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Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB)

Status of this Memo

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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 managed objects for Multiprotocol Label Switching (MPLS) based traffic engineering (TE).

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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 managed objects for modeling a Multiprotocol Label Switching (MPLS) [RFC3031] based traffic engineering. This MIB module should be used in conjunction with the companion document [RFC3813] for MPLS based traffic engineering configuration and management.

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 BCP 14, RFC 2119, reference [RFC2119].

2. Terminology

This document uses terminology from the MPLS architecture document [RFC3031] and MPLS Label Switch Router MIB [RFC3813]. Some frequently used terms are described next.

An explicitly routed LSP (ERLSP) is referred to as an MPLS tunnel. It consists of in-segment(s) and/or out-segment(s) at the egress/ingress LSRs, each segment being associated with one MPLS interface. These are also referred to as tunnel segments. Additionally, at an intermediate LSR, we model a connection as consisting of one or more in-segments and/or one or more out-segments. The binding or interconnection between in-segments and out-segments is performed using a cross-connect. These objects are defined in the MPLS Label Switch Router MIB [RFC3813].

3. 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].

4. Feature List

The MPLS traffic engineering MIB module is designed to satisfy the following requirements and constraints:

- The MIB module supports configuration of point-to-point unidirectional tunnels.

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

- The MIB module supports tunnel establishment via an MPLS signalling protocol wherein the tunnel parameters are specified using this MIB module at the head end of the LSP, and end-to-end tunnel LSP establishment is accomplished via signalling. The MIB module also supports manually configured tunnels, i.e., those for which label associations at each hop of the tunnel LSP are provisioned by the administrator via the LSR MIB [RFC3813].

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

5. Outline

Traffic engineering support for MPLS tunnels requires the following configuration:

- Setting up MPLS tunnels along with appropriate configuration parameters.

- Configuring tunnel for loose and strict source routed hops.

These actions may need to be accompanied by corresponding actions using [RFC3813] to establish and configure tunnel segments, if this is done manually. Also, the in-segment and out-segment performance tables, mplsInSegmentPerfTable, and mplsOutSegmentPerfTable [RFC3813], should be used to determine performance of the tunnels and tunnel segments, in addition to mplsTunnelPerfTable in this MIB module.

5.1. Summary of Traffic Engineering MIB Module

The MIB module objects for performing these actions consist of the following tables:

- Tunnel table (mplsTunnelTable) for setting up MPLS tunnels.

- Resource table (mplsTunnelResourceTable) for setting up the tunnel resources.

- Tunnel specified, actual, and computed hop tables (mplsTunnelHopTable, mplsTunnelARHopTable, and mplsTunnelCHopTable) for strict and loose source routed MPLS tunnel hops.

- Tunnel performance table (mplsTunnelPerfTable) for measuring tunnel performance.

- CRLDP resource table (mplsTunnelCRLDPResTable) for specifying resource objects applicable to tunnels signaled using CRLDP.

These tables are described in the subsequent sections.

6. Brief Description of MIB Objects

The objects described in this section support the functionality described in documents [RFC3209] and [RFC3212]. The tables support both manually configured and signaled tunnels.

6.1. mplsTunnelTable

The mplsTunnelTable allows new MPLS tunnels to be created between an MPLS LSR and a remote endpoint, and existing tunnels to be reconfigured or removed. Note that we only support point-to-point tunnels, although multipoint-to-point and point-to-multipoint connections are supported by an LSR acting as a cross-connect. Each MPLS tunnel can thus have one out-segment originating at an LSR and/or one in-segment terminating at that LSR.

mplsTunnelTable does not define the in and out segments forming the tunnel. Instead, these are defined by creating rows in the in-segment and out-segment tables, defining relationships in the cross-connect table, and referring to these rows in the mplsTunnelTable using a cross-connect index, mplsTunnelXCIndex. These segment and cross-connect related objects are defined in [RFC3813].

6.2. mplsTunnelResourceTable

mplsTunnelResourceTable is used to indicate the resources required for a tunnel. Multiple tunnels may share the same resources by pointing to the same entry in this table. Tunnels that do not share resources must point to separate entries in this table.

6.3. mplsTunnelHopTable

mplsTunnelHopTable is used to indicate the hops, strict or loose, for an MPLS tunnel defined in mplsTunnelTable, when it is established via signalling. Multiple tunnels may share the same hops by pointing to the same entry in this table. Each row also has a secondary index, mplsTunnelHopIndex, corresponding to the next hop of this tunnel. The scalar mplsTunnelMaxHops indicates the maximum number of hops that can be specified on each tunnel supported by this LSR.

At transit LSRs, this table contains the hops, strict or loose, that apply to the downstream part of this tunnel only. This corresponds to the requested path received through the signaling protocol.

6.4. mplsTunnelARHopTable

mplsTunnelARHopTable is used to indicate the actual hops traversed by a tunnel as reported by the MPLS signalling protocol after the tunnel is setup. The support of this table is optional since not all MPLS signalling protocols may support this feature.

At transit LSRs, this table contains the actual hops traversed by the tunnel along its entire length if that information is available. This corresponds to the recorded path reported by the MPLS signalling protocol, possibly derived from multiple signaling messages.

6.5. mplsTunnelCHoptable

mplsTunnelCHopTable lists the actual hops computed by a constraint-based routing algorithm based on the mplsTunnelHopTable for the MPLS signalling protocol in use. The support of this table is optional since not all implementations may support computation of hop lists using a constraint-based routing protocol.

At transit LSRs, this table contains the hops computed to apply to the downstream part of this tunnel. This corresponds to the requested path signaled from this LSR through the signaling protocol.

6.6. mplsTunnelPerfTable

mplsTunnelPerfTable provides several counters to measure the performance of the MPLS tunnels. This table augments mplsTunnelTable.

6.7. mplsTunnelCRLDPResTable

mplsTunnelCRLDPResTable contains resource information for those tunnels that are signaled using CRLDP [RFC3212]. This is a sparse extension to mplsTunnelResourceTable and is also indexed by mplsTunnelResourceIndex. As with mplsTunnelResourceTable, multiple tunnels may share the same resources by pointing to the same entry in this table. Tunnels that do not share resources must point to separate entries in this table. The mplsTunnelCRLDPResTable may be supported only by implementations that support the CR-LDP signaling protocol.

7. Use of 32-bit and 64-bit Counters

64-bit counters are provided in this MIB module for high-speed interfaces where the use of 32-bit counters might be impractical. The requirements on the use of 32-bit and 64-bit counters (copied verbatim from [RFC2863]) are as follows:

For interfaces that operate at 20,000,000 (20 million) bits per second or less, 32-bit byte and packet counters MUST be supported. For interfaces that operate faster than 20,000,000 bits/second, and slower than 650,000,000 bits/second, 32-bit packet counters MUST be supported and 64-bit octet counters MUST be supported. For interfaces that operate at 650,000,000 bits/second or faster, 64-bit packet counters AND 64-bit octet counters MUST be supported.

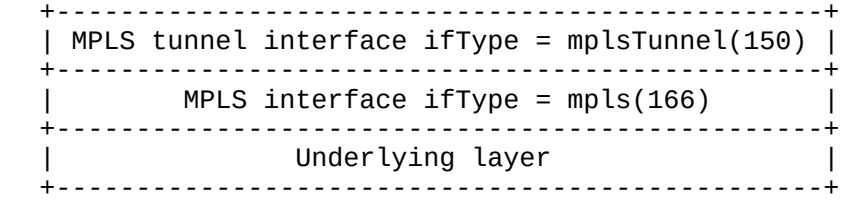
8. Application of the Interface Group to MPLS Tunnels

The Interfaces Group of MIB II defines generic managed objects for managing interfaces. This memo contains the media-specific extensions to the Interfaces Group for managing MPLS Tunnels as logical interfaces.

This memo assumes the interpretation of the Interfaces Group to be in accordance with [RFC2863] which states that the interfaces table (ifTable) contains information on the managed resource's interfaces and that each sub-layer below the internetwork layer of a network

interface is considered an interface. Thus, the MPLS interface is represented as an entry in the ifTable. The inter-relation of entries in the ifTable is defined by the Interfaces Stack Group defined in [RFC2863].

When using MPLS Tunnels as interfaces, the interface stack table might appear as follows:



In the above diagram, "Underlying Layer" refers to the ifIndex of any interface type for which MPLS internetworking has been defined. Examples include ATM, Frame Relay, and Ethernet.

8.1. Support of the MPLS Tunnel Interface by ifTable

Some specific interpretations of the ifTable for those MPLS tunnels represented as interfaces follow:

Object	Use for the MPLS tunnel.
ifIndex	Each MPLS tunnel is represented by an ifEntry.
ifDescr	Description of the MPLS tunnel.
ifType	The value that is allocated for the MPLS tunnel is 150.
ifSpeed	The total bandwidth in bits per second for use by the MPLS tunnel.
ifPhysAddress	Unused.
ifAdminStatus	See [RFC2863].
ifOperStatus	This value reflects the actual operational status of the MPLS tunnel. Assumes the value down(2) if the MPLS tunnel is down.
ifLastChange	See [RFC2863].

ifInOctets	The number of octets received over the MPLS tunnel.
ifOutOctets	The number of octets transmitted over the MPLS tunnel.
ifInErrors	The number of labeled packets dropped due to uncorrectable errors.
ifInUnknownProtos	The number of received packets discarded during packet header validation, including packets with unrecognized label values.
ifOutErrors	See [RFC2863].
ifName	Textual name (unique on this system) of the MPLS tunnel or an octet string of zero length.
ifLinkUpDownTrapEnable	Default is disabled (2).
ifConnectorPresent	Set to false (2).
ifHighSpeed	See [RFC2863].
ifHCInOctets	The 64-bit version of ifInOctets; supported if required by the compliance statements in [RFC2863].
ifHCOutOctets	The 64-bit version of ifOutOctets; supported if required by the compliance statements in [RFC2863].
ifAlias	The non-volatile 'alias' name for the MPLS tunnel as specified by a network manager.

