible column
  mplsTunnelResourcePointer = mplsTunnelResourceMaxRate.5,
  mplsTunnelInstancePriority = 1,
  mplsTunnelHopTableIndex   = 1,
  mplsTunnelIncludeAnyAffinity = 0,
  mplsTunnelIncludeAllAffinity = 0,
  mplsTunnelExcludeAnyAffinity = 0,
  mplsTunnelRole            = head (1),
  -- Mandatory parameters needed to activate the row go here
  mplsTunnelRowStatus       = createAndGo (4)
}
```

9.1.2. mplsTunnelExtEntry

```
-- An MPLS extension table
In mplsTunnelExtTable:
{
  -- This opposite-direction tunnel pointer may point to 0.0
  -- if co-routed bidirectional tunnel is managed by single tunnel
  -- entry
  mplsTunnelExtOppositeDirTnlPtr      = 0.0
  -- Set both the Ingress and Egress LocalId objects to TRUE, as
  -- this tunnel entry uses the local identifiers.
  mplsTunnelExtIngressLSRLocalIdValid = true,
  mplsTunnelExtEgressLSRLocalIdValid = true
}
```

Next, we must create the appropriate in-segment and out-segment entries. These are done in [RFC3813] using the mplsInSegmentTable and mplsOutSegmentTable.

9.1.3. Forward-Direction mplsOutSegmentEntry

For the forward direction:

```
In mplsOutSegmentTable:
{
  mplsOutSegmentIndex      = 0x0000001,
  mplsOutSegmentInterface  = 13, -- outgoing interface
  mplsOutSegmentPushTopLabel = true(1),
  mplsOutSegmentTopLabel   = 22, -- outgoing label

  -- RowPointer MUST point to the first accessible column.
  mplsOutSegmentTrafficParamPtr = 0.0,
  mplsOutSegmentRowStatus      = createAndGo (4)
}
```

9.1.4. Reverse-Direction mplsInSegmentEntry

For the reverse direction:

```
In mplsInSegmentTable:
{
  mplsInSegmentIndex      = 0x0000001
  mplsInSegmentLabel      = 21, -- incoming label
  mplsInSegmentNPop       = 1,
  mplsInSegmentInterface  = 13, -- incoming interface
}
```



```
-- RowPointer MUST point to the first accessible column.
mplsInSegmentTrafficParamPtr    = 0.0,
mplsInSegmentRowStatus          = createAndGo (4)
}
```

Next, two cross-connect entries are created in the mplsXCTable of the MPLS-LSR-STD-MIB [RFC3813], thereby associating the newly created segments together.

9.1.5. Forward-Direction mplsXCEntry

```
In mplsXCTable:
{
    mplsXCIndex                = 0x01,
    mplsXCInSegmentIndex       = 0x00000000,
    mplsXCOutSegmentIndex      = 0x00000001,
    mplsXCLspId                 = 0x0102 -- unique ID

    -- only a single outgoing label
    mplsXCLabelStackIndex       = 0x00,
    mplsXCRowStatus              = createAndGo(4)
}
```

9.1.6. Reverse-Direction mplsXCEntry

```
In mplsXCTable:
{
    mplsXCIndex                = 0x01,
    mplsXCInSegmentIndex       = 0x00000001,
    mplsXCOutSegmentIndex      = 0x00000000,
    mplsXCLspId                 = 0x0102 -- unique ID
    -- only a single outgoing label
    mplsXCLabelStackIndex       = 0x00,
    mplsXCRowStatus              = createAndGo(4)
}
```

This table entry is extended by an entry in the mplsXCExtTable. Note that the nature of the 'extends' relationship is a sparse augmentation so that the entry in the mplsXCExtTable has the same index values as the entry in the mplsXCTable.

9.1.7. Forward-Direction mplsXCExtEntry

```

In mplsXCExtTable (0x01, 0x00000000, 0x00000001)
{
    -- Back pointer from XC table to Tunnel table
    mplsXCExtTunnelPointer      = mplsTunnelName.1.1.1.2
    mplsXCExtOppositeDirXCPtr  =
                                mplsXCLspId.4.0.0.0.1.4.0.0.0.1.1.0
}

```

9.1.8. Reverse-Direction mplsXCExtEntry

Next, for the reverse direction:

```

In mplsXCExtTable (0x01, 0x00000001, 0x00000000)
{
    -- Back pointer from XC table to Tunnel table
    mplsXCExtTunnelPointer      = mplsTunnelName.1.1.1.2
    mplsXCExtOppositeDirXCPtr  =
                                mplsXCLspId.4.0.0.0.1.1.0.4.0.0.0.1
}

```

9.2. Example of MPLS-TP Static Associated Bidirectional Tunnel Setup

The MPLS-TP associated bidirectional tunnel is implemented by two different unidirectional tunnels (Forward and Reverse LSPs), and these are associated together using mplsTunnelExtTable. Two different tunnel entries to provide the forward and reverse directions MAY be used for co-routed bidirectional tunnels as well.

The following denotes the associated bidirectional forward tunnel "head" entry:

9.2.1. Forward-Direction mplsTunnelEntry

In mplsTunnelTable:

```

{
    mplsTunnelIndex              = 1,
    mplsTunnelInstance           = 1,
    -- Local map number created in mplsTunnelExtNodeConfigTable for
    -- Ingress LSR ID
    mplsTunnelIngressLSRId       = 1,
}

```

```

-- Local map number created in mplsTunnelExtNodeConfigTable for
-- Egress LSR ID
mplsTunnelEgressLSRId      = 2,
mplsTunnelName              = "TP associated bidirectional
                             forward LSP",
mplsTunnelDescr            = "East to West",
mplsTunnelIsIf              = true (1),
-- RowPointer MUST point to the first accessible column
mplsTunnelXCPointer        =
                             mplsXCLspId.4.0.0.0.1.1.0.4.0.0.0.1,
mplsTunnelSignallingProto  = none (1),
mplsTunnelSetupPrio        = 0,
mplsTunnelHoldingPrio      = 0,
mplsTunnelSessionAttributes = 0,
mplsTunnelLocalProtectInUse = false (0),
-- RowPointer MUST point to the first accessible column
mplsTunnelResourcePointer  = mplsTunnelResourceMaxRate.5,
mplsTunnelInstancePriority = 1,
mplsTunnelHopTableIndex    = 1,
mplsTunnelIncludeAnyAffinity = 0,

mplsTunnelIncludeAllAffinity = 0,
mplsTunnelExcludeAnyAffinity = 0,
mplsTunnelRole                = head (1),
-- Mandatory parameters needed to activate the row go here
mplsTunnelRowStatus          = createAndGo (4)
}

```

9.2.2. Forward-Direction mplsTunnelExtEntry

For the associated bidirectional forward LSP,
in mplsTunnelExtTable:

```

{
  mplsTunnelExtOppositeDirPtr      = mplsTunnelName.2.1.2.1
-- Set both the Ingress and Egress LocalId objects to TRUE, as
-- this tunnel entry uses the local identifiers.
  mplsTunnelExtIngressLSRLocalIdValid = true,
  mplsTunnelExtEgressLSRLocalIdValid = true
}

```

9.2.3. Forward-Direction mplsOutSegmentTable

For the forward direction:

```
In mplsOutSegmentTable:
{
    mplsOutSegmentIndex      = 0x00000001,
    mplsOutSegmentInterface  = 13, -- outgoing interface
    mplsOutSegmentPushTopLabel = true(1),
    mplsOutSegmentTopLabel   = 22, -- outgoing label

    -- RowPointer MUST point to the first accessible column.
    mplsOutSegmentTrafficParamPtr = 0.0,
    mplsOutSegmentRowStatus      = createAndGo (4)
}
```

9.2.4. Forward-Direction mplsXCEntry

```
In mplsXCTable:
{
    mplsXCIndex      = 0x01,
    mplsXCInSegmentIndex = 0x00000000,
    mplsXCOutSegmentIndex = 0x00000001,
    mplsXCLspId       = 0x0102 -- unique ID
    -- only a single outgoing label
    mplsXCLabelStackIndex = 0x00,
    mplsXCRowStatus      = createAndGo(4)
}
```

9.2.5. Forward-Direction mplsXCExtEntry

