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MPLS-TP Traffic Engineering (TE) Management Information Base (MIB) draft-ietf-mpls-tp-te-mib-08.txt

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 of Tunnels, Identifiers, Label Switching Router and Textual conventions to support Multiprotocol Label Switching (MPLS) MIB modules for transport networks.

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This Internet-Draft will expire on November 7, 2014.

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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 managed objects of Tunnels, Identifiers, Label Switching Router and Textual conventions to support Multiprotocol Label Switching (MPLS) MIB modules for transport networks. MIB modules defined in this document extends the existing MPLS MIB objects in such a way that they support MPLS-TP and Non-MPLS-TP networks as well. Hence, the MPLS-TP name is not included in the MIB module name.

The existing MPLS Traffic Engineering (TE) Management Information Base (MIB) [RFC3812] and Generalized Multiprotocol Label Switching (GMPLS) Traffic Engineering Management Information Base [RFC4802] do not support the management of transport network requirements of Tunnel end points with non-IP based identifiers and static bidirectional tunnels. This document focuses on static bidirectional MIB modules that should be used in conjunction with [RFC3812] and companion document [RFC3813] for MPLS Transport Profile (MPLS-TP) path configuration and management.

It is understood that SNMP SET is not used for MPLS configuration these days, however the read-write and read-create option is still specified for some objects as a way to provide the information model.

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 [RFC2578], STD 58 [RFC2579] and STD 58 [RFC2580].

3. Overview

3.1. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD 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 Switching 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. However, with MPLS-TP, the characteristics of Tunnels were enhanced. 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 service, as defined in [RFC6370], we use the term "MPLS-TP Tunnel" or simply "tunnel" For example, MPLS-TP tunnels, are bidirectional in nature and could be used with non-IP identifiers for the tunnel end points. As the existing MPLS-TE-STD-MIB and GMPLS-TE-STD-MIB were defined mainly to support unidirectional tunnel and signaled co-routed bidirectional tunnel definitions respectively, these existing MIBs 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 re-use the existing MIB definition instead of a defining a new MIB.

This document defines four 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 new MIB modules are required for MPLS-TP functionality, these are retained in the same document, instead of a separate document.

5. Feature List

This document identifies the following requirements and constraints:

The MIB module supports static and signaled point-to-point, co-routed bi-directional and associated bi-directional tunnels.

- The MPLS tunnels need not be interfaces, but it is possible to configure an MPLS TP tunnel as an interface.

- The mplsTunnelTable [RFC3812] to be also used for MPLS-TP tunnels

- New MPLS-TP specific textual conventions and identifiers

- The mplsTunnelTable is sparsely extended to support MPLS-TP tunnel specific objects.

- A node configuration table (mplsTunnelExtNodeConfigTable) is used to translate the Global_ID::Node_ID or ICC_Operator_ID::Node_ID to the local identifier in order to index mplsTunnelTable.

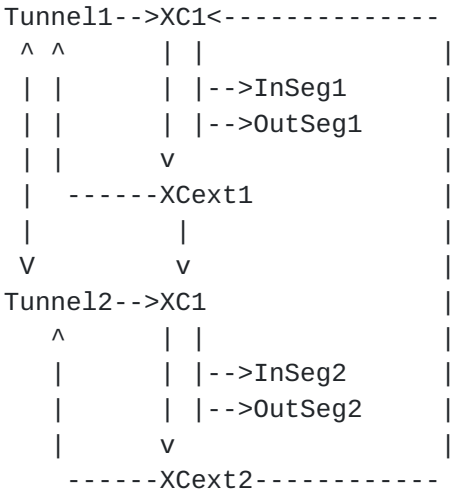
- The mplsXCTable is sparsely extended to support MPLS-TP XC(Cross Connect) specific objects.

- The MIB module supports persistent, as well as non-persistent tunnels.

6. Brief description of MIB modules

This section describes the MIB modules present in this document. The tables and MIB modules that are mentioned in the below subsections support the functionality described in documents [RFC5654] and [RFC6370]. The tables support both IP compatible and ICC based tunnel configurations.

The below diagram depicts how the table references are followed in this MIB.



6.1. 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 alphabetic characters represented with upper case letters (i.e., A-Z). 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 upper case letters. 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. 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 environment, 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 environment, 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 LSR ID in mplsTunnelTable. As the regular TE tunnels use IP address as LSR ID, the local identifier should be below the first valid IP address, which is 16777216[1.0.0.0].

6.2. 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, while indexing mplsTunnelTable.

6.3. 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, while indexing mplsTunnelTable.