9. Example of Tunnel Setup

This section contains an example of which MIB objects should be modified if one would like to create a best effort, loosely routed, unidirectional traffic engineered tunnel, which spans two hops of a simple network. Note that these objects should be created on the "head-end" LSR. Those objects relevant to illustrating the relationships amongst different tables are shown here. Other objects may be needed before conceptual row activation can happen.

The RowStatus values shown in this section are those to be used in the set request, typically createAndGo(4) which is used to create the conceptual row and have its status immediately set to active. A subsequent retrieval operation on the conceptual row will return a different value, such as active(1). Please see [RFC2579] for a detailed discussion on the use of RowStatus.

In mplsTunnelResourceTable:

```
{
  mplsTunnelResourceIndex           = 5,
  mplsTunnelResourceMaxRate         = 0,
  mplsTunnelResourceMeanRate        = 0,
  mplsTunnelResourceMaxBurstSize    = 0,
  mplsTunnelResourceMeanBurstSize   = 0,
  mplsTunnelResourceExBurstSize     = 0,
  mplsTunnelResourceExBurstSize     = unspecified (1),
  mplsTunnelResourceWeight          = 0,
-- Mandatory parameters needed to activate the row go here
  mplsTunnelResourceRowStatus       = createAndGo (4)
}
```

The next two instances of mplsTunnelHopEntry are used to denote the hops this tunnel will take across the network.

The following denotes the beginning of the tunnel, or the first hop. We have used the fictitious LSR identified by "192.168.100.1" as our example head-end router.

In mplsTunnelHopTable:

```
{
  mplsTunnelHopListIndex          = 1,
  mplsTunnelPathOptionIndex       = 1,
  mplsTunnelHopIndex              = 1,
  mplsTunnelHopAddrType           = ipv4 (1),
  mplsTunnelHopIpAddr             = "192.168.100.1",
  mplsTunnelHopIpPrefixLen        = 32,
  mplsTunnelHopType               = strict (2),
  mplsTunnelHopInclude            = true (1),
  mplsTunnelHopPathOptionName     = "Here to there",
  mplsTunnelHopEntryPathComp      = explicit (2),
-- Mandatory parameters needed to activate the row go here
  mplsTunnelHopRowStatus          = createAndGo (4)
}
```

The following denotes the end of the tunnel, or the last hop in our example. We have used the fictitious LSR identified by "192.168.101.1" as our end router.

In mplsTunnelHopTable:

```
{
  mplsTunnelHopListIndex          = 1,
  mplsTunnelPathOptionIndex       = 1,
  mplsTunnelHopIndex              = 2,
  mplsTunnelHopAddrType           = ipv4 (1),
  mplsTunnelHopIpAddr             = "192.168.101.1",
  mplsTunnelHopIpPrefixLen        = 32,
  mplsTunnelHopType               = loose (2),
  mplsTunnelHopInclude            = true (1),
  mplsTunnelHopPathOptionName     = "Here to there",
  mplsTunnelHopEntryPathComp      = explicit (2),
-- Mandatory parameters needed to activate the row go here
  mplsTunnelHopRowStatus          = createAndGo (4)
}
```

The following denotes the configured tunnel "head" entry:

In mplsTunnelTable:

```
{
  mplsTunnelIndex             = 1,
  mplsTunnelInstance          = 0,
  mplsTunnelIngressLSRId      = 192.168.100.1,
  mplsTunnelEgressLSRId       = 192.168.101.1,
  mplsTunnelName              = "My first tunnel",
  mplsTunnelDescr             = "Here to there",
  mplsTunnelIsIf              = true (1),
--  RowPointer MUST point to the first accessible column
  mplsTunnelXCPointer         = 0.0,
  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,
  mplsTunnelPathInUse         = 1,
```

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

Note that any active or signaled instances of the above tunnel would appear with the same primary mplsTunnelIndex, but would have values greater than 0 for mplsTunnelInstance. They would also have other objects such as the mplsTunnelXCPointer set accordingly.

10. The Use of RowPointer

RowPointer is a textual convention used to identify a conceptual row in a conceptual table in a MIB by pointing to the first accessible object. In this MIB module, in mplsTunnelTable, the objects mplsTunnelXCPointer and mplsTunnelResourcePointer are of type RowPointer. The object mplsTunnelXCPointer points to a specific entry in the mplsXCTable [RFC3813]. This entry in the mplsXCTable is the associated LSP for the given MPLS tunnel entry. The object mplsTunnelResourcePointer points to a specific entry in a traffic parameter table. An example of such a traffic parameter table is mplsTunnelResourceTable. It indicates a specific instance of a traffic parameter entry that is associated with a given MPLS tunnel entry. These RowPointer objects MUST point to the first instance of the first accessible columnar object in the appropriate conceptual row in order to allow the manager to find the appropriate corresponding entry in either MPLS-LSR-STD-MIB [RFC3813] or MPLS-TE-STD-MIB. If object mplsTunnelXCPointer returns zeroDotZero, it implies that there is no LSP associated with that particular instance of tunnel entry. If object mplsTunnelResourcePointer returns zeroDotZero, it implies that there is no QoS resource associated with that particular instance of tunnel entry.

11. MPLS Traffic Engineering MIB Definitions

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

IMPORTS
   MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
   Integer32, Unsigned32, Counter32, Counter64, TimeTicks,
   zeroDotZero
      FROM SNMPv2-SMI                                  -- [RFC2578]
   MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
      FROM SNMPv2-CONF                                 -- [RFC2580]
   TruthValue, RowStatus, RowPointer, StorageType,
   TimeStamp
      FROM SNMPv2-TC                                   -- [RFC2579]
   InterfaceIndexOrZero, ifGeneralInformationGroup,
```

```
      ifCounterDiscontinuityGroup
         FROM IF-MIB                                        -- [RFC2863]
      mplsStdMIB, MplsBitRate, MplsBurstSize, MplsLSPID,
      MplsTunnelIndex, MplsTunnelInstanceIndex,
      MplsTunnelAffinity, MplsExtendedTunnelId, MplsPathIndex,
      MplsPathIndexOrZero, MplsOwner, TeHopAddressType,
      TeHopAddress, TeHopAddressAS, TeHopAddressUnnum
         FROM MPLS-TC-STD-MIB                               -- [RFC3811]
      SnmpAdminString
         FROM SNMP-FRAMEWORK-MIB                            -- [RFC3411]
      IndexIntegerNextFree
         FROM DIFFSERV-MIB                                  -- [RFC3289]
      InetAddressPrefixLength
         FROM INET-ADDRESS-MIB                              -- [RFC3291]
      ;

   mplsTeStdMIB MODULE-IDENTITY
      LAST-UPDATED
         "200406030000Z" -- June 3, 2004
      ORGANIZATION
         "Multiprotocol Label Switching (MPLS) Working Group"
      CONTACT-INFO
           "        Cheenu Srinivasan
                    Bloomberg L.P.
            Email:  cheenu@bloomberg.net

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                   Comments about this document should be emailed
                   directly to the MPLS working group mailing list at
                   mpls@uu.net."
      DESCRIPTION
            "Copyright (C) The Internet Society (2004). The
            initial version of this MIB module was published
            in RFC 3812. For full legal notices see the RFC
            itself or see: http://www.ietf.org/copyrights/ianamib.html

            This MIB module contains managed object definitions
             for MPLS Traffic Engineering (TE) as defined in:
            1. Extensions to RSVP for LSP Tunnels, Awduche et
             al, RFC 3209, December 2001
            2. Constraint-Based LSP Setup using LDP, Jamoussi
```

```
             (Editor), RFC 3212, January 2002
            3. Requirements for Traffic Engineering Over MPLS,
             Awduche, D., Malcolm, J., Agogbua, J., O'Dell, M.,
             and J. McManus, [RFC2702], September 1999"

      -- Revision history.

      REVISION
         "200406030000Z" -- June 3, 2004
      DESCRIPTION
           "Initial version issued as part of RFC 3812."

      ::= { mplsStdMIB 3 }

   -- Top level components of this MIB module.