```
In mplsXCExtTable (0x01, 0x00000000, 0x00000001)
{
    -- Back pointer from XC table to Tunnel table
    mplsXCExtTunnelPointer      = mplsTunnelName.1.1.1.2
    mplsXCExtOppositeDirXCPtr   =
                                mplsXCLspId.4.0.0.0.1.4.0.0.0.1.1.0
}
```

9.2.6. Reverse-Direction mplSTunnelEntry

The following denotes the configured associated bidirectional reverse tunnel "tail" entry:

In mplSTunnelTable:

```
{
  mplSTunnelIndex          = 2,
  mplSTunnelInstance       = 1,
  -- Local map number created in mplSTunnelExtNodeConfigTable for
  -- Ingress LSR ID
  mplSTunnelIngressLSRId   = 2,
  -- Local map number created in mplSTunnelExtNodeConfigTable for
  -- Egress LSR ID
  mplSTunnelEgressLSRId    = 1,
  mplSTunnelName           = "TP associated bidirectional
                           reverse LSP",
  mplSTunnelDescr          = "West to East",
  mplSTunnelIsIf           = true (1),
  -- RowPointer MUST point to the first accessible column
  mplSTunnelXCPointer      =
                           mplSXCLspId.4.0.0.0.1.4.0.0.0.1.1.0,
  mplSTunnelSignallingProto = none (1),
  mplSTunnelSetupPrio      = 0,
  mplSTunnelHoldingPrio    = 0,
  mplSTunnelSessionAttributes = 0,
  mplSTunnelLocalProtectInUse = false (0),

  -- RowPointer MUST point to the first accessible column
  mplSTunnelResourcePointer = mplSTunnelResourceMaxRate.5,
  mplSTunnelInstancePriority = 1,
  mplSTunnelHopTableIndex   = 1,
  mplSTunnelIncludeAnyAffinity = 0,
  mplSTunnelIncludeAllAffinity = 0,
  mplSTunnelExcludeAnyAffinity = 0,
  mplSTunnelRole            = head (1),
  -- Mandatory parameters needed to activate the row go here

  mplSTunnelRowStatus       = createAndGo (4)
}
```

9.2.7. Reverse-Direction mplsTunnelExtEntry

For the associated bidirectional reverse LSP,
in mplsTunnelExtTable:

```
{
  mplsTunnelExtOppositeDirPtr      = mplsTunnelName.1.1.1.2
  -- Set both the Ingress and Egress LocalId objects to TRUE, as
  -- this tunnel entry uses the local identifiers.
  mplsTunnelExtIngressLSRLocalIdValid = true,
  mplsTunnelExtEgressLSRLocalIdValid = true
}
```

9.2.8. Reverse-Direction mplsInSegmentEntry

Next, we must create the appropriate in-segment and out-segment
entries. These are done in [RFC3813] using the mplsInSegmentTable
and mplsOutSegmentTable.

In mplsInSegmentTable:

```
{
  mplsInSegmentIndex      = 0x00000001
  mplsInSegmentLabel      = 21, -- incoming label
  mplsInSegmentNPop       = 1,
  mplsInSegmentInterface  = 13, -- incoming interface

  -- RowPointer MUST point to the first accessible column.
  mplsInSegmentTrafficParamPtr = 0.0,
  mplsInSegmentRowStatus      = createAndGo (4)
}
```

Next, two cross-connect entries are created in the mplsXCTable of the
MPLS-LSR-STD-MIB [RFC3813], thereby associating the newly created
segments together.

9.2.9. Reverse-Direction mplsXCEntry

In mplsXCTable:

```
{
  mplsXCIndex      = 0x01,
  mplsXCInSegmentIndex = 0x00000001,
  mplsXCOutSegmentIndex = 0x00000000,
  mplsXCLspId      = 0x0102 -- unique ID
  -- only a single outgoing label
  mplsXCLabelStackIndex = 0x00,

  mplsXCRowStatus      = createAndGo(4)
}
```

This table entry is extended by an entry in the `mplsXCExtTable`. Note that the nature of the 'extends' relationship is a sparse augmentation so that the entry in the `mplsXCExtTable` has the same index values as the entry in the `mplsXCTable`.

9.2.10. Reverse-Direction `mplsXCExtEntry`

Next, for the reverse direction:

```
In mplsXCExtTable (0x01, 0x00000001, 0x00000000)
{
  -- Back pointer from XC table to Tunnel table
  mplsXCExtTunnelPointer      = mplsTunnelName.2.1.2.1
  mplsXCExtOppositeDirXCPtr   =
                                mplsXCLspId.4.0.0.0.1.1.0.4.0.0.0.1
}
```

9.3. Example of MPLS-TP Signaled Co-routed Bidirectional Tunnel Setup

The following denotes the co-routed bidirectional tunnel "head" entry. In intermediate and tail-end nodes, the tunnel table and its associated tables are created by the local management subsystem (e.g., agent) when the MPLS-TP Tunnel is signaled successfully. Refer to [RFC3812] and [RFC4802] for examples of signaled tunnel table configuration.

9.3.1. `mplsTunnelEntry`

In `mplsTunnelTable`:

```
{
  mplsTunnelIndex      = 1,
  mplsTunnelInstance   = 0,
  -- Local map number created in mplsTunnelExtNodeConfigTable for
  -- Ingress LSR-Id. For the intermediate and tail-end nodes,
  -- the local management entity is expected to pick the first
  -- available local identifier that is not used in mplsTunnelTable.
  mplsTunnelIngressLSRId = 1,

  -- Local map number created in mplsTunnelExtNodeConfigTable for
  -- Egress LSR ID
  mplsTunnelEgressLSRId = 2,
  mplsTunnelName        = "TP co-routed bidirectional LSP",
  mplsTunnelDescr       = "East to West",
  mplsTunnelIsIf        = true (1),
```

```

-- RowPointer MUST point to the first accessible column
mplsTunnelXCPointer      =
                        mplsXCLspId.4.0.0.0.1.1.0.4.0.0.0.1,
mplsTunnelSignallingProto = none (1),
mplsTunnelSetupPrio      = 0,
mplsTunnelHoldingPrio    = 0,
mplsTunnelSessionAttributes = 0,
mplsTunnelLocalProtectInUse = false (0),
-- RowPointer MUST point to the first accessible column
mplsTunnelResourcePointer = mplsTunnelResourceMaxRate.5,
mplsTunnelInstancePriority = 1,
mplsTunnelHopTableIndex   = 1,
mplsTunnelIncludeAnyAffinity = 0,
mplsTunnelIncludeAllAffinity = 0,
mplsTunnelExcludeAnyAffinity = 0,
mplsTunnelRole             = head (1),
-- Mandatory parameters needed to activate the row go here
mplsTunnelRowStatus        = createAndGo (4)
}

```

9.3.2. mplsTunnelExtEntry

```

-- An MPLS extension table
In mplsTunnelExtTable:
{
  -- This opposite-direction tunnel pointer may point to 0.0
  -- if co-routed bidirectional tunnel is managed by a single
  -- tunnel entry
  mplsTunnelExtOppositeDirTnlPtr      = 0.0
  -- Set both the Ingress and Egress LocalId objects to TRUE, as
  -- this tunnel entry uses the local identifiers.
  mplsTunnelExtIngressLSRLocalIdValid = true,
  mplsTunnelExtEgressLSRLocalIdValid = true
}

```

Next, we must create the appropriate in-segment and out-segment entries. These are done in [RFC3813] using the mplsInSegmentTable and mplsOutSegmentTable.

9.3.3. Forward-Direction mplsOutSegmentEntry

The forward-direction mplsOutSegmentTable will be populated automatically based on the information received from the signaling protocol.

9.3.4. Reverse-Direction mplsInSegmentEntry

The reverse-direction mplsOutSegmentTable will be populated automatically based on the information received from the signaling protocol.

Next, two cross-connect entries are created in the mplsXCTable of the MPLS-LSR-STD-MIB [RFC3813], thereby associating the newly created segments together.

9.3.5. Forward-Direction mplsXCEntry

The forward-direction mplsXCEntry will be populated as soon as the forward-path label information is available.

9.3.6. Reverse-Direction mplsXCEntry

The reverse-direction mplsXCEntry will be populated as soon as the reverse-path label information is available.

This table entry is extended by an entry in the mplsXCExtTable. Note that the nature of the 'extends' relationship is a sparse augmentation so that the entry in the mplsXCExtTable has the same index values as the entry in the mplsXCTable.

9.3.7. Forward-Direction mplsXCExtEntry

Once the forward path information is negotiated using the signaling protocol, the forward-direction mplsXCExtEntry will be created for associating the opposite-direction XC entry and tunnel table entry.

9.3.8. Reverse-Direction mplsXCExtEntry

Once the reverse path information is negotiated using the signaling protocol, the reverse-direction mplsXCExtEntry will be created for associating the opposite-direction XC entry and tunnel table entry.

10. MPLS Textual Convention Extension MIB Definitions