6.4. mplsTunnelExtTable

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

6.5 MPLS-TC-EXT-STD-MIB

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

6.6 MPLS-ID-STD-MIB

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

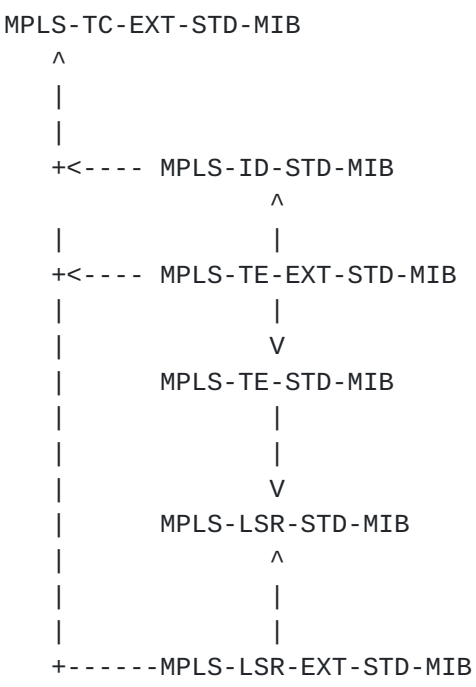
6.7 MPLS-LSR-EXT-STD-MIB

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

7. MIB Module Interdependencies

This section provides an overview of the relationship 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 "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.



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.

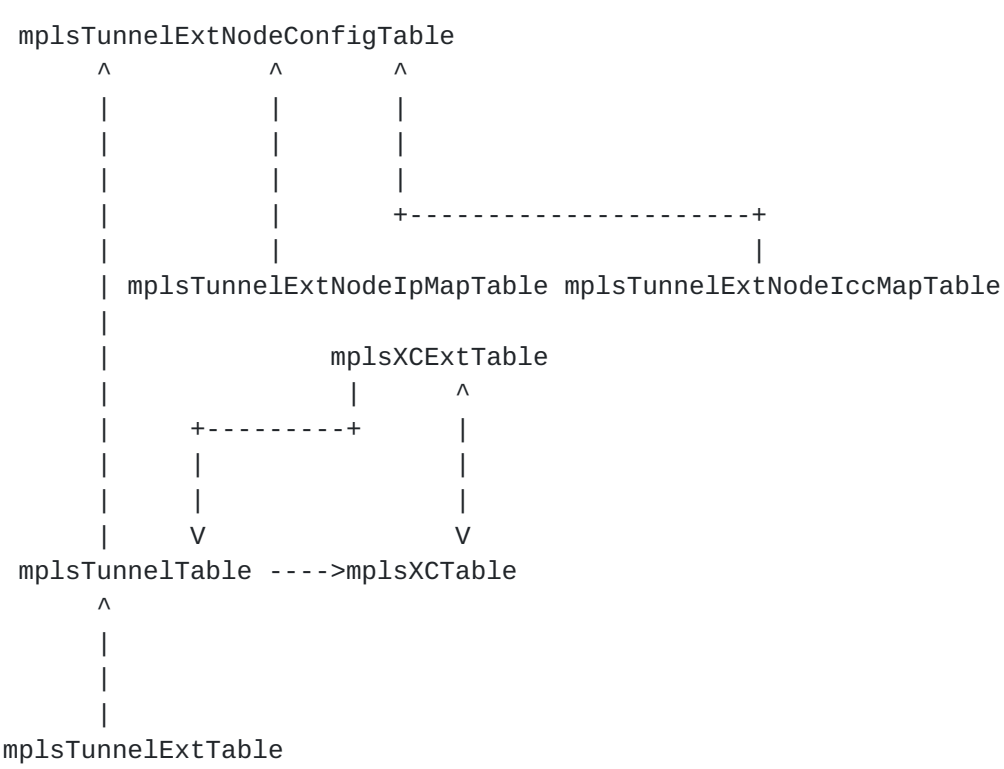
The mplsXCExtTable sparsely extends the mplsXCTable of MPLS-LSR-STD-MIB [RFC3813]. This helps in pointing back to the tunnel entry for easy tunnel access from XC entry.

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.



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.

New mplsTunnelExtTable table provides the reverse direction LSP information for the existing tunnel table in order to achieve bidirectional LSPs.

mplsXCExtTable 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 to configure MPLS-TP bidirectional tunnels with IP tunnel identifiers. This example provides the usage of MPLS-TP Tunnel MIB along with the extended new MIB modules introduced in this document.

Do note that a MPLS-TP tunnel could be setup statically as well as signaled via control plane. This example considers accessing MIB objects on a head-end for a static and signaled MPLS-TP tunnels. This section shows the configuration of the forward and reverse direction MPLS-TP LSPs that runs between East and West and vice-versa. Only

relevant objects which are applicable for MPLS-TP tunnel 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. A separate entry is made for both Ingress LSR and Egress LSR.