   -- traps
   mplsTeNotifications OBJECT IDENTIFIER ::= { mplsTeStdMIB 0 }
   -- tables, scalars
   mplsTeScalars       OBJECT IDENTIFIER ::= { mplsTeStdMIB 1 }
   mplsTeObjects       OBJECT IDENTIFIER ::= { mplsTeStdMIB 2 }
   -- conformance
   mplsTeConformance   OBJECT IDENTIFIER ::= { mplsTeStdMIB 3 }


   -- MPLS Tunnel scalars.

   mplsTunnelConfigured OBJECT-TYPE
      SYNTAX        Unsigned32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "The number of tunnels configured on this device. A
             tunnel is considered configured if the
             mplsTunnelRowStatus is active(1)."
      ::= { mplsTeScalars 1 }

   mplsTunnelActive OBJECT-TYPE
      SYNTAX        Unsigned32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "The number of tunnels active on this device. A
             tunnel is considered active if the
             mplsTunnelOperStatus is up(1)."
      ::= { mplsTeScalars 2 }

   mplsTunnelTEDistProto OBJECT-TYPE
```

```
      SYNTAX        BITS {
             other (0),
             ospf (1),
             isis (2)
         }
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "The traffic engineering distribution protocol(s)
            used by this LSR. Note that an LSR may support more
            than one distribution protocol simultaneously."
      ::= { mplsTeScalars 3 }

   mplsTunnelMaxHops OBJECT-TYPE
      SYNTAX        Unsigned32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "The maximum number of hops that can be specified for
            a tunnel on this device."
      ::= { mplsTeScalars 4 }

   mplsTunnelNotificationMaxRate OBJECT-TYPE
      SYNTAX       Unsigned32
      MAX-ACCESS   read-write
      STATUS       current
      DESCRIPTION
           "This variable indicates the maximum number of
            notifications issued per second. If events occur
            more rapidly, the implementation may simply fail to
            emit these notifications during that period, or may
            queue them until an appropriate time. A value of 0
            means no throttling is applied and events may be
            notified at the rate at which they occur."
      DEFVAL       { 0 }
      ::= { mplsTeScalars 5 }

   -- End of MPLS Tunnel scalars.


   -- MPLS tunnel table.

   mplsTunnelIndexNext OBJECT-TYPE
      SYNTAX        IndexIntegerNextFree (0..65535)
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
          "This object contains an unused value for
```

```
            mplsTunnelIndex, or a zero to indicate
            that none exist. Negative values are not allowed,
            as they do not correspond to valid values of
            mplsTunnelIndex.

            Note that this object offers an unused value
            for an mplsTunnelIndex value at the ingress
            side of a tunnel. At other LSRs the value
            of mplsTunnelIndex SHOULD be taken from the
            value signaled by the MPLS signaling protocol.
          "
      ::= { mplsTeObjects 1 }

   mplsTunnelTable OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsTunnelEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "The mplsTunnelTable allows new MPLS tunnels to be
             created between an LSR and a remote endpoint, and
             existing tunnels to be reconfigured or removed.
             Note that only point-to-point tunnel segments are
             supported, although multipoint-to-point and point-
             to-multipoint connections are supported by an LSR
             acting as a cross-connect.  Each MPLS tunnel can
             thus have one out-segment originating at this LSR
             and/or one in-segment terminating at this LSR."
      ::= { mplsTeObjects 2 }

   mplsTunnelEntry OBJECT-TYPE
      SYNTAX        MplsTunnelEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "An entry in this table represents an MPLS tunnel.
             An entry can be created by a network administrator
             or by an SNMP agent as instructed by an MPLS
             signalling protocol. Whenever a new entry is
             created with mplsTunnelIsIf set to true(1), then a
             corresponding entry is created in ifTable as well
             (see RFC 2863). The ifType of this entry is
             mplsTunnel(150).

           A tunnel entry needs to be uniquely identified across
             a MPLS network. Indices mplsTunnelIndex and
             mplsTunnelInstance uniquely identify a tunnel on
             the LSR originating the tunnel.  To uniquely
             identify a tunnel across an MPLS network requires
```

```
            index mplsTunnelIngressLSRId.  The last index
            mplsTunnelEgressLSRId is useful in identifying all
            instances of a tunnel that terminate on the same
            egress LSR."
      REFERENCE
           "1. RFC 2863 - The Interfaces Group MIB, McCloghrie,
            K., and F. Kastenholtz, June 2000 "
      INDEX {  mplsTunnelIndex,
               mplsTunnelInstance,
               mplsTunnelIngressLSRId,
               mplsTunnelEgressLSRId
            }
      ::= { mplsTunnelTable 1 }

   MplsTunnelEntry ::= SEQUENCE {
         mplsTunnelIndex              MplsTunnelIndex,
         mplsTunnelInstance           MplsTunnelInstanceIndex,
         mplsTunnelIngressLSRId       MplsExtendedTunnelId,
         mplsTunnelEgressLSRId        MplsExtendedTunnelId,
         mplsTunnelName               SnmpAdminString,
         mplsTunnelDescr              SnmpAdminString,
         mplsTunnelIsIf               TruthValue,
         mplsTunnelIfIndex            InterfaceIndexOrZero,
         mplsTunnelOwner              MplsOwner,
         mplsTunnelRole               INTEGER,
         mplsTunnelXCPointer          RowPointer,
         mplsTunnelSignallingProto    INTEGER,
         mplsTunnelSetupPrio          Integer32,
         mplsTunnelHoldingPrio        Integer32,
         mplsTunnelSessionAttributes  BITS,
         mplsTunnelLocalProtectInUse  TruthValue,
         mplsTunnelResourcePointer    RowPointer,
         mplsTunnelPrimaryInstance    MplsTunnelInstanceIndex,
         mplsTunnelInstancePriority   Unsigned32,
         mplsTunnelHopTableIndex      MplsPathIndexOrZero,
         mplsTunnelPathInUse          MplsPathIndexOrZero,
         mplsTunnelARHopTableIndex    MplsPathIndexOrZero,
         mplsTunnelCHopTableIndex     MplsPathIndexOrZero,
         mplsTunnelIncludeAnyAffinity MplsTunnelAffinity,
         mplsTunnelIncludeAllAffinity MplsTunnelAffinity,
         mplsTunnelExcludeAnyAffinity MplsTunnelAffinity,
         mplsTunnelTotalUpTime        TimeTicks,
         mplsTunnelInstanceUpTime     TimeTicks,
         mplsTunnelPrimaryUpTime      TimeTicks,
         mplsTunnelPathChanges        Counter32,
         mplsTunnelLastPathChange     TimeTicks,
         mplsTunnelCreationTime       TimeStamp,
         mplsTunnelStateTransitions   Counter32,
```

```
         mplsTunnelAdminStatus        INTEGER,
         mplsTunnelOperStatus         INTEGER,
         mplsTunnelRowStatus          RowStatus,
         mplsTunnelStorageType        StorageType
      }

   mplsTunnelIndex OBJECT-TYPE
      SYNTAX        MplsTunnelIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Uniquely identifies a set of tunnel instances
             between a pair of ingress and egress LSRs.
             Managers should obtain new values for row
             creation in this table by reading
             mplsTunnelIndexNext. When
             the MPLS signalling protocol is rsvp(2) this value
             SHOULD be equal to the value signaled in the
             Tunnel Id of the Session object. When the MPLS
             signalling protocol is crldp(3) this value
             SHOULD be equal to the value signaled in the
             LSP ID."
      ::= { mplsTunnelEntry 1 }

   mplsTunnelInstance OBJECT-TYPE
      SYNTAX        MplsTunnelInstanceIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Uniquely identifies a particular instance of a
             tunnel between a pair of ingress and egress LSRs.
             It is useful to identify multiple instances of
             tunnels for the purposes of backup and parallel
             tunnels. When the MPLS signaling protocol is
             rsvp(2) this value SHOULD be equal to the LSP Id
             of the Sender Template object. When the signaling
             protocol is crldp(3) there is no equivalent
             signaling object."
      ::= { mplsTunnelEntry 2 }

   mplsTunnelIngressLSRId OBJECT-TYPE
      SYNTAX        MplsExtendedTunnelId
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Identity of the ingress LSR associated with this
             tunnel instance. When the MPLS signalling protocol
             is rsvp(2) this value SHOULD be equal to the Tunnel
```

```
            Sender Address in the Sender Template object and MAY
            be equal to the Extended Tunnel Id field in the
            SESSION object. When the MPLS signalling protocol is
            crldp(3) this value SHOULD be equal to the Ingress
            LSR Router ID field in the LSPID TLV object."
      REFERENCE
           "1. RSVP-TE: Extensions to RSVP for LSP Tunnels,
             Awduche et al, RFC 3209, December 2001
            2. Constraint-Based LSP Setup using LDP, Jamoussi
             (Editor), RFC 3212, January 2002"
      ::= { mplsTunnelEntry 3 }

   mplsTunnelEgressLSRId OBJECT-TYPE
      SYNTAX        MplsExtendedTunnelId
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Identity of the egress LSR associated with this
             tunnel instance."
      ::= { mplsTunnelEntry 4 }

   mplsTunnelName OBJECT-TYPE
      SYNTAX        SnmpAdminString
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The canonical name assigned to the tunnel. This name
             can be used to refer to the tunnel on the LSR's
             console port.  If mplsTunnelIsIf is set to true
             then the ifName of the interface corresponding to
             this tunnel should have a value equal to
             mplsTunnelName.  Also see the description of ifName
             in RFC 2863."
      REFERENCE
           "RFC 2863 - The Interfaces Group MIB, McCloghrie, K.,
             and F. Kastenholtz, June 2000"
      DEFVAL {""}
      ::= { mplsTunnelEntry 5 }

   mplsTunnelDescr OBJECT-TYPE
      SYNTAX        SnmpAdminString
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "A textual string containing information about the
             tunnel.  If there is no description this object
             contains a zero length string. This object is may
             not be signaled by MPLS signaling protocols,
```