```
MPLS-TC-EXT-STD-MIB DEFINITIONS ::= BEGIN
```

```
IMPORTS
```

```
    MODULE-IDENTITY, Unsigned32
    FROM SNMPv2-SMI -- RFC 2578
```

```
    TEXTUAL-CONVENTION
    FROM SNMPv2-TC -- RFC 2579
```

```
    mplsStdMIB
    FROM MPLS-TC-STD-MIB -- RFC 3811
```

```
;
```

```
mplsTcExtStdMIB MODULE-IDENTITY
```

```
    LAST-UPDATED
```

```
        "201502020000Z" -- February 2, 2015
```

```
    ORGANIZATION
```

```
        "Multiprotocol Label Switching (MPLS) Working Group"
```

```
    CONTACT-INFO
```

```
        "
```

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```

```
            Thomas D. Nadeau
            Email: tnadeau@lucidvision.com
```

```
        "
```

```
    DESCRIPTION
```

```
        "This MIB module contains Textual Conventions for LSPs of MPLS-
        based transport networks."
```

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-- Revision history.

REVISION

"201502020000Z" -- February 2, 2015

DESCRIPTION

"MPLS Textual Convention Extensions"

::= { mplsStdMIB 17 }

MplsGlobalId ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"This object contains the Textual Convention for an IP-based operator-unique identifier (Global_ID). The Global_ID can contain the 2-octet or 4-octet value of the operator's Autonomous System Number (ASN).

When the Global_ID is derived from a 2-octet ASN, the two high-order octets of this 4-octet identifier MUST be set to zero (0x00). Further, ASN 0 is reserved. The size of the Global_ID string MUST be zero if the Global_ID is invalid.

Note that a Global_ID of zero is limited to entities contained within a single operator and MUST NOT be used across a Network-to-Network Interface (NNI). A non-zero Global_ID MUST be derived from an ASN owned by the operator."

REFERENCE

"MPLS Transport Profile (MPLS-TP) Identifiers, RFC 6370, Section 3"

SYNTAX OCTET STRING (SIZE (4))

MplsCcId ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"The CC (Country Code) is a string of two characters, each being an uppercase Basic Latin alphabetic (i.e., A-Z).

The characters are encoded using ITU-T Recommendation T.50. The size of the CC string MUST be zero if the CC identifier is invalid."

REFERENCE

"MPLS-TP Identifiers Following ITU-T Conventions, RFC 6923, Section 3.
International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IA5) - Information technology - 7-bit coded character set for information exchange, ITU-T Recommendation T.50, September 1992."

SYNTAX OCTET STRING (SIZE (0|2))

MplsIccId ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"The ICC is a string of one to six characters, each an uppercase Basic Latin alphabetic (i.e., A-Z) or numeric (i.e., 0-9). The characters are encoded using ITU-T Recommendation T.50. The size of the ICC string MUST be zero if the ICC identifier is invalid."

REFERENCE

"MPLS-TP Identifiers Following ITU-T Conventions, RFC 6923, Section 3.
International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IA5) - Information technology - 7-bit coded character set for information exchange, ITU-T Recommendation T.50, September 1992."

SYNTAX OCTET STRING (SIZE (0|1..6))

MplsNodeId ::= TEXTUAL-CONVENTION

DISPLAY-HINT "d"

STATUS current

DESCRIPTION

"The Node_ID is assigned within the scope of the Global_ID/ICC_Operator_ID.

When IPv4 addresses are in use, the value of this object can be derived from the LSR's IPv4 loopback address.

When IPv6 addresses are in use, the value of this object can be a 32-bit value unique within the scope of a Global_ID.

Note that, when IP reachability is not needed, the 32-bit Node_ID is not required to have any association with the IPv4 address space. The value of 0 indicates an invalid Node_ID."

REFERENCE

"MPLS Transport Profile (MPLS-TP) Identifiers, RFC 6370,
Section 4"

SYNTAX Unsigned32 (0|1..4294967295)

-- MPLS-TC-EXT-STD-MIB module ends
END

11. MPLS Identifier MIB Definitions

MPLS-ID-STD-MIB DEFINITIONS ::= BEGIN

IMPORTS

MODULE-IDENTITY, OBJECT-TYPE
FROM SNMPv2-SMI -- RFC 2578
MODULE-COMPLIANCE, OBJECT-GROUP
FROM SNMPv2-CONF -- RFC 2580
mplsStdMIB
FROM MPLS-TC-STD-MIB -- RFC 3811
MplsGlobalId, MplsCcId, MplsIccId, MplsNodeId
FROM MPLS-TC-EXT-STD-MIB
;

mplsIdStdMIB MODULE-IDENTITY

LAST-UPDATED

"201502020000Z" -- February 2, 2015

ORGANIZATION

"Multiprotocol Label Switching (MPLS) Working Group"

CONTACT-INFO

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"

DESCRIPTION

"This MIB module contains identifier object definitions for MPLS Traffic Engineering in transport networks.

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-- Revision history.

REVISION

"201502020000Z" -- February 2, 2015

DESCRIPTION

"This MIB modules defines the MIB objects for MPLS-TP identifiers"

::= { mplsStdMIB 18 }

-- notifications

mplsIdNotifications OBJECT IDENTIFIER ::= { mplsIdStdMIB 0 }

-- tables, scalars

mplsIdObjects OBJECT IDENTIFIER ::= { mplsIdStdMIB 1 }

-- conformance

mplsIdConformance OBJECT IDENTIFIER ::= { mplsIdStdMIB 2 }

-- MPLS common objects

mplsIdGlobalId OBJECT-TYPE

SYNTAX MplsGlobalId

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This object allows the operator or service provider to assign a unique operator identifier, also called the MPLS-TP Global_ID.

If this value is used in mplsTunnelExtNodeConfigGlobalId for mapping Global_ID::Node_ID with the local identifier, then this object value MUST NOT be changed."

::= { mplsIdObjects 1 }

mplsIdNodeId OBJECT-TYPE

SYNTAX MplsNodeId
MAX-ACCESS read-write
STATUS current

DESCRIPTION

"This object allows the operator or service provider to assign a unique MPLS-TP Node_ID. The Node_ID is assigned within the scope of the Global_ID/ICC_Operator_ID. If this value is used in mplsTunnelExtNodeConfigNodeId for mapping Global_ID::Node_ID with the local identifier, then this object value SHOULD NOT be changed. If this value is used in mplsTunnelExtNodeConfigNodeId for mapping ICC_Operator_ID::Node_ID with the local identifier, then this object value MUST NOT be changed."

::= { mplsIdObjects 2 }

mplsIdCc OBJECT-TYPE

SYNTAX MplsCcId
MAX-ACCESS read-write
STATUS current

DESCRIPTION

"This object allows the operator or service provider to assign a Country Code (CC) to the node. Global uniqueness of ICC is assured by concatenating the ICC with a Country Code (CC). If this value is used in mplsTunnelExtNodeConfigCcId for mapping ICC_Operator_ID::Node_ID with the local identifier, then this object value MUST NOT be changed."

REFERENCE

"MPLS-TP Identifiers Following ITU-T Conventions,
RFC 6923, Section 3"

::= { mplsIdObjects 3 }

mplsIdIcc OBJECT-TYPE

SYNTAX MplsIccId
MAX-ACCESS read-write
STATUS current

DESCRIPTION

"This object allows the operator or service provider to assign a unique MPLS-TP ITU-T Carrier Code (ICC) to the node. Together, the CC and the ICC form the ICC_Operator_ID as CC::ICC. If this value is used in mplsTunnelExtNodeConfigIccId for mapping ICC_Operator_ID::Node_ID with the local identifier, then this object value MUST NOT be changed."

REFERENCE

"MPLS-TP Identifiers Following ITU-T Conventions,
RFC 6923, Section 3"

```
 ::= { mplsIdObjects 4 }

-- Module compliance.

mplsIdCompliances
  OBJECT IDENTIFIER ::= { mplsIdConformance 1 }

mplsIdGroups
  OBJECT IDENTIFIER ::= { mplsIdConformance 2 }

-- Compliance requirement for fully compliant implementations.

mplsIdModuleFullCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION
    "Compliance statement for agents that provide full
    support of the MPLS-ID-STD-MIB module."