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

}
```

We must next 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 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 has two different direction tunnels[Forward and Reverse LSPs] and these are associated together using mplsTunnelExtTable. Two different tunnel entries for both forward and reverse direction MAY be used for co-routed bidirectional tunnel 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 bi-directional
                                  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 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          = 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)
  }
```

9.2.4. 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 bi-directional
                                    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 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

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

```
  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.

9.2.9. 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 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 and 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 [RFC3812] and [RFC4802] for signaled tunnel table configuration examples.

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 a first available
```

```
   -- local identifier which 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 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
   }
```

We must next 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 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 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 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               -- [RFC2578]

      TEXTUAL-CONVENTION
         FROM SNMPv2-TC                -- [RFC2579]

      mplsStdMIB
         FROM MPLS-TC-STD-MIB          -- [RFC3811]

      ;

   mplsTcExtStdMIB MODULE-IDENTITY

      LAST-UPDATED
         "201405050000Z" -- May 05, 2014
      ORGANIZATION
         "Multiprotocol Label Switching (MPLS) Working Group"
      CONTACT-INFO
         "
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                Santa Clara, CA 95051, USA
          Email:  aldrin.ietf@gmail.com

                Thomas D. Nadeau
          Email: tnadeau@lucidvision.com
         "
      DESCRIPTION
          "Copyright (c) 2014 IETF Trust and the persons identified
           as the document authors.  All rights reserved.

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

      -- Revision history.
```

```
      REVISION

         "201405050000Z" -- May 05, 2014
      DESCRIPTION
           "MPLS Textual Convention Extensions"

      ::= { mplsStdMIB xxx } -- xxx to be replaced with correct value

   MplsGlobalId ::= TEXTUAL-CONVENTION
      STATUS      current
      DESCRIPTION
           "This object contains the Textual Convention of 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 AS number,
            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 an 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, [RFC6370]
            Section 3"
      SYNTAX  OCTET STRING (SIZE (4))

   MplsCcId ::= TEXTUAL-CONVENTION
      STATUS      current
      DESCRIPTION
           "The CC (Country Code) is a string of two alphabetic
            characters represented with upper case
            letters (i.e., A-Z). The size of the CC string MUST be
            zero if the CC identifier is invalid."
   REFERENCE
           "MPLS-TP Identifiers Following ITU-T Conventions,
            [RFC6923] Section 3"
   SYNTAX  OCTET STRING (SIZE (2))

   MplsIccId ::= TEXTUAL-CONVENTION
      STATUS      current
      DESCRIPTION
           "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 upper case letters. The size of the ICC string MUST
            be zero if the ICC identifier is invalid."
   REFERENCE
           "MPLS-TP Identifiers Following ITU-T Conventions,
           [RFC6923] Section 3"
   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 loop back 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 reach ability 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
           the invalid Node identifier."
      REFERENCE
           "MPLS Transport Profile (MPLS-TP) Identifiers, [RFC6370]
            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                                 -- [RFC2578]
     MODULE-COMPLIANCE, OBJECT-GROUP
        FROM SNMPv2-CONF                                -- [RFC2580]
     mplsStdMIB
        FROM MPLS-TC-STD-MIB                            -- [RFC3811]
     MplsGlobalId, MplsCcId, MplsIccId, MplsNodeId
        FROM MPLS-TC-EXT-STD-MIB
```

```
    ;

   mplsIdStdMIB MODULE-IDENTITY
     LAST-UPDATED
        "201405050000Z" -- May 05, 2014
     ORGANIZATION
        "Multiprotocol Label Switching (MPLS) Working Group"

     CONTACT-INFO
        "
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               Santa Clara, CA 95051, USA
         Email:  aldrin.ietf@gmail.com

               Thomas D. Nadeau
         Email: tnadeau@lucidvision.com
       "
     DESCRIPTION
         "Copyright (c) 2014 IETF Trust and the persons identified
          as the document authors.  All rights reserved.

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

     -- Revision history.

     REVISION
         "201405050000Z" -- May 05, 2014
     DESCRIPTION
          "This MIB modules defines the MIB objects for MPLS-TP
           identifiers"

     ::= { mplsStdMIB xxx } -- xxx to be replaced with correct value
```

```
    -- 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 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,
             [RFC6923] 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,
             [RFC6923] 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 which support
             IP based identifier configuration."

        GROUP mplsIdIccOperatorGroup
        DESCRIPTION
            "This group is mandatory for devices which 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 which support
             IP based identifier configuration."