```
            consequentally the value of this object at transit
            and egress LSRs MAY be automatically generated or
            absent."
      DEFVAL {""}
      ::= { mplsTunnelEntry 6 }

   mplsTunnelIsIf OBJECT-TYPE
      SYNTAX        TruthValue
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "Denotes whether or not this tunnel corresponds to an
            interface represented in the interfaces group
            table. Note that if this variable is set to true
            then the ifName of the interface corresponding to
            this tunnel should have a value equal to
            mplsTunnelName.  Also see the description of ifName
            in RFC 2863.  This object is meaningful only at the
            ingress and egress LSRs."
      REFERENCE
           "RFC 2863 - The Interfaces Group MIB, McCloghrie, K.,
            and F. Kastenholtz, June 2000"
      DEFVAL { false }
      ::= { mplsTunnelEntry 7 }

   mplsTunnelIfIndex OBJECT-TYPE
      SYNTAX        InterfaceIndexOrZero
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "If mplsTunnelIsIf is set to true, then this value
            contains the LSR-assigned ifIndex which corresponds
            to an entry in the interfaces table.  Otherwise
            this variable should contain the value of zero
            indicating that a valid ifIndex was not assigned to
            this tunnel interface."
      REFERENCE
           "RFC 2863 - The Interfaces Group MIB, McCloghrie, K.,
            and F. Kastenholtz, June 2000"
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 8 }

   mplsTunnelOwner OBJECT-TYPE
      SYNTAX        MplsOwner
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Denotes the entity that created and is responsible
```

```
            for managing this tunnel. This column is
            automatically filled by the agent on creation of a
            row."
      ::= { mplsTunnelEntry 9 }

   mplsTunnelRole OBJECT-TYPE
      SYNTAX        INTEGER { head(1),
                              transit(2),
                              tail(3),
                              headTail(4) }
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This value signifies the role that this tunnel
            entry/instance represents. This value MUST be set
            to head(1) at the originating point of the tunnel.
            This value MUST be set to transit(2) at transit
            points along the tunnel, if transit points are
            supported. This value MUST be set to tail(3) at the
            terminating point of the tunnel if tunnel tails are
            supported.

           The value headTail(4) is provided for tunnels that
            begin and end on the same LSR."
      DEFVAL { head }
      ::= { mplsTunnelEntry 10 }

   mplsTunnelXCPointer OBJECT-TYPE
      SYNTAX        RowPointer
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This variable points to a row in the mplsXCTable.
            This table identifies the segments that compose
            this tunnel, their characteristics, and
            relationships to each other. A value of zeroDotZero
            indicates that no LSP has been associated with this
            tunnel yet."
      REFERENCE
           "Srinivasan, C., Viswanathan, A., and T. Nadeau,
            Multiprotocol Label Switching (MPLS) Label Switching
            Router (LSR) Management Information Base (MIB), RFC 3813,
            June 2004"
      DEFVAL        { zeroDotZero }
      ::= { mplsTunnelEntry 11 }

   mplsTunnelSignallingProto OBJECT-TYPE
      SYNTAX       INTEGER {
```

```
                        none(1),
                        rsvp(2),
                        crldp(3),
                        other(4)
                        }
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The signalling protocol, if any, used to setup this
            tunnel."
      DEFVAL        { none }
      ::= { mplsTunnelEntry 12 }

   mplsTunnelSetupPrio OBJECT-TYPE
      SYNTAX        Integer32 (0..7)
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "Indicates the setup priority of this tunnel."
      REFERENCE
           "1. RSVP-TE: Extensions to RSVP for LSP Tunnels,
              Awduche et al, RFC 3209, December 2001
            2. Constraint-Based LSP Setup using LDP, Jamoussi
              (Editor), RFC 3212, January 2002"
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 13 }

   mplsTunnelHoldingPrio OBJECT-TYPE
      SYNTAX        Integer32 (0..7)
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "Indicates the holding priority for this tunnel."
      REFERENCE
           "1. RSVP-TE: Extensions to RSVP for LSP Tunnels,
              Awduche et al, RFC 3209, December 2001

            2. Constraint-Based LSP Setup using LDP, Jamoussi
              (Editor), RFC 3212, January 2002"
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 14 }

   mplsTunnelSessionAttributes OBJECT-TYPE
      SYNTAX      BITS {
                     fastReroute (0),
                     mergingPermitted (1),
                     isPersistent (2),
                     isPinned (3),
```

```
                    recordRoute(4)
                   }
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This bit mask indicates optional session values for
             this tunnel. The following describes these bit
             fields:

           fastRerouteThis flag indicates that the any tunnel
             hop may choose to reroute this tunnel without
             tearing it down.  This flag permits transit routers
             to use a local repair mechanism which may result in
             violation of the explicit routing of this tunnel.
             When a fault is detected on an adjacent downstream
             link or node, a transit router can re-route traffic
             for fast service restoration.

           mergingPermitted This flag permits transit routers
             to merge this session with other RSVP sessions for
             the purpose of reducing resource overhead on
             downstream transit routers, thereby providing
             better network scaling.

           isPersistent  Indicates whether this tunnel should
             be restored automatically after a failure occurs.

           isPinned   This flag indicates whether the loose-
             routed hops of this tunnel are to be pinned.

           recordRouteThis flag indicates whether or not the
             signalling protocol should remember the tunnel path
             after it has been signaled."
      REFERENCE
           "1. RSVP-TE: Extensions to RSVP for LSP Tunnels,
             Awduche et al, RFC 3209, December 2001."
      ::= { mplsTunnelEntry 15 }

   mplsTunnelLocalProtectInUse  OBJECT-TYPE
      SYNTAX        TruthValue
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "Indicates that the local repair mechanism is in use
             to maintain this tunnel (usually in the face of an
             outage of the link it was previously routed over)."
      DEFVAL { false }
      ::= { mplsTunnelEntry 16 }
```

```
   mplsTunnelResourcePointer OBJECT-TYPE
      SYNTAX        RowPointer
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This variable represents a pointer to the traffic
            parameter specification for this tunnel.  This
            value may point at an entry in the
            mplsTunnelResourceEntry to indicate which
            mplsTunnelResourceEntry is to be assigned to this
            LSP instance.  This value may optionally point at
            an externally defined traffic parameter
            specification table.  A value of zeroDotZero
            indicates best-effort treatment.  By having the
            same value of this object, two or more LSPs can
            indicate resource sharing."
      DEFVAL        { zeroDotZero }
      ::= { mplsTunnelEntry 17 }

   mplsTunnelPrimaryInstance OBJECT-TYPE
      SYNTAX        MplsTunnelInstanceIndex
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Specifies the instance index of the primary instance
            of this tunnel. More details of the definition of
            tunnel instances and the primary tunnel instance
            can be found in the description of the TEXTUAL-CONVENTION
            MplsTunnelInstanceIndex."
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 18 }

   mplsTunnelInstancePriority OBJECT-TYPE
      SYNTAX        Unsigned32
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This value indicates which priority, in descending
            order, with 0 indicating the lowest priority,
            within a group of tunnel instances. A group of
            tunnel instances is defined as a set of LSPs with
            the same mplsTunnelIndex in this table, but with a
            different mplsTunnelInstance. Tunnel instance
            priorities are used to denote the priority at which
            a particular tunnel instance will supercede
            another. Instances of tunnels containing the same
            mplsTunnelInstancePriority will be used for load
            sharing."
```

```
      DEFVAL        { 0 }
      ::= { mplsTunnelEntry 19 }

   mplsTunnelHopTableIndex OBJECT-TYPE
      SYNTAX        MplsPathIndexOrZero
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "Index into the mplsTunnelHopTable entry that
             specifies the explicit route hops for this tunnel.
             This object is meaningful only at the head-end of
             the tunnel."
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 20 }

   mplsTunnelPathInUse OBJECT-TYPE
      SYNTAX        MplsPathIndexOrZero
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This value denotes the configured path that was
             chosen for this tunnel. This value reflects the
             secondary index into mplsTunnelHopTable. This path
             may not exactly match the one in
             mplsTunnelARHopTable due to the fact that some CSPF
             modification may have taken place. See
             mplsTunnelARHopTable for the actual path being
             taken by the tunnel. A value of zero denotes that
             no path is currently in use or available."
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 21 }

   mplsTunnelARHopTableIndex OBJECT-TYPE
      SYNTAX        MplsPathIndexOrZero
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Index into the mplsTunnelARHopTable entry that
             specifies the actual hops traversed by the tunnel.
             This is automatically updated by the agent when the
             actual hops becomes available."
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 22 }

   mplsTunnelCHopTableIndex OBJECT-TYPE
      SYNTAX        MplsPathIndexOrZero
      MAX-ACCESS    read-only
      STATUS        current
```

```
      DESCRIPTION
           "Index into the mplsTunnelCHopTable entry that
            specifies the computed hops traversed by the
            tunnel. This is automatically updated by the agent
            when computed hops become available or when
            computed hops get modified."
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 23 }

   mplsTunnelIncludeAnyAffinity OBJECT-TYPE
      SYNTAX        MplsTunnelAffinity
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "A link satisfies the include-any constraint if and
            only if the constraint is zero, or the link and the
            constraint have a resource class in common."
      REFERENCE
           "1. RSVP-TE: Extensions to RSVP for LSP Tunnels,
            Awduche et al, RFC 3209, December 2001."
      ::= { mplsTunnelEntry 24 }

   mplsTunnelIncludeAllAffinity OBJECT-TYPE
      SYNTAX        MplsTunnelAffinity
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "A link satisfies the include-all constraint if and
            only if the link contains all of the administrative
            groups specified in the constraint."
      REFERENCE
           "1. RSVP-TE: Extensions to RSVP for LSP Tunnels,
            Awduche et al, RFC 3209, December 2001."
      ::= { mplsTunnelEntry 25 }

   mplsTunnelExcludeAnyAffinity OBJECT-TYPE
      SYNTAX        MplsTunnelAffinity
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "A link satisfies the exclude-any constraint if and
            only if the link contains none of the
            administrative groups specified in the constraint."
      REFERENCE
           "1. RSVP-TE: Extensions to RSVP for LSP Tunnels,
            Awduche et al, RFC 3209, December 2001."
      DEFVAL { 0 }
      ::= { mplsTunnelEntry 26 }
```