  MODULE -- this module

    -- The mandatory group has to be implemented by all LSRs that
    -- originate, terminate, or act as transit for MPLS-TP Tunnels.

    GROUP mplsIdIpOperatorGroup
    DESCRIPTION
      "This group is mandatory for devices that support
      IP-based identifier configuration."

    GROUP mplsIdIccOperatorGroup
    DESCRIPTION
      "This group is mandatory for devices that support
      ICC-based identifier configuration."

    ::= { mplsIdCompliances 1 }

-- Compliance requirement for read-only implementations.

mplsIdModuleReadOnlyCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION
    "Compliance statement for agents that only provide
    read-only support for the MPLS-ID-STD-MIB module."

  MODULE -- this module
```



```
GROUP mplsIdIpOperatorGroup
DESCRIPTION
    "This group is mandatory for devices that support
    IP-based identifier configuration."

GROUP mplsIdIccOperatorGroup
DESCRIPTION
    "This group is mandatory for devices that support
    ICC-based identifier configuration."

OBJECT mplsIdGlobalId
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."

OBJECT mplsIdNodeId
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."

OBJECT mplsIdCc
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."

OBJECT mplsIdIcc
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."

 ::= { mplsIdCompliances 2 }

-- Units of conformance.

mplsIdIpOperatorGroup OBJECT-GROUP
    OBJECTS { mplsIdGlobalId,
              mplsIdNodeId
            }
    STATUS current
    DESCRIPTION
        "The objects in this group are optional for an
        ICC-based node."
    ::= { mplsIdGroups 1 }
```

```

mplsIdIccOperatorGroup OBJECT-GROUP
    OBJECTS { mplsIdNodeId,
               mplsIdCc,
               mplsIdIcc
            }
    STATUS current
    DESCRIPTION
        "The objects in this group are optional for an
        IP-based node."
    ::= { mplsIdGroups 2 }

```

```

-- MPLS-ID-STD-MIB module ends
END

```

12. MPLS LSR Extension MIB Definitions

```

MPLS-LSR-EXT-STD-MIB DEFINITIONS ::= BEGIN

```

IMPORTS

```

    MODULE-IDENTITY, OBJECT-TYPE
        FROM SNMPv2-SMI -- RFC 2578
    MODULE-COMPLIANCE, OBJECT-GROUP
        FROM SNMPv2-CONF -- RFC 2580
    mplsStdMIB
        FROM MPLS-TC-STD-MIB -- RFC 3811
    RowPointer
        FROM SNMPv2-TC -- RFC 2579
    mplsXCIndex, mplsXCInSegmentIndex, mplsXCOutSegmentIndex,
    mplsInterfaceGroup, mplsInSegmentGroup, mplsOutSegmentGroup,
    mplsXCGroup, mplsLsrNotificationGroup
        FROM MPLS-LSR-STD-MIB; -- RFC 3813

```

```

mplsLsrExtStdMIB MODULE-IDENTITY

```

```

    LAST-UPDATED

```

```

        "201502020000Z" -- February 2, 2015

```

```

    ORGANIZATION

```

```

        "Multiprotocol Label Switching (MPLS) Working Group"

```

```

    CONTACT-INFO

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"

DESCRIPTION

"This MIB module contains generic object definitions for
MPLS LSRs in transport networks.

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-- Revision history.

REVISION

"201502020000Z" -- February 2, 2015

DESCRIPTION

"MPLS LSR-specific MIB objects extension"

::= { mplsStdMIB 19 }

-- notifications

mplsLsrExtNotifications OBJECT IDENTIFIER ::= { mplsLsrExtStdMIB 0 }

-- tables, scalars

mplsLsrExtObjects OBJECT IDENTIFIER
::= { mplsLsrExtStdMIB 1 }

-- conformance

mplsLsrExtConformance OBJECT IDENTIFIER
::= { mplsLsrExtStdMIB 2 }

-- MPLS LSR common objects

```

mplsXCExtTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF MplsXCExtEntry
    MAX-ACCESS   not-accessible
    STATUS       current
    DESCRIPTION
        "This table sparse augments the mplsXCTable of
        MPLS-LSR-STD-MIB (RFC 3813) to provide MPLS-TP-specific
        information about associated tunnel information"
    REFERENCE
        "Multiprotocol Label Switching (MPLS) Label Switching
        Router (LSR) Management Information Base (MIB), RFC 3813."
 ::= { mplsLsrExtObjects 1 }

mplsXCExtEntry OBJECT-TYPE
    SYNTAX      MplsXCExtEntry
    MAX-ACCESS   not-accessible

    STATUS       current
    DESCRIPTION
        "An entry in this table sparsely extends the cross-connect
        information represented by an entry in
        the mplsXCTable in MPLS-LSR-STD-MIB (RFC 3813) through
        a sparse augmentation.  An entry can be created by
        a network operator via SNMP SET commands or in
        response to signaling protocol events."
    REFERENCE
        "Multiprotocol Label Switching (MPLS) Label Switching
        Router (LSR) Management Information Base (MIB), RFC 3813."

    INDEX { mplsXCIndex, mplsXCInSegmentIndex,
            mplsXCOutSegmentIndex }
 ::= { mplsXCExtTable 1 }

MplsXCExtEntry ::= SEQUENCE {
    mplsXCExtTunnelPointer      RowPointer,
    mplsXCExtOppositeDirXCPtr   RowPointer
}

mplsXCExtTunnelPointer OBJECT-TYPE
    SYNTAX      RowPointer
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
        "This read-only object indicates the back pointer to
        the tunnel entry segment.
        The only valid value for Tunnel Pointer is
        mplsTunnelTable entry."

```

REFERENCE

"Multiprotocol Label Switching (MPLS) Label Switching
Router (LSR) Management Information Base (MIB), RFC 3813."

::= { mplsXCExtEntry 1 }

mplsXCExtOppositeDirXCPtr OBJECT-TYPE

SYNTAX RowPointer
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This object indicates the pointer to the opposite-direction XC entry. This object cannot be modified if mplsXCRowStatus for the corresponding entry in the mplsXCTable is active(1). If this pointer is not set or removed, mplsXCOperStatus should be set to down(2)."

REFERENCE

"Multiprotocol Label Switching (MPLS) Label Switching
Router (LSR) Management Information Base (MIB), RFC 3813."

::= { mplsXCExtEntry 2 }

mplsLsrExtCompliances

OBJECT IDENTIFIER ::= { mplsLsrExtConformance 1 }

mplsLsrExtGroups

OBJECT IDENTIFIER ::= { mplsLsrExtConformance 2 }

-- Compliance requirement for fully compliant implementations.

mplsLsrExtModuleFullCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"Compliance statement for agents that provide full support for MPLS-LSR-EXT-STD-MIB.

The mandatory group has to be implemented by all LSRs that originate, terminate, or act as transit for TE-LSPs/tunnels.

In addition, depending on the type of tunnels supported, other groups become mandatory as explained below."