        GROUP mplsIdIccOperatorGroup
        DESCRIPTION
            "This group is mandatory for devices which 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 ICC based
                   node."
              ::= { mplsIdGroups 1 }

        mplsIdIccOperatorGroup OBJECT-GROUP
              OBJECTS { mplsIdNodeId,
                        mplsIdCc,
                        mplsIdIcc

              }
              STATUS  current
              DESCRIPTION
                 "The objects in this group are optional for 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                                -- [RFC2578]
      MODULE-COMPLIANCE, OBJECT-GROUP
         FROM SNMPv2-CONF                               -- [RFC2580]
      mplsStdMIB
         FROM MPLS-TC-STD-MIB                           -- [RFC3811]
      RowPointer
         FROM SNMPv2-TC                                 -- [RFC2579]
      mplsXCIndex, mplsXCInSegmentIndex, mplsXCOutSegmentIndex,
      mplsInterfaceGroup, mplsInSegmentGroup, mplsOutSegmentGroup,
```

```
      mplsXCGroup, mplsLsrNotificationGroup
         FROM MPLS-LSR-STD-MIB;                          -- [RFC3813]

   mplsLsrExtStdMIB MODULE-IDENTITY
      LAST-UPDATED
         "201405050000Z" -- May 05, 2014
      ORGANIZATION
         "Multiprotocol Label Switching (MPLS) Working Group"
      CONTACT-INFO
         "
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               Thomas D. Nadeau
         Email: tnadeau@lucidvision.com
        "
      DESCRIPTION
          "Copyright (c) 2014 IETF Trust and the persons identified
           as the document authors.  All rights reserved.

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

      -- Revision history.

      REVISION
        "201405050000Z" -- May 05, 2014
      DESCRIPTION
           "MPLS LSR specific MIB objects extension"

      ::= { mplsStdMIB xxx } -- xxx to be replaced with correct value
```

```
   -- 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 [RFC3813] to provide MPLS-TP specific
           information about associated tunnel information"
       REFERENCE
          "1. 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 [RFC3813] 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
          "1. 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
          "1. 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)."
       REFERENCE
          "1. 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, RFC3813

     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 which 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 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

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

     IMPORTS
        MODULE-IDENTITY, OBJECT-TYPE, Counter32,
           Counter64, zeroDotZero

           FROM SNMPv2-SMI                              -- [RFC2578]
```

```
        MODULE-COMPLIANCE, OBJECT-GROUP
           FROM SNMPv2-CONF                              -- [RFC2580]
        TruthValue, RowStatus, RowPointer, StorageType
           FROM SNMPv2-TC                                -- [RFC2579]
        IndexIntegerNextFree
           FROM DIFFSERV-MIB                             -- [RFC3289]
        MplsGlobalId, MplsNodeId, MplsCcId, MplsIccId
           FROM MPLS-TC-EXT-STD-MIB
        mplsStdMIB, MplsTunnelIndex, MplsTunnelInstanceIndex,
        MplsExtendedTunnelId
           FROM MPLS-TC-STD-MIB                          -- [RFC3811]
        mplsTunnelIndex, mplsTunnelInstance, mplsTunnelIngressLSRId,
        mplsTunnelEgressLSRId
           FROM MPLS-TE-STD-MIB                          -- [RFC3812]
        ;

     mplsTeExtStdMIB MODULE-IDENTITY
        LAST-UPDATED
            "201405050000Z" -- May 05, 2014
        ORGANIZATION
           "Multiprotocol Label Switching (MPLS) Working Group"
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              "
        DESCRIPTION
            "Copyright (c) 2014 IETF Trust and the persons identified
             as the document authors.  All rights reserved.

             This MIB module contains generic object definitions for
```

```
            MPLS Traffic Engineering in transport networks."


        -- Revision history.

        REVISION
           "201405050000Z" -- May 05, 2014

        DESCRIPTION
             "MPLS TE MIB objects extension"

        ::= { mplsStdMIB xxx } -- xxx to be replaced
                               -- with correct value

     -- 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."

       ::= { mplsTeExtObjects 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
          with node or LSR.

          As per [RFC6370], IP compatible mapping is represented
          as Global_ID::Node_ID.

          As per [RFC6923], 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 lower size LSR identifier in order to index
            the mplsTunnelTable.

            The Local Identifier is configured between 0 and 16777215,
            as valid IP address range starts from 16777216(01.00.00.00).
            This range is chosen to identify the mplsTunnelTable's
            Ingress/Egress LSR-id is IP address or Local identifier,
            if the configured range is not IP address, operator is
            expected to retrieve the complete information
            (Global_ID::Node_ID or ICC_Operator_ID::Node_ID) from
            mplsTunnelExtNodeConfigTable.
            This way, existing mplsTunnelTable is reused for
            bidirectional tunnel extensions for MPLS based transport
            networks.