```
   mplsTunnelTotalUpTime OBJECT-TYPE
      SYNTAX        TimeTicks
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "This value represents the aggregate up time for all
             instances of this tunnel, if available. If this
             value is unavailable, it MUST return a value of 0."
         ::= { mplsTunnelEntry 27 }

   mplsTunnelInstanceUpTime OBJECT-TYPE
      SYNTAX        TimeTicks
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "This value identifies the total time that this
             tunnel instance's operStatus has been Up(1)."
         ::= { mplsTunnelEntry 28 }

   mplsTunnelPrimaryUpTime OBJECT-TYPE
      SYNTAX        TimeTicks
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Specifies the total time the primary instance of
             this tunnel has been active. The primary instance
             of this tunnel is defined in
             mplsTunnelPrimaryInstance."
      ::= { mplsTunnelEntry 29 }

   mplsTunnelPathChanges OBJECT-TYPE
      SYNTAX        Counter32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Specifies the number of times the actual path for
            this tunnel instance has changed."
      ::= { mplsTunnelEntry 30 }

   mplsTunnelLastPathChange OBJECT-TYPE
      SYNTAX        TimeTicks
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Specifies the time since the last change to the
            actual path for this tunnel instance."
      ::= { mplsTunnelEntry 31 }
```

```
   mplsTunnelCreationTime OBJECT-TYPE
      SYNTAX        TimeStamp
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Specifies the value of SysUpTime when the first
             instance of this tunnel came into existence.
             That is, when the value of mplsTunnelOperStatus
             was first set to up(1)."
      ::= { mplsTunnelEntry 32 }

   mplsTunnelStateTransitions OBJECT-TYPE
      SYNTAX        Counter32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Specifies the number of times the state
             (mplsTunnelOperStatus) of this tunnel instance has
             changed."
      ::= { mplsTunnelEntry 33 }

   mplsTunnelAdminStatus OBJECT-TYPE
      SYNTAX     INTEGER {
                      -- ready to pass packets
                      up(1),
                      down(2),
                      -- in some test mode
                      testing(3)
                 }
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "Indicates the desired operational status of this
             tunnel."
      ::= { mplsTunnelEntry 34 }

   mplsTunnelOperStatus OBJECT-TYPE
      SYNTAX     INTEGER {
                  -- ready to pass packets
                  up(1),
                  down(2),
                  -- in some test mode
                  testing(3),
                  -- status cannot be determined
                  unknown(4),
                  dormant(5),
                  -- some component is missing
                  notPresent(6),
```

```
                -- down due to the state of
                -- lower layer interfaces
                lowerLayerDown(7)
              }
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Indicates the actual operational status of this
             tunnel, which is typically but not limited to, a
             function of the state of individual segments of
             this tunnel."
      ::= { mplsTunnelEntry 35 }

   mplsTunnelRowStatus OBJECT-TYPE
      SYNTAX        RowStatus
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This variable is used to create, modify, and/or
             delete a row in this table.  When a row in this
             table is in active(1) state, no objects in that row
             can be modified by the agent except
             mplsTunnelAdminStatus, mplsTunnelRowStatus and
             mplsTunnelStorageType."
      ::= { mplsTunnelEntry 36 }

   mplsTunnelStorageType OBJECT-TYPE
      SYNTAX        StorageType
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION  "The storage type for this tunnel entry.
                    Conceptual rows having the value 'permanent'
                    need not allow write-access to any columnar
                    objects in the row."
      DEFVAL { volatile }
      ::= { mplsTunnelEntry 37 }

   -- End of mplsTunnelTable

   mplsTunnelHopListIndexNext OBJECT-TYPE
      SYNTAX        MplsPathIndexOrZero
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "This object contains an appropriate value to be used
             for mplsTunnelHopListIndex when creating entries in
             the mplsTunnelHopTable.  If the number of
             unassigned entries is exhausted, a retrieval
```

```
            operation will return a value of 0.  This object
            may also return a value of 0 when the LSR is unable
            to accept conceptual row creation, for example, if
            the mplsTunnelHopTable is implemented as read-only.
            To obtain the value of mplsTunnelHopListIndex for a
            new entry in the mplsTunnelHopTable, the manager
            issues a management protocol retrieval operation to
            obtain the current value of mplsTunnelHopIndex.

           When the SET is performed to create a row in the
            mplsTunnelHopTable, the Command Responder (agent)
            must determine whether the value is indeed still
            unused; Two Network Management Applications may
            attempt to create a row (configuration entry)
            simultaneously and use the same value. If it is
            currently unused, the SET succeeds and the Command
            Responder (agent) changes the value of this object,
            according to an implementation-specific algorithm.
            If the value is in use, however, the SET fails.  The
            Network Management Application must then re-read
            this variable to obtain a new usable value."
      ::= { mplsTeObjects 3 }

   mplsTunnelHopTable  OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsTunnelHopEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "The mplsTunnelHopTable is used to indicate the hops,
            strict or loose, for an instance of an MPLS tunnel
            defined in mplsTunnelTable, when it is established
            via signalling, for the outgoing direction of the
            tunnel. Thus at a transit LSR, this table contains
            the desired path of the tunnel from this LSR
            onwards. Each row in this table is indexed by
            mplsTunnelHopListIndex which corresponds to a group
            of hop lists or path options.  Each row also has a
            secondary index mplsTunnelHopIndex, which indicates
            a group of hops (also known as a path option).
            Finally, the third index, mplsTunnelHopIndex
            indicates the specific hop information for a path
            option. In case we want to specify a particular
            interface on the originating LSR of an outgoing
            tunnel by which we want packets to exit the LSR,
            we specify this as the first hop for this tunnel in
            mplsTunnelHopTable."
      ::= { mplsTeObjects 4 }
```

```
   mplsTunnelHopEntry  OBJECT-TYPE
      SYNTAX        MplsTunnelHopEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "An entry in this table represents a tunnel hop.  An
            entry is created by a network administrator for
            signaled ERLSP set up by an MPLS signalling
            protocol."
      INDEX {
         mplsTunnelHopListIndex,
         mplsTunnelHopPathOptionIndex,
         mplsTunnelHopIndex
      }
      ::= { mplsTunnelHopTable 1 }

   MplsTunnelHopEntry ::= SEQUENCE {
         mplsTunnelHopListIndex          MplsPathIndex,
         mplsTunnelHopPathOptionIndex    MplsPathIndex,
         mplsTunnelHopIndex              MplsPathIndex,
         mplsTunnelHopAddrType           TeHopAddressType,
         mplsTunnelHopIpAddr             TeHopAddress,
         mplsTunnelHopIpPrefixLen        InetAddressPrefixLength,
         mplsTunnelHopAsNumber           TeHopAddressAS,
         mplsTunnelHopAddrUnnum          TeHopAddressUnnum,
         mplsTunnelHopLspId              MplsLSPID,
         mplsTunnelHopType               INTEGER,
         mplsTunnelHopInclude            TruthValue,
         mplsTunnelHopPathOptionName     SnmpAdminString,
         mplsTunnelHopEntryPathComp      INTEGER,
         mplsTunnelHopRowStatus          RowStatus,
         mplsTunnelHopStorageType        StorageType
      }

   mplsTunnelHopListIndex OBJECT-TYPE
      SYNTAX        MplsPathIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Primary index into this table identifying a
            particular explicit route object."
      ::= { mplsTunnelHopEntry 1 }

   mplsTunnelHopPathOptionIndex OBJECT-TYPE
      SYNTAX        MplsPathIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
```

```
            "Secondary index into this table identifying a
              particular group of hops representing a particular
              configured path. This is otherwise known as a path
              option."
       ::= { mplsTunnelHopEntry 2 }

   mplsTunnelHopIndex OBJECT-TYPE
      SYNTAX        MplsPathIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
            "Tertiary index into this table identifying a
              particular hop."
      ::= { mplsTunnelHopEntry 3 }

   mplsTunnelHopAddrType OBJECT-TYPE
       SYNTAX        TeHopAddressType
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION  "The Hop Address Type of this tunnel hop.

                     The value of this object cannot be changed
                     if the value of the corresponding
                     mplsTunnelHopRowStatus object is 'active'.

                     Note that lspid(5) is a valid option only
                     for tunnels signaled via CRLDP.
                    "
       DEFVAL        { ipv4 }
       ::= { mplsTunnelHopEntry 4 }

   mplsTunnelHopIpAddr OBJECT-TYPE
       SYNTAX        TeHopAddress
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION  "The Tunnel Hop Address for this tunnel hop.

                     The type of this address is determined by the
                     value of the corresponding mplsTunnelHopAddrType.