MODULE MPLS-LSR-STD-MIB -- The MPLS-LSR-STD-MIB, RFC 3813

```
MANDATORY-GROUPS {
    mplsInSegmentGroup,
    mplsOutSegmentGroup,
    mplsXCGroup,
    mplsLsrNotificationGroup
}
```

```
MODULE -- this module

MANDATORY-GROUPS {
    mplsXCExtGroup
}

::= { mplsLsrExtCompliances 1 }

-- Compliance requirement for implementations that provide
-- read-only access.

mplsLsrExtModuleReadOnlyCompliance MODULE-COMPLIANCE
    STATUS current
    DESCRIPTION
        "Compliance requirement for implementations that only
        provide read-only support for MPLS-LSR-EXT-STD-MIB.
        Such devices can then be monitored but cannot be
        configured using this MIB module."

MODULE MPLS-LSR-STD-MIB

MANDATORY-GROUPS {
    mplsInterfaceGroup,
    mplsInSegmentGroup,
    mplsOutSegmentGroup
}

MODULE -- this module

GROUP mplsXCExtReadOnlyObjectsGroup
DESCRIPTION
    "This group is mandatory for devices that support
    opposite-direction XC configuration of tunnels."

-- mplsXCExtTable
OBJECT mplsXCExtOppositeDirXCPtr
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required.
    This object indicates the pointer to the opposite-
    direction XC entry. The only valid value for XC
    Pointer is mplsXCTable entry."
::= { mplsLsrExtCompliances 2 }

-- Units of conformance.
```

```

mplsXCExtGroup OBJECT-GROUP
OBJECTS {
    mplsXCExtTunnelPointer,
    mplsXCExtOppositeDirXCPtr
}
STATUS current
DESCRIPTION
    "This object should be supported in order to access
    the tunnel entry from the XC entry."
 ::= { mplsLsrExtGroups 1 }

mplsXCExtReadOnlyObjectsGroup OBJECT-GROUP
OBJECTS {
    mplsXCExtTunnelPointer,
    mplsXCExtOppositeDirXCPtr
}
STATUS current
DESCRIPTION
    "This Object is needed to associate the opposite-direction
    (forward/reverse) XC entry."
 ::= { mplsLsrExtGroups 2 }

-- MPLS-LSR-EXT-STD-MIB module ends
END

```

13. MPLS Tunnel Extension MIB Definitions

This MIB module imports from [RFC2578], [RFC2579], [RFC2580], [RFC3289], [RFC3811], and [RFC3812].

MPLS-TE-EXT-STD-MIB DEFINITIONS ::= BEGIN

```

IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE
        FROM SNMPv2-SMI -- RFC 2578
    MODULE-COMPLIANCE, OBJECT-GROUP
        FROM SNMPv2-CONF -- RFC 2580
    TruthValue, RowStatus, RowPointer, StorageType
        FROM SNMPv2-TC -- RFC 2579
    IndexIntegerNextFree
        FROM DIFFSERV-MIB -- RFC 3289
    MplsGlobalId, MplsNodeId, MplsCcId, MplsIccId
        FROM MPLS-TC-EXT-STD-MIB
    mplsStdMIB, MplsTunnelIndex, MplsTunnelInstanceIndex,
    MplsExtendedTunnelId
        FROM MPLS-TC-STD-MIB -- RFC 3811
    mplsTunnelIndex, mplsTunnelInstance, mplsTunnelIngressLSRId,
    mplsTunnelEgressLSRId

```

FROM MPLS-TE-STD-MIB

-- RFC 3812

;

mplsTeExtStdMIB MODULE-IDENTITY

LAST-UPDATED

"201502020000Z" -- February 2, 2015

ORGANIZATION

"Multiprotocol Label Switching (MPLS) Working Group"

CONTACT-INFO

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"

DESCRIPTION

"This MIB module contains generic object definitions for extending the MPLS Traffic Engineering tunnels in transport networks.

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```
-- Revision history.

REVISION
  "201502020000Z" -- February 2, 2015

DESCRIPTION
  "MPLS TE MIB objects extension"

 ::= { mplsStdMIB 20 }

-- Top-level components of this MIB module.

-- tables, scalars
mplsTeExtObjects      OBJECT IDENTIFIER
                      ::= { mplsTeExtStdMIB 0 }

-- conformance
mplsTeExtConformance  OBJECT IDENTIFIER
                      ::= { mplsTeExtStdMIB 1 }

-- Start of MPLS Transport Profile Node configuration table

mplsTunnelExtNodeConfigLocalIdNext OBJECT-TYPE
SYNTAX      IndexIntegerNextFree (0..16777215)
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "This object contains an unused value for
   mplsTunnelExtNodeConfigLocalId, or a zero to indicate
   that none exist.  Negative values are not allowed,
   as they do not correspond to valid values of
   mplsTunnelExtNodeConfigLocalId."
 ::= { mplsTeExtObjects 1 }

mplsTunnelExtNodeConfigTable OBJECT-TYPE
SYNTAX      SEQUENCE OF MplsTunnelExtNodeConfigEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
  "This table allows the operator to map a node or
   LSR identifier (IP-compatible [Global_ID::Node_ID] or
   ICC-based [ICC_Operator_ID::Node_ID]) with a local
   identifier.

   This table is created to reuse the existing
   mplsTunnelTable for MPLS-based transport network
   tunnels also.
```

Since the MPLS tunnel's Ingress/Egress LSR identifiers' size (Unsigned32) value is not compatible for MPLS-TP Tunnel, i.e., Global_ID::Node_ID of size 8 bytes and ICC_Operator_ID::Node_ID of size 12 bytes, there exists a need to map the Global_ID::Node_ID or ICC_Operator_ID::Node_ID with the local identifier of size 4 bytes (Unsigned32) value in order to index (Ingress/Egress LSR identifier) the existing mplstunnelTable."

```
::= { mplstExtObjects 2 }
```

mplstunnelExtNodeConfigEntry OBJECT-TYPE

SYNTAX MplstunnelExtNodeConfigEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table represents a mapping identification for the operator or service provider to a node or an LSR.

As per RFC 6370, IP-compatible mapping is represented as Global_ID::Node_ID.

As per RFC 6923, the CC and the ICC form the ICC_Operator_ID as CC::ICC, and ICC-compatible mapping is represented as ICC_Operator_ID::Node_ID.

Note: Each entry in this table should have a unique [Global_ID and Node_ID] or [CC::ICC and Node_ID] combination."

INDEX { mplstunnelExtNodeConfigLocalId }