            This 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 the 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 [RFC6370]
                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 false."
             REFERENCE
                "MPLS-TP Identifiers Following ITU-T Conventions,
                [RFC6923] 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 false."
             REFERENCE
                "MPLS-TP Identifiers Following ITU-T Conventions,
                 [RFC6923] 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 [RFC6370]
                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 and 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 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
            which 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 and 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 upper case 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 upper case
              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
            which 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 [RFC6370], 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 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 and
```

```
          mplsTunnelExtNodeConfigLocalId is used to create an entry
          in mplsTunnelTable."
       REFERENCE
             "MPLS Transport Profile (MPLS-TP) Identifiers [RFC6370]."
       ::= { mplsTeExtObjects 5 }

      mplsTunnelExtEntry OBJECT-TYPE
      SYNTAX        MplsTunnelExtEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
            "An entry in this table represents MPLS-TP
             specific additional 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, which 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 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
           complete Ingress LSRId."
         REFERENCE
           "MPLS-TE-STD-MIB [RFC3812], 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 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
          complete Egress LSRId."
        REFERENCE
          "MPLS-TE-STD-MIB [RFC3812], 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 which support
               configuration of IP based identifier tunnels."

          GROUP mplsTunnelExtIccOperatorGroup
          DESCRIPTION
              "This group is mandatory for devices which 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 MPLS-TE-EXT-STD-MIB module."

       MODULE -- this module

    MANDATORY-GROUPS    {
       mplsTunnelExtGroup
    }

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

    GROUP mplsTunnelExtIccOperatorGroup
    DESCRIPTION
        "This group is mandatory for devices which 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."



          ::= { mplsTeExtCompliances 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."
          ::= { mplsTeExtGroups 1 }

     mplsTunnelExtIpOperatorGroup  OBJECT-GROUP
          OBJECTS { mplsTunnelExtNodeConfigLocalIdNext,
                    mplsTunnelExtNodeConfigGlobalId,
                    mplsTunnelExtNodeConfigNodeId,
                    mplsTunnelExtNodeIpMapLocalId,
                    mplsTunnelExtNodeConfigStorageType,
                    mplsTunnelExtNodeConfigRowStatus
          }
          STATUS  current
          DESCRIPTION
               "Object(s) needed to implement IP compatible tunnels."
          ::= { mplsTeExtGroups 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 Consideration

It is clear that this MIB module is potentially useful for the monitoring of MPLS TE tunnels. This MIB module can also be used for the configuration of certain objects, and anything that can be configured can be incorrectly configured, with potentially disastrous results.

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. These are the tables and objects and their sensitivity/vulnerability:

- the tables specified in [RFC3812], [RFC3813] and this document MIB tables mplsTunnelExtNodeConfigTable, mplsTunnelExtTable and mplsXCExtTable collectively contain objects to provision MPLS-TP tunnels, tunnel hops, and tunnel resources.
  Unauthorized access to objects in these tables, could result in disruption of traffic on the network. This is especially true if a tunnel has been established. The use of stronger mechanisms, such as SNMPv3 security, should be considered where possible. Specifically, SNMPv3 VACM and USM MUST be used with any v3 agent which implements this MIB. Administrators should consider whether read access to these objects should be allowed, since read access may be undesirable under certain circumstances.

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:

- the tables specified in [RFC3812], [RFC3813] and this document MIB tables mplsTunnelExtNodeConfigTable, mplsTunnelExtTable, and mplsXCExtTable collectively show the MPLS-TP tunnel network topology characteristics. 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), even then, 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.

It is recommended that implementers consider the security features as provided by the SNMPv3 framework (see [RFC3410], section 8), including full supports for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

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 principles (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

15. IANA Considerations

As described in [RFC4221], [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 4 MPLS MIB Modules contained in this document, each of the following "IANA Considerations" subsections requests IANA for a new assignment 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 is requested to assign an OID { mplsStdMIB OID } to the MPLS-TC-EXT-STD-MIB module specified in this document.

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

IANA is requested to assign an OID { mplsStdMIB OID } to the MPLS-ID-STD-MIB module specified in this document.

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

IANA is requested to assign an OID { mplsStdMIB OID } to the MPLS-LSR-EXT-STD-MIB module specified in this document.

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

IANA is requested to assign an OID { mplsStdMIB OID } to the MPLS-TE-EXT-STD-MIB module specified in this document.

16. References

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