                     The value of this object cannot be changed
                     if the value of the corresponding
                     mplsTunnelHopRowStatus object is 'active'.
                    "
       DEFVAL       { '00000000'h }  -- IPv4 address 0.0.0.0
       ::= { mplsTunnelHopEntry 5 }

    mplsTunnelHopIpPrefixLen OBJECT-TYPE
```

```
        SYNTAX        InetAddressPrefixLength
        MAX-ACCESS    read-create
        STATUS        current
        DESCRIPTION  "If mplsTunnelHopAddrType is set to ipv4(1) or
                      ipv6(2), then this value will contain an
                      appropriate prefix length for the IP address in
                      object mplsTunnelHopIpAddr. Otherwise this value
                      is irrelevant and should be ignored.
                     "
        DEFVAL         { 32 }
        ::= { mplsTunnelHopEntry 6 }

    mplsTunnelHopAsNumber OBJECT-TYPE
       SYNTAX        TeHopAddressAS
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
            "If mplsTunnelHopAddrType is set to asnumber(3), then
              this value will contain the AS number of this hop.
              Otherwise the agent should set this object to zero-
              length string and the manager should ignore this."
       ::= { mplsTunnelHopEntry 7 }

    mplsTunnelHopAddrUnnum OBJECT-TYPE
       SYNTAX        TeHopAddressUnnum
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
            "If mplsTunnelHopAddrType is set to unnum(4), then
              this value will contain the interface identifier of
              the unnumbered interface for this hop. This object
              should be used in conjunction with
              mplsTunnelHopIpAddress which would contain the LSR
              Router ID in this case. Otherwise the agent should
              set this object to zero-length string and the
              manager should ignore this."
       ::= { mplsTunnelHopEntry 8 }

    mplsTunnelHopLspId OBJECT-TYPE
       SYNTAX        MplsLSPID
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
            "If mplsTunnelHopAddrType is set to lspid(5), then
              this value will contain the LSPID of a tunnel of
              this hop. The present tunnel being configured is
              tunneled through this hop (using label stacking).
              This object is otherwise insignificant and should
```

```
            contain a value of 0 to indicate this fact."
      ::= { mplsTunnelHopEntry 9 }

   mplsTunnelHopType OBJECT-TYPE
      SYNTAX        INTEGER {
                         strict(1),
                         loose(2)
                        }
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "Denotes whether this tunnel hop is routed in a
            strict or loose fashion. The value of this object
            has no meaning if the mplsTunnelHopInclude object
            is set to 'false'."
      ::= { mplsTunnelHopEntry 10 }

   mplsTunnelHopInclude OBJECT-TYPE
      SYNTAX        TruthValue
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "If this value is set to true, then this indicates
            that this hop must be included in the tunnel's
            path. If this value is set to 'false', then this hop
            must be avoided when calculating the path for this
            tunnel. The default value of this object is 'true',
            so that by default all indicated hops are included
            in the CSPF path computation. If this object is set
            to 'false' the value of mplsTunnelHopType should be
            ignored."
      DEFVAL { true }
      ::= { mplsTunnelHopEntry 11 }

   mplsTunnelHopPathOptionName OBJECT-TYPE
      SYNTAX        SnmpAdminString
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The description of this series of hops as they
            relate to the specified path option. The
            value of this object SHOULD be the same for
            each hop in the series that comprises a
            path option."
      ::= { mplsTunnelHopEntry 12 }

   mplsTunnelHopEntryPathComp OBJECT-TYPE
      SYNTAX        INTEGER {
```

```
                        dynamic(1),    -- CSPF computed
                        explicit(2)    -- strict hop
                    }
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "If this value is set to dynamic, then the user
             should only specify the source and destination of
             the path and expect that the CSPF will calculate
             the remainder of the path.  If this value is set to
             explicit, the user should specify the entire path
             for the tunnel to take.  This path may contain
             strict or loose hops.  Each hop along a specific
             path SHOULD have this object set to the same value"
      ::= { mplsTunnelHopEntry 13 }

   mplsTunnelHopRowStatus OBJECT-TYPE
      SYNTAX        RowStatus
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This variable is used to create, modify, and/or
             delete a row in this table.  When a row in this
             table is in active(1) state, no objects in that row
             can be modified by the agent except
             mplsTunnelHopRowStatus and
             mplsTunnelHopStorageType."
      ::= { mplsTunnelHopEntry 14 }

   mplsTunnelHopStorageType OBJECT-TYPE
      SYNTAX        StorageType
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The storage type for this Hop entry. Conceptual
            rows having the value 'permanent' need not
            allow write-access to any columnar objects
            in the row."
      DEFVAL { volatile }
      ::= { mplsTunnelHopEntry 15 }

   -- End of mplsTunnelHopTable

   -- Begin of mplsTunnelResourceTable

   mplsTunnelResourceIndexNext OBJECT-TYPE
      SYNTAX        Unsigned32 (0.. 2147483647)
      MAX-ACCESS    read-only
```

```
      STATUS        current
      DESCRIPTION
           "This object contains the next appropriate value to
            be used for mplsTunnelResourceIndex when creating
            entries in the mplsTunnelResourceTable. If the
            number of unassigned entries is exhausted, a
            retrieval operation will return a value of 0.  This
            object may also return a value of 0 when the LSR is
            unable to accept conceptual row creation, for
            example, if the mplsTunnelTable is implemented as
            read-only.  To obtain the mplsTunnelResourceIndex
            value for a new entry, the manager must first issue
            a management protocol retrieval operation to obtain
            the current value of this object.

           When the SET is performed to create a row in the
            mplsTunnelResourceTable, the Command Responder
            (agent) must determine whether the value is indeed
            still unused; Two Network Management Applications
            may attempt to create a row (configuration entry)
            simultaneously and use the same value. If it is
            currently unused, the SET succeeds and the Command
            Responder (agent) changes the value of this object,
            according to an implementation-specific algorithm.
            If the value is in use, however, the SET fails.  The
            Network Management Application must then re-read
            this variable to obtain a new usable value."
      ::= { mplsTeObjects 5 }

   mplsTunnelResourceTable OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsTunnelResourceEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "The mplsTunnelResourceTable allows a manager to
            specify which resources are desired for an MPLS
            tunnel.  This table also allows several tunnels to
            point to a single entry in this table, implying
            that these tunnels should share resources."
      ::= { mplsTeObjects 6 }

   mplsTunnelResourceEntry OBJECT-TYPE
      SYNTAX        MplsTunnelResourceEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "An entry in this table represents a set of resources
            for an MPLS tunnel.  An entry can be created by a
```

```
            network administrator or by an SNMP agent as
            instructed by any MPLS signalling protocol.
           An entry in this table referenced by a tunnel instance
            with zero mplsTunnelInstance value indicates a
            configured set of resource parameter. An entry
            referenced by a tunnel instance with a non-zero
            mplsTunnelInstance reflects the in-use resource
            parameters for the tunnel instance which may have
            been negotiated or modified by the MPLS signaling
            protocols."
      INDEX         { mplsTunnelResourceIndex }
      ::= { mplsTunnelResourceTable 1 }

   MplsTunnelResourceEntry ::= SEQUENCE {
         mplsTunnelResourceIndex                Unsigned32,
         mplsTunnelResourceMaxRate              MplsBitRate,
         mplsTunnelResourceMeanRate             MplsBitRate,
         mplsTunnelResourceMaxBurstSize         MplsBurstSize,
         mplsTunnelResourceMeanBurstSize        MplsBurstSize,
         mplsTunnelResourceExBurstSize          MplsBurstSize,
         mplsTunnelResourceFrequency            INTEGER,
         mplsTunnelResourceWeight               Unsigned32,
         mplsTunnelResourceRowStatus            RowStatus,
         mplsTunnelResourceStorageType          StorageType
      }

   mplsTunnelResourceIndex OBJECT-TYPE
      SYNTAX        Unsigned32 (1..2147483647)
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Uniquely identifies this row."
      ::= { mplsTunnelResourceEntry 1 }

   mplsTunnelResourceMaxRate OBJECT-TYPE
      SYNTAX        MplsBitRate
      UNITS         "kilobits per second"
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The maximum rate in bits/second.  Note that setting
            mplsTunnelResourceMaxRate,
            mplsTunnelResourceMeanRate, and
            mplsTunnelResourceMaxBurstSize to 0 indicates best-
            effort treatment."
      ::= { mplsTunnelResourceEntry 2 }

   mplsTunnelResourceMeanRate OBJECT-TYPE
```

```
      SYNTAX        MplsBitRate
      UNITS         "kilobits per second"
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This object is copied into an instance of
            mplsTrafficParamMeanRate in the
            mplsTrafficParamTable. The OID of this table entry
            is then copied into the corresponding
            mplsInSegmentTrafficParamPtr."
      ::= { mplsTunnelResourceEntry 3 }

   mplsTunnelResourceMaxBurstSize OBJECT-TYPE
      SYNTAX        MplsBurstSize
      UNITS         "bytes"
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The maximum burst size in bytes."
      ::= { mplsTunnelResourceEntry 4 }

   mplsTunnelResourceMeanBurstSize OBJECT-TYPE
      SYNTAX       MplsBurstSize
      UNITS        "bytes"
      MAX-ACCESS   read-create
      STATUS       current
      DESCRIPTION
           "The mean burst size in bytes.  The implementations
            which do not implement this variable must return
            a noSuchObject exception for this object and must
            not allow a user to set this object."
      ::= { mplsTunnelResourceEntry 5 }

   mplsTunnelResourceExBurstSize OBJECT-TYPE
      SYNTAX       MplsBurstSize
      UNITS        "bytes"
      MAX-ACCESS   read-create
      STATUS       current
      DESCRIPTION
           "The Excess burst size in bytes.  The implementations
            which do not implement this variable must return
            noSuchObject exception for this object and must
            not allow a user to set this value."
      REFERENCE
           "CR-LDP Specification, Section 4.3."
      ::= { mplsTunnelResourceEntry 6 }