```
::= { mplstunnelExtNodeConfigTable 1 }
```

MplstunnelExtNodeConfigEntry ::= SEQUENCE {

mplstunnelExtNodeConfigLocalId MplsExtendedTunnelId,

mplstunnelExtNodeConfigGlobalId MplsGlobalId,

mplstunnelExtNodeConfigCcId MplsCcId,

mplstunnelExtNodeConfigIccId MplsIccId,

mplstunnelExtNodeConfigNodeId MplsNodeId,

mplstunnelExtNodeConfigIccValid TruthValue,

mplstunnelExtNodeConfigStorageType StorageType,

mplstunnelExtNodeConfigRowStatus RowStatus

}

mplstunnelExtNodeConfigLocalId OBJECT-TYPE

SYNTAX MplsExtendedTunnelId

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object is used in accommodating the bigger-size Global_ID::Node_ID and/or the ICC_Operator_ID::Node_ID with the smaller-size LSR identifier in order to index the mplSTunnelTable.

The local identifier is configured between 0 and 16777215, as the valid IP address range starts from 16777216(01.00.00.00).

This range is chosen to determine whether the mplSTunnelTable's Ingress/Egress LSR ID is an IP address or local identifier. If the configured range is not an IP address, the operator is expected to retrieve the complete information (Global_ID::Node_ID or ICC_Operator_ID::Node_ID) from mplSTunnelExtNodeConfigTable. This way, the existing mplSTunnelTable is reused for bidirectional tunnel extensions for MPLS-based transport networks.

The local identifier allows the operator to assign a unique identifier to map Global_ID::Node_ID and/or ICC_Operator_ID::Node_ID. As this local identifier is unique within the node and the same syntax of this object can be used for MPLS-TE tunnel also, it is up to the operator/local management entity to choose a non-conflicting value for indexing the MPLS and MPLS-TP tunnel entries."

::= { mplSTunnelExtNodeConfigEntry 1 }

mplSTunnelExtNodeConfigGlobalId OBJECT-TYPE

SYNTAX MplsGlobalId
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This object indicates the Global Operator Identifier. This object has no meaning when mplSTunnelExtNodeConfigIccValid is set true."

REFERENCE

"MPLS Transport Profile (MPLS-TP) Identifiers, RFC 6370, Section 3."

::= { mplSTunnelExtNodeConfigEntry 2 }

mplSTunnelExtNodeConfigCcId OBJECT-TYPE

SYNTAX MplsCcId
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This object allows the operator or service provider to configure a unique MPLS-TP ITU-T Country Code (CC) either for Ingress ID or Egress ID.

This object has no meaning when
mplsTunnelExtNodeConfigIccValid is set to false."

REFERENCE

"MPLS-TP Identifiers Following ITU-T Conventions,
RFC 6923, Section 3"

::= { mplsTunnelExtNodeConfigEntry 3 }

mplsTunnelExtNodeConfigIccId OBJECT-TYPE

SYNTAX MplsIccId
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This object allows the operator or service provider to configure a unique MPLS-TP ITU-T Carrier Code (ICC) either for Ingress ID or Egress ID.

This object has no meaning when
mplsTunnelExtNodeConfigIccValid is set to false."

REFERENCE

"MPLS-TP Identifiers Following ITU-T Conventions,
RFC 6923, Section 3"

::= { mplsTunnelExtNodeConfigEntry 4 }

mplsTunnelExtNodeConfigNodeId OBJECT-TYPE

SYNTAX MplsNodeId
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This object indicates the Node_ID within the scope
of a Global_ID or ICC_Operator_ID."

REFERENCE

"MPLS Transport Profile (MPLS-TP) Identifiers, RFC 6370,
Section 4."

::= { mplsTunnelExtNodeConfigEntry 5 }

mplsTunnelExtNodeConfigIccValid OBJECT-TYPE

SYNTAX TruthValue
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"Denotes whether or not this entry uses
mplsTunnelExtNodeConfigCcId,
mplsTunnelExtNodeConfigIccId, and

mplsTunnelExtNodeConfigNodeId for mapping the ICC-based identifiers with the local identifier. Note that if this variable is set to false, then the mplsTunnelExtNodeConfigGlobalId and mplsTunnelExtNodeConfigNodeId objects should have the valid information."

```
DEFVAL { false }
::= { mplsTunnelExtNodeConfigEntry 6 }
```

mplsTunnelExtNodeConfigStorageType OBJECT-TYPE

```
SYNTAX          StorageType
MAX-ACCESS      read-create
STATUS          current
```

DESCRIPTION

"This variable indicates the storage type for this object.

Conceptual rows having the value 'permanent' need not allow write-access to any columnar objects in the row."

```
DEFVAL { volatile }
::= { mplsTunnelExtNodeConfigEntry 7 }
```

mplsTunnelExtNodeConfigRowStatus OBJECT-TYPE

```
SYNTAX          RowStatus
MAX-ACCESS      read-create
STATUS          current
```

DESCRIPTION

"This object allows the operator to create, modify, and/or delete a row in this table."

```
::= { mplsTunnelExtNodeConfigEntry 8 }
```

-- End of MPLS Transport Profile Node configuration table

-- Start of MPLS Transport Profile Node IP-compatible
-- mapping table

mplsTunnelExtNodeIpMapTable OBJECT-TYPE

```
SYNTAX          SEQUENCE OF MplsTunnelExtNodeIpMapEntry
```

```
MAX-ACCESS      not-accessible
STATUS          current
```

DESCRIPTION

"This read-only table allows the operator to retrieve the local identifier for a given Global_ID::Node_ID in an IP-compatible operator environment.

This table MAY be used in on-demand and/or proactive OAM operations to get the Ingress/Egress LSR identifier

(local identifier) from Src-Global_Node_ID or Dst-Global_Node_ID. The Ingress and Egress LSR identifiers are used to retrieve the tunnel entry.

This table returns nothing when the associated entry is not defined in mplstunnelExtNodeConfigTable."

::= { mplstExtObjects 3 }

mplstunnelExtNodeIpMapEntry OBJECT-TYPE

SYNTAX MplstunnelExtNodeIpMapEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table represents a mapping of Global_ID::Node_ID with the local identifier.

An entry in this table is created automatically when the local identifier is associated with Global_ID and Node_Id in the mplstunnelExtNodeConfigTable.

Note: Each entry in this table should have a unique Global_ID and Node_ID combination."

INDEX { mplstunnelExtNodeIpMapGlobalId,
mplstunnelExtNodeIpMapNodeId
}

::= { mplstunnelExtNodeIpMapTable 1 }

MplstunnelExtNodeIpMapEntry ::= SEQUENCE {

mplstunnelExtNodeIpMapGlobalId MplsGlobalId,

mplstunnelExtNodeIpMapNodeId MplsNodeId,

mplstunnelExtNodeIpMapLocalId MplsExtendedTunnelId

}

mplstunnelExtNodeIpMapGlobalId OBJECT-TYPE

SYNTAX MplsGlobalId

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object indicates the Global_ID."

::= { mplstunnelExtNodeIpMapEntry 1 }

mplstunnelExtNodeIpMapNodeId OBJECT-TYPE

SYNTAX MplsNodeId

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object indicates the Node_ID within the operator."

::= { mplsTunnelExtNodeIpMapEntry 2 }

mplsTunnelExtNodeIpMapLocalId OBJECT-TYPE

SYNTAX MplsExtendedTunnelId

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This object contains an IP-compatible local identifier that is defined in mplsTunnelExtNodeConfigTable."

::= { mplsTunnelExtNodeIpMapEntry 3 }

-- End MPLS Transport Profile Node IP compatible table

-- Start of MPLS Transport Profile Node ICC based table

mplsTunnelExtNodeIccMapTable OBJECT-TYPE

SYNTAX SEQUENCE OF MplsTunnelExtNodeIccMapEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This read-only table allows the operator to retrieve the local identifier for a given ICC_Operator_ID::Node_ID in an ICC operator environment.

This table MAY be used in on-demand and/or proactive OAM operations to get the Ingress/Egress LSR identifier (local identifier) from Src-ICC or Dst-ICC. The Ingress and Egress LSR identifiers are used to retrieve the tunnel entry. This table returns nothing when the associated entry is not defined in mplsTunnelExtNodeConfigTable."

::= { mplsTeExtObjects 4 }

mplsTunnelExtNodeIccMapEntry OBJECT-TYPE

SYNTAX MplsTunnelExtNodeIccMapEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table represents a mapping of ICC_Operator_ID::Node_ID with the local identifier.

An entry in this table is created automatically when the local identifier is associated with ICC_Operator_ID::Node_ID in the mplsTunnelExtNodeConfigTable."

```

INDEX { mplSTunnelExtNodeIccMapCcId,
        mplSTunnelExtNodeIccMapIccId,
        mplSTunnelExtNodeIccMapNodeId }
 ::= { mplSTunnelExtNodeIccMapTable 1 }

```

```

MplSTunnelExtNodeIccMapEntry ::= SEQUENCE {
    mplSTunnelExtNodeIccMapCcId      MplsCcId,
    mplSTunnelExtNodeIccMapIccId     MplsIccId,
    mplSTunnelExtNodeIccMapNodeId     MplsNodeId,
    mplSTunnelExtNodeIccMapLocalId    MplsExtendedTunnelId
}

```

mplSTunnelExtNodeIccMapCcId OBJECT-TYPE

SYNTAX MplsCcId

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object allows the operator or service provider to configure a unique MPLS-TP ITU-T Country Code (CC) either for Ingress or Egress LSR ID.

The CC is a string of two alphabetic characters represented with uppercase letters (i.e., A-Z)."