   mplsTunnelResourceFrequency  OBJECT-TYPE
```

```
      SYNTAX       INTEGER { unspecified(1),
                             frequent(2),
                             veryFrequent(3)
                           }
      MAX-ACCESS   read-create
      STATUS       current
      DESCRIPTION
           "The granularity of the availability of committed
            rate.  The implementations which do not implement
            this variable must return unspecified(1) for this
            value and must not allow a user to set this value."
      REFERENCE
           "CR-LDP Specification, Section 4.3."
      ::= { mplsTunnelResourceEntry 7 }

   mplsTunnelResourceWeight    OBJECT-TYPE
      SYNTAX       Unsigned32(0..255)
      MAX-ACCESS   read-create
      STATUS       current
      DESCRIPTION
           "The relative weight for using excess bandwidth above
            its committed rate.  The value of 0 means that
            weight is not applicable for the CR-LSP."
      REFERENCE
           "CR-LDP Specification, Section 4.3."
      ::= { mplsTunnelResourceEntry 8 }

   mplsTunnelResourceRowStatus OBJECT-TYPE
      SYNTAX        RowStatus
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "This variable is used to create, modify, and/or
            delete a row in this table.  When a row in this
            table is in active(1) state, no objects in that row
            can be modified by the agent except
            mplsTunnelResourceRowStatus and
            mplsTunnelResourceStorageType."
      ::= { mplsTunnelResourceEntry 9 }

   mplsTunnelResourceStorageType OBJECT-TYPE
      SYNTAX        StorageType
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The storage type for this Hop entry. Conceptual
            rows having the value 'permanent' need not
            allow write-access to any columnar objects
```

```
            in the row."
      DEFVAL { volatile }

      ::= { mplsTunnelResourceEntry 10 }


   -- End mplsTunnelResourceTable
   -- Tunnel Actual Route Hop table.

   mplsTunnelARHopTable  OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsTunnelARHopEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "The mplsTunnelARHopTable is used to indicate the
            hops for an MPLS tunnel defined in mplsTunnelTable,
            as reported by the MPLS signalling protocol. Thus at
            a transit LSR, this table (if the table is supported
            and if the signaling protocol is recording actual
            route information) contains the actual route of the
            whole tunnel. If the signaling protocol is not
            recording the actual route, this table MAY report
            the information from the mplsTunnelHopTable or the
            mplsTunnelCHopTable.

           Each row in this table is indexed by
            mplsTunnelARHopListIndex. Each row also has a
            secondary index mplsTunnelARHopIndex, corresponding
            to the next hop that this row corresponds to.

           Please note that since the information necessary to
            build entries within this table is not provided by
            some MPLS signalling protocols, implementation of
            this table is optional. Furthermore, since the
            information in this table is actually provided by
            the MPLS signalling protocol after the path has
            been set-up, the entries in this table are provided
            only for observation, and hence, all variables in
            this table are accessible exclusively as read-
            only.

           Note also that the contents of this table may change
            while it is being read because of re-routing
            activities. A network administrator may verify that
            the actual route read is consistent by reference to
            the mplsTunnelLastPathChange object."
      ::= { mplsTeObjects 7 }
```

```
   mplsTunnelARHopEntry  OBJECT-TYPE
      SYNTAX        MplsTunnelARHopEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "An entry in this table represents a tunnel hop.  An
            entry is created by the agent for signaled ERLSP
            set up by an MPLS signalling protocol."
      INDEX { mplsTunnelARHopListIndex, mplsTunnelARHopIndex }
      ::= { mplsTunnelARHopTable 1 }

   MplsTunnelARHopEntry ::= SEQUENCE {
         mplsTunnelARHopListIndex          MplsPathIndex,
         mplsTunnelARHopIndex              MplsPathIndex,
         mplsTunnelARHopAddrType           TeHopAddressType,
         mplsTunnelARHopIpAddr             TeHopAddress,
         mplsTunnelARHopAddrUnnum          TeHopAddressUnnum,
         mplsTunnelARHopLspId              MplsLSPID
      }

   mplsTunnelARHopListIndex OBJECT-TYPE
      SYNTAX        MplsPathIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Primary index into this table identifying a
            particular recorded hop list."
      ::= { mplsTunnelARHopEntry 1 }

   mplsTunnelARHopIndex OBJECT-TYPE
      SYNTAX        MplsPathIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Secondary index into this table identifying the
            particular hop."
      ::= { mplsTunnelARHopEntry 2 }

   mplsTunnelARHopAddrType OBJECT-TYPE
      SYNTAX        TeHopAddressType
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "The Hop Address Type of this tunnel hop.

            Note that lspid(5) is a valid option only
            for tunnels signaled via CRLDP."
      DEFVAL        { ipv4 }
```

```
      ::= { mplsTunnelARHopEntry 3 }

   mplsTunnelARHopIpAddr OBJECT-TYPE
      SYNTAX        TeHopAddress
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "The Tunnel Hop Address for this tunnel hop.

            The type of this address is determined by the
            value of the corresponding mplsTunnelARHopAddrType.
            If mplsTunnelARHopAddrType is set to unnum(4),
             then this value contains the LSR Router ID of the
             unnumbered interface. Otherwise the agent SHOULD
             set this object to the zero-length string and the
             manager should ignore this object."
       DEFVAL       { '00000000'h }  -- IPv4 address 0.0.0.0
      ::= { mplsTunnelARHopEntry 4 }

   mplsTunnelARHopAddrUnnum OBJECT-TYPE
      SYNTAX        TeHopAddressUnnum
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "If mplsTunnelARHopAddrType is set to unnum(4), then
             this value will contain the interface identifier of
             the unnumbered interface for this hop. This object
             should be used in conjunction with
             mplsTunnelARHopIpAddr which would contain the LSR
             Router ID in this case. Otherwise the agent should
             set this object to zero-length string and the
             manager should ignore this."
      ::= { mplsTunnelARHopEntry 5 }

   mplsTunnelARHopLspId OBJECT-TYPE
      SYNTAX        MplsLSPID
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "If mplsTunnelARHopAddrType is set to lspid(5), then
             this value will contain the LSP ID of this hop.
             This object is otherwise insignificant and should
             contain a value of 0 to indicate this fact."
      ::= { mplsTunnelARHopEntry 6 }

   -- End of mplsTunnelARHopTable
```

```
   -- Tunnel Computed Hop table.

   mplsTunnelCHopTable  OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsTunnelCHopEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "The mplsTunnelCHopTable is used to indicate the
            hops, strict or loose, for an MPLS tunnel defined
            in mplsTunnelTable, as computed by a constraint-
            based routing protocol, based on the
            mplsTunnelHopTable for the outgoing direction of
            the tunnel. Thus at a transit LSR, this table (if
            the table is supported) MAY contain the path
            computed by the CSPF engine on (or on behalf of)
            this LSR. Each row in this table is indexed by
            mplsTunnelCHopListIndex.  Each row also has a
            secondary index mplsTunnelCHopIndex, corresponding
            to the next hop that this row corresponds to. In
            case we want to specify a particular interface on
            the originating LSR of an outgoing tunnel by which
            we want packets to exit the LSR, we specify this as
            the first hop for this tunnel in
            mplsTunnelCHopTable.

           Please note that since the information necessary to
            build entries within this table may not be
            supported by some LSRs, implementation of this
            table is optional. Furthermore, since the
            information in this table describes the path
            computed by the CSPF engine the entries in this
            table are read-only."
      ::= { mplsTeObjects 8 }

   mplsTunnelCHopEntry  OBJECT-TYPE
      SYNTAX        MplsTunnelCHopEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "An entry in this table represents a tunnel hop.  An
            entry in this table is created by a path
            computation engine using CSPF techniques applied to
            the information collected by routing protocols and
            the hops specified in the corresponding
            mplsTunnelHopTable."
      INDEX { mplsTunnelCHopListIndex, mplsTunnelCHopIndex }
      ::= { mplsTunnelCHopTable 1 }
```

```
   MplsTunnelCHopEntry ::= SEQUENCE {
         mplsTunnelCHopListIndex          MplsPathIndex,
         mplsTunnelCHopIndex              MplsPathIndex,
         mplsTunnelCHopAddrType           TeHopAddressType,
         mplsTunnelCHopIpAddr             TeHopAddress,
         mplsTunnelCHopIpPrefixLen        InetAddressPrefixLength,
         mplsTunnelCHopAsNumber           TeHopAddressAS,
         mplsTunnelCHopAddrUnnum          TeHopAddressUnnum,
         mplsTunnelCHopLspId              MplsLSPID,
         mplsTunnelCHopType               INTEGER
      }

   mplsTunnelCHopListIndex OBJECT-TYPE
      SYNTAX        MplsPathIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Primary index into this table identifying a
            particular computed hop list."
      ::= { mplsTunnelCHopEntry 1 }

   mplsTunnelCHopIndex OBJECT-TYPE
      SYNTAX        MplsPathIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "Secondary index into this table identifying the
            particular hop."
      ::= { mplsTunnelCHopEntry 2 }

   mplsTunnelCHopAddrType OBJECT-TYPE
      SYNTAX        TeHopAddressType
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "The Hop Address Type of this tunnel hop.

            Note that lspid(5) is a valid option only
            for tunnels signaled via CRLDP."
      DEFVAL        { ipv4 }
      ::= { mplsTunnelCHopEntry 3 }

   mplsTunnelCHopIpAddr OBJECT-TYPE
      SYNTAX        TeHopAddress
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "The Tunnel Hop Address for this tunnel hop.
```

```
            The type of this address is determined by the
             value of the corresponding mplsTunnelCHopAddrType.

            If mplsTunnelCHopAddrType is set to unnum(4), then
             this value will contain the LSR Router ID of the
             unnumbered interface. Otherwise the agent should
             set this object to the zero-length string and the
             manager SHOULD ignore this object."
        DEFVAL       { '00000000'h }  -- IPv4 address 0.0.0.0
       ::= { mplsTunnelCHopEntry 4 }

   mplsTunnelCHopIpPrefixLen OBJECT-TYPE
      SYNTAX        InetAddressPrefixLength
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
            "If mplsTunnelCHopAddrType is set to ipv4(1) or
              ipv6(2), then this value will contain an
              appropriate prefix length for the IP address in
              object mplsTunnelCHopIpAddr. Otherwise this value
              is irrelevant and should be ignored.
             "
        DEFVAL         { 32 }
       ::= { mplsTunnelCHopEntry 5 }

   mplsTunnelCHopAsNumber OBJECT-TYPE
      SYNTAX        TeHopAddressAS
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "If mplsTunnelCHopAddrType is set to asnumber(3),
             then this value will contain the AS number of this
             hop. Otherwise the agent should set this object to
             zero-length string and the manager should ignore
             this."
      ::= { mplsTunnelCHopEntry 6 }

   mplsTunnelCHopAddrUnnum OBJECT-TYPE
      SYNTAX        TeHopAddressUnnum
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "If mplsTunnelCHopAddrType is set to unnum(4), then
             this value will contain the unnumbered interface
             identifier of this hop. This object should be used
             in conjunction with mplsTunnelCHopIpAddr which
             would contain the LSR Router ID in this case.
```

```
            Otherwise the agent should set this object to zero-
            length string and the manager should ignore this."
      ::= { mplsTunnelCHopEntry 7 }

   mplsTunnelCHopLspId OBJECT-TYPE
      SYNTAX        MplsLSPID
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "If mplsTunnelCHopAddrType is set to lspid(5), then
            this value will contain the LSP ID of this hop.
            This object is otherwise insignificant and should
            contain a value of 0 to indicate this fact."
      ::= { mplsTunnelCHopEntry 8 }

   mplsTunnelCHopType OBJECT-TYPE
      SYNTAX        INTEGER { strict(1),
                              loose(2)
                            }
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Denotes whether this is tunnel hop is routed in a
            strict or loose fashion."
      ::= { mplsTunnelCHopEntry 9 }

   -- End of mplsTunnelCHopTable


   -- MPLS Tunnel Performance Table.

   mplsTunnelPerfTable  OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsTunnelPerfEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "This table provides per-tunnel instance MPLS
            performance information."
      ::= { mplsTeObjects 9 }

   mplsTunnelPerfEntry OBJECT-TYPE
      SYNTAX        MplsTunnelPerfEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "An entry in this table is created by the LSR for
            every tunnel.  Its is an extension to
            mplsTunnelEntry."
```

```
      AUGMENTS { mplsTunnelEntry }
      ::= { mplsTunnelPerfTable 1 }

   MplsTunnelPerfEntry ::= SEQUENCE {
         mplsTunnelPerfPackets           Counter32,
         mplsTunnelPerfHCPackets         Counter64,
         mplsTunnelPerfErrors            Counter32,
         mplsTunnelPerfBytes             Counter32,
         mplsTunnelPerfHCBytes           Counter64
      }

   mplsTunnelPerfPackets OBJECT-TYPE
      SYNTAX        Counter32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Number of packets forwarded by the tunnel.
            This object should represents the 32-bit
            value of the least significant part of the
            64-bit value if both mplsTunnelPerfHCPackets
            is returned."
      ::= { mplsTunnelPerfEntry 1 }

   mplsTunnelPerfHCPackets OBJECT-TYPE
      SYNTAX        Counter64
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "High capacity counter for number of packets
            forwarded by the tunnel. "
      ::= { mplsTunnelPerfEntry 2 }

   mplsTunnelPerfErrors OBJECT-TYPE
      SYNTAX        Counter32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Number of packets dropped because of errors or for
            other reasons."
      ::= { mplsTunnelPerfEntry 3 }

   mplsTunnelPerfBytes OBJECT-TYPE
      SYNTAX        Counter32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "Number of bytes forwarded by the tunnel.
            This object should represents the 32-bit
```

```
            value of the least significant part of the
            64-bit value if both mplsTunnelPerfHCBytes
            is returned."
      ::= { mplsTunnelPerfEntry 4 }

   mplsTunnelPerfHCBytes OBJECT-TYPE
      SYNTAX        Counter64
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
           "High capacity counter for number of bytes forwarded
            by the tunnel."
      ::= { mplsTunnelPerfEntry 5 }

   -- End of mplsTunnelPerfTable


   -- CR-LDP Tunnel Resource Table

   mplsTunnelCRLDPResTable OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsTunnelCRLDPResEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "The mplsTunnelCRLDPResTable allows a manager to
            specify which CR-LDP-specific resources are desired
            for an MPLS tunnel if that tunnel is signaled using
            CR-LDP. Note that these attributes are in addition
            to those specified in mplsTunnelResourceTable. This
            table also allows several tunnels to point to a
            single entry in this table, implying that these
            tunnels should share resources."
      ::= { mplsTeObjects 10 }

   mplsTunnelCRLDPResEntry OBJECT-TYPE
      SYNTAX        MplsTunnelCRLDPResEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
           "An entry in this table represents a set of resources
            for an MPLS tunnel established using CRLDP
            (mplsTunnelSignallingProto equal to crldp (3)). An
            entry can be created by a network administrator or
            by an SNMP agent as instructed by any MPLS
            signalling protocol."
      INDEX { mplsTunnelResourceIndex }
      ::= { mplsTunnelCRLDPResTable 1 }
```

```
   MplsTunnelCRLDPResEntry ::= SEQUENCE {
         mplsTunnelCRLDPResMeanBurstSize   MplsBurstSize,
         mplsTunnelCRLDPResExBurstSize     MplsBurstSize,
         mplsTunnelCRLDPResFrequency       INTEGER,
         mplsTunnelCRLDPResWeight          Unsigned32,
         mplsTunnelCRLDPResFlags           Unsigned32,
         mplsTunnelCRLDPResRowStatus       RowStatus,
         mplsTunnelCRLDPResStorageType     StorageType
      }

   mplsTunnelCRLDPResMeanBurstSize OBJECT-TYPE
      SYNTAX        MplsBurstSize
      UNITS         "bytes"
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The mean burst size in bytes."
      ::= { mplsTunnelCRLDPResEntry 1 }

   mplsTunnelCRLDPResExBurstSize OBJECT-TYPE
      SYNTAX        MplsBurstSize
      UNITS         "bytes"
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
        "The Excess burst size in bytes."
      REFERENCE
        "CR-LDP Specification, Section 4.3."
      ::= { mplsTunnelCRLDPResEntry 2 }

   mplsTunnelCRLDPResFrequency OBJECT-TYPE
      SYNTAX  INTEGER {
            unspecified(1),
            frequent(2),
            veryFrequent(3)
         }
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The granularity of the availability of committed
            rate."
      REFERENCE
           "CR-LDP Specification, Section 4.3."
      ::= { mplsTunnelCRLDPResEntry 3 }

   mplsTunnelCRLDPResWeight OBJECT-TYPE
      SYNTAX        Unsigned32(0..255)
      MAX-ACCESS    read-create
```

```
      STATUS        current
      DESCRIPTION
           "The relative weight for using excess bandwidth above
             its committed rate.  The value of 0 means that
             weight is not applicable for the CR-LSP."
      REFERENCE
           "CR-LDP Specification, Section 4.3."
      DEFVAL { 0 }
      ::= { mplsTunnelCRLDPResEntry 4 }

   mplsTunnelCRLDPResFlags OBJECT-TYPE
      SYNTAX        Unsigned32 (0..63)
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
           "The value of the 1 byte Flags conveyed as part of
             the traffic parameters during the establishment of
             the CRLSP. The bits in this object are to be
             interpreted as follows.

             +--+--+--+--+--+--+--+--+
             | Res |F6|F5|F4|F3|F2|F1|
             +--+--+--+--+--+--+--+--+

           Res - These bits are reserved. Zero on transmission.
             Ignored on receipt.
           F1 - Corresponds to the PDR.
           F2 - Corresponds to the PBS.
           F3 - Corresponds to the CDR.
           F4 - Corresponds to the CBS.
           F5 - Corresponds to the EBS.
           F6 - Corresponds to the Weight.

           Each flag if is a Negotiable Flag corresponding to a
             Traffic Parameter. The Negotiable Flag value zero
             denotes Not Negotiable and value one denotes
             Negotiable."
       REFERENCE
           "1. Section 4.3, Constraint-Based LSP Setup using
             LDP, Jamoussi (Editor), RFC 3212, January 2002"
       DEFVAL { 0 }
       ::= { mplsTunnelCRLDPResEntry 5 }

   mplsTunnelCRLDPResRowStatus OBJECT-TYPE
      SYNTAX        RowStatus
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
```

```
            "This variable is used to create, modify, and/