```
 ::= { mplSTunnelExtNodeIccMapEntry 1 }

```

mplSTunnelExtNodeIccMapIccId OBJECT-TYPE

SYNTAX MplsIccId

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object allows the operator or service provider to configure a unique MPLS-TP ITU-T Carrier Code (ICC) either for Ingress or Egress LSR ID.

The ICC is a string of one to six characters, each character being either alphabetic (i.e., A-Z) or numeric (i.e., 0-9) characters. Alphabetic characters in the ICC should be represented with uppercase letters."

```
 ::= { mplSTunnelExtNodeIccMapEntry 2 }

```

mplSTunnelExtNodeIccMapNodeId OBJECT-TYPE

SYNTAX MplsNodeId

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object indicates the Node_ID within the ICC-based operator."


```

 ::= { mplstunnelExtNodeIccMapEntry 3}

mplstunnelExtNodeIccMapLocalId OBJECT-TYPE
    SYNTAX      MplsExtendedTunnelId
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
        "This object contains an ICC-based local identifier
         that is defined in mplstunnelExtNodeConfigTable."
 ::= { mplstunnelExtNodeIccMapEntry 4 }

-- End MPLS Transport Profile Node ICC-based table

-- Start of MPLS Tunnel table extension

mplstunnelExtTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF MplsTunnelExtEntry
    MAX-ACCESS   not-accessible
    STATUS       current
    DESCRIPTION
        "This table represents extensions to mplstunnelTable
         in order to support MPLS-TP Tunnels.

        As per MPLS-TP Identifiers (RFC 6370), LSP_ID for IP-based
        co-routed bidirectional tunnel:

        A1-{Global_ID::Node_ID::Tunnel_Num}::Z9-{Global_ID::
        Node_ID::Tunnel_Num}::LSP_Num

        LSP_ID for IP based associated bidirectional tunnel:
        A1-{Global_ID::Node_ID::Tunnel_Num::LSP_Num}::
        Z9-{Global_ID::Node_ID::Tunnel_Num::LSP_Num}

        mplstunnelTable is reused for forming the LSP_ID
        as follows:

        Source Tunnel_Num is mapped with mplstunnelIndex,
        Source Node_ID is mapped with
        mplstunnelIngressLSRId, Destination Node_ID is
        mapped with mplstunnelEgressLSRId, and LSP_Num is mapped with
        mplstunnelInstance.

        Source Global_ID::Node_ID and/or ICC_Operator_ID::Node_ID and
        Destination Global_ID::Node_ID and/or ICC_Operator_ID::Node-ID
        are maintained in the mplstunnelExtNodeConfigTable.
        mplstunnelExtNodeConfigLocalId is used to create an entry
        in mplstunnelTable."

```

REFERENCE

"MPLS Transport Profile (MPLS-TP) Identifiers, RFC 6370."
 ::= { mplsTeExtObjects 5 }

mplsTunnelExtEntry OBJECT-TYPE

SYNTAX MplsTunnelExtEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table represents additional MPLS-TP-specific tunnel configurations."

INDEX {

mplsTunnelIndex,
 mplsTunnelInstance,
 mplsTunnelIngressLSRId,
 mplsTunnelEgressLSRId

}

::= { mplsTunnelExtTable 1 }

MplsTunnelExtEntry ::= SEQUENCE {

mplsTunnelExtOppositeDirPtr	RowPointer,
mplsTunnelExtOppositeDirTnlValid	TruthValue,
mplsTunnelExtDestTnlIndex	MplsTunnelIndex,
mplsTunnelExtDestTnlLspIndex	MplsTunnelInstanceIndex,
mplsTunnelExtDestTnlValid	TruthValue,
mplsTunnelExtIngressLSRLocalIdValid	TruthValue,
mplsTunnelExtEgressLSRLocalIdValid	TruthValue

}

mplsTunnelExtOppositeDirPtr OBJECT-TYPE

SYNTAX RowPointer

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object points to the opposite-direction tunnel entry."

::= { mplsTunnelExtEntry 1 }

mplsTunnelExtOppositeDirTnlValid OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Denotes whether or not this tunnel uses mplsTunnelExtOppositeDirPtr for identifying the opposite-direction tunnel information. Note that if this variable is set to true, then the mplsTunnelExtOppositeDirPtr should point to the first accessible row of the valid opposite-direction tunnel."

```
DEFVAL { false }  
 ::= { mplsTunnelExtEntry 2 }
```

mplsTunnelExtDestTnlIndex OBJECT-TYPE

SYNTAX MplsTunnelIndex

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object is applicable only for the bidirectional tunnel that has the forward and reverse LSPs in the different tunnel entries.

The values of this object and the mplsTunnelExtDestTnlLspIndex object together can be used to identify an opposite-direction LSP, i.e., if the mplsTunnelIndex and mplsTunnelInstance hold the value for forward LSP, this object and mplsTunnelExtDestTnlLspIndex can be used to retrieve the reverse-direction LSP and vice versa.

This object and mplsTunnelExtDestTnlLspIndex values provide the first two indices of tunnel entry, and the remaining indices can be derived as follows: the Ingress and Egress Identifiers should be swapped in order to index the other direction tunnel."

```
 ::= { mplsTunnelExtEntry 3 }
```

mplsTunnelExtDestTnlLspIndex OBJECT-TYPE

SYNTAX MplsTunnelInstanceIndex

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object is applicable only for the bidirectional tunnel that has the forward and reverse LSPs in the different tunnel entries. This object holds the instance index of the opposite-direction tunnel."

```
 ::= { mplsTunnelExtEntry 4 }
```

mplsTunnelExtDestTnlValid OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Denotes whether or not this tunnel uses mplsTunnelExtDestTnlIndex and mplsTunnelExtDestTnlLspIndex for identifying the opposite-direction tunnel information. Note that if this variable is set to true, then the

mplsTunnelExtDestTnlIndex and
mplsTunnelExtDestTnlLspIndex objects should have
the valid opposite-direction tunnel indices."
DEFVAL { false }
::= { mplsTunnelExtEntry 5 }

mplsTunnelExtIngressLSRLocalIdValid OBJECT-TYPE

SYNTAX TruthValue
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This object denotes whether the mplsTunnelIngressLSRId
contains the local value that is used to reference
the complete Ingress Global_ID::Node_ID or ICC_Operator_ID
from the mplsTunnelExtNodeConfigTable.

If this object is set to FALSE, mplsTunnelExtNodeConfigTable
will not contain an entry to reference the local identifier
with Global_ID::Node_ID or ICC_Operator_ID::Node_ID value.

This object is set to FALSE for legacy implementations like
MPLS TE tunnels where mplsTunnelIngressId itself provides
the complete Ingress LSR ID."

REFERENCE

"MPLS-TE-STD-MIB (RFC 3812), Section 11.

mplsTunnelIngressLSRId object in mplsTunnelTable."

DEFVAL { false }
::= { mplsTunnelExtEntry 6 }

mplsTunnelExtEgressLSRLocalIdValid OBJECT-TYPE

SYNTAX TruthValue
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This object denotes whether the mplsTunnelEgressLSRId
contains the local value, which is used to reference
the complete Egress Global_ID::Node_ID or
ICC_Operator_ID::Node_ID from
the mplsTunnelExtNodeConfigTable.

If this object is set to FALSE, mplsTunnelExtNodeConfigTable
will not contain an entry to reference the local identifier
with Global_ID::Node_ID or ICC_Operator_ID::Node_ID value.

This object is set to FALSE for legacy implementations like
MPLS TE tunnels where mplsTunnelEgressId itself provides
the complete Egress LSR ID."

REFERENCE

"MPLS-TE-STD-MIB (RFC 3812), Section 11.
mplsTunnelEgressLSRId object in mplsTunnelTable."

DEFVAL { false }
::= { mplsTunnelExtEntry 7 }

-- End of MPLS Tunnel table extension

-- Module compliance.

mplsTeExtCompliances

OBJECT IDENTIFIER ::= { mplsTeExtConformance 1 }

mplsTeExtGroups

OBJECT IDENTIFIER ::= { mplsTeExtConformance 2 }

-- Compliance requirement for fully compliant implementations.

mplsTeExtModuleFullCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"Compliance statement for agents that provide full
support the MPLS-TE-EXT-STD-MIB module."

MODULE -- this module

-- The mandatory group has to be implemented by all
-- LSRs that originate/terminate MPLS-TP Tunnels.
-- In addition, depending on the type of tunnels
-- supported, other groups become mandatory as
-- explained below.

MANDATORY-GROUPS {
 mplsTunnelExtGroup
}

GROUP mplsTunnelExtIpOperatorGroup

DESCRIPTION

"This group is mandatory for devices that support
configuration of IP-based identifier tunnels."

GROUP mplsTunnelExtIccOperatorGroup

DESCRIPTION

"This group is mandatory for devices that support
configuration of ICC based tunnels."

::= { mplsTeExtCompliances 1 }

```
-- Compliance requirement for read-only implementations.

mplsTeExtModuleReadOnlyCompliance MODULE-COMPLIANCE
    STATUS current
    DESCRIPTION
        "Compliance statement for agents that only provide
        read-only support for the MPLS-TE-EXT-STD-MIB module."

    MODULE -- this module

MANDATORY-GROUPS {
    mplsTunnelExtGroup
}

GROUP mplsTunnelExtIpOperatorGroup
DESCRIPTION
    "This group is mandatory for devices that support
    configuration of IP-based identifier tunnels."

GROUP mplsTunnelExtIccOperatorGroup
DESCRIPTION
    "This group is mandatory for devices that support
    configuration of ICC-based tunnels."

-- mplsTunnelExtTable

OBJECT      mplsTunnelExtOppositeDirPtr
MIN-ACCESS  read-only
DESCRIPTION
    "Write access is not required."

OBJECT      mplsTunnelExtOppositeDirTnlValid
MIN-ACCESS  read-only
DESCRIPTION
    "Write access is not required."

OBJECT      mplsTunnelExtDestTnlIndex
MIN-ACCESS  read-only
DESCRIPTION
    "Write access is not required."

OBJECT      mplsTunnelExtDestTnlLspIndex
MIN-ACCESS  read-only
DESCRIPTION
    "Write access is not required."
```

OBJECT mplsTunnelExtDestTnlValid
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

OBJECT mplsTunnelExtIngressLSRLocalIdValid
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

OBJECT mplsTunnelExtEgressLSRLocalIdValid
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

OBJECT mplsTunnelExtNodeConfigGlobalId
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

OBJECT mplsTunnelExtNodeConfigNodeId
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

OBJECT mplsTunnelExtNodeConfigStorageType
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

OBJECT mplsTunnelExtNodeConfigRowStatus
SYNTAX RowStatus { active(1) }
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

OBJECT mplsTunnelExtNodeConfigCcId
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

OBJECT mplsTunnelExtNodeConfigIccId
MIN-ACCESS read-only
DESCRIPTION
 "Write access is not required."

```
OBJECT      mplstunnelExtNodeConfigIccValid
MIN-ACCESS  read-only
DESCRIPTION
    "Write access is not required."

    ::= { mplstextCompliances 2 }

-- Units of conformance.

mplstunnelExtGroup OBJECT-GROUP
OBJECTS {
    mplstunnelExtOppositeDirPtr,
    mplstunnelExtOppositeDirTnlValid,
    mplstunnelExtDestTnlIndex,
    mplstunnelExtDestTnlLspIndex,
    mplstunnelExtDestTnlValid,
    mplstunnelExtIngressLSRLocalIdValid,
    mplstunnelExtEgressLSRLocalIdValid
}

STATUS current
DESCRIPTION
    "Necessary, but not sufficient, set of objects to
    implement tunnels. In addition, depending on the
    operating environment, the following groups are
    mandatory."
    ::= { mplstextGroups 1 }

mplstunnelExtIpOperatorGroup OBJECT-GROUP
OBJECTS { mplstunnelExtNodeConfigLocalIdNext,
    mplstunnelExtNodeConfigGlobalId,
    mplstunnelExtNodeConfigNodeId,
    mplstunnelExtNodeIpMapLocalId,
    mplstunnelExtNodeConfigStorageType,
    mplstunnelExtNodeConfigRowStatus
}
STATUS current
DESCRIPTION
    "Object(s) needed to implement IP-compatible tunnels."
    ::= { mplstextGroups 2 }

mplstunnelExtIccOperatorGroup OBJECT-GROUP
OBJECTS { mplstunnelExtNodeConfigLocalIdNext,
    mplstunnelExtNodeConfigCcId,
    mplstunnelExtNodeConfigIccId,
    mplstunnelExtNodeConfigNodeId,
    mplstunnelExtNodeConfigIccValid,
    mplstunnelExtNodeIccMapLocalId,
```



```

        mplsTunnelExtNodeConfigStorageType,
        mplsTunnelExtNodeConfigRowStatus
    }
    STATUS current
    DESCRIPTION
        "Object(s) needed to implement ICC-based tunnels."
    ::= { mplsTeExtGroups 3 }

-- MPLS-TE-EXT-STD-MIB module ends
END

```

14. Security Considerations

This document follows the security considerations mentioned in Section 12 of [RFC3812]. These security considerations are also applicable to the MIB objects and tables defined in this document, which are identified as below.

- The common objects mplsIdGlobalId, mplsIdNodeId, mplsIdCc, and mplsIdIcc are used to define the identity of an MPLS-TP node for OAM purposes. If write-access is allowed to these objects it offers the possibility for incorrect values to be entered that will confuse the information returned by OAM functions and possibly prevent OAM from operating correctly. Furthermore, there is the possibility of inducing one node to impersonate another with confusing results.
- mplsTunnelExtNodeConfigTable, mplsTunnelExtTable and mplsXCExtTable collectively contain objects to provision MPLS-TP Tunnels, tunnel hops, and tunnel resources.

Some of the readable objects in this MIB module (i.e., objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP. These are the tables and objects and their sensitivity/vulnerability:

- mplsTunnelExtNodeConfigTable, mplsTunnelExtTable, and mplsXCExtTable collectively show the characteristics of the MPLS-TP tunnel network topology. If an Administrator does not want to reveal this information, then these tables should be considered sensitive/vulnerable.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec), there is no control as to who on the secure network is allowed to

access and GET/SET (read/change/create/delete) the objects in this MIB module.

Implementations SHOULD provide the security features described by the SNMPv3 framework (see [RFC3410]), and implementations claiming compliance to the SNMPv3 standard MUST include full support for authentication and privacy via the User-based Security Model (USM) [RFC3414] with the AES cipher algorithm [RFC3826]. Implementations MAY also provide support for the Transport Security Model (TSM) [RFC5591] in combination with a secure transport such as SSH [RFC5592] or TLS/DTLS [RFC6353].

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

15. IANA Considerations

As described in [RFC4221] and [RFC6639], and as requested in the MPLS-TC-STD-MIB [RFC3811], MPLS-related Standards Track MIB modules should be rooted under the `mplsStdMIB` subtree. There are four MPLS MIB modules contained in this document; each of the following subsections lists a new assignment made by IANA under the `mplsStdMIB` subtree. New assignments can only be made via a Standards Action as specified in [RFC5226].

15.1. IANA Considerations for MPLS-TC-EXT-STD-MIB

IANA has assigned the OID { `mplsStdMIB 17` } to the MPLS-TC-EXT-STD-MIB module specified in this document.

15.2. IANA Considerations for MPLS-ID-STD-MIB

IANA has assigned the OID { `mplsStdMIB 18` } to the MPLS-ID-STD-MIB module specified in this document.

15.3. IANA Considerations for MPLS-LSR-EXT-STD-MIB

IANA has assigned the OID { `mplsStdMIB 19` } to the MPLS-LSR-EXT-STD-MIB module specified in this document.

15.4. IANA Considerations for MPLS-TE-EXT-STD-MIB

IANA has assigned the OID { mplsStdMIB 20 } to the MPLS-TE-EXT-STD-MIB module specified in this document.

16. References

16.1. Normative References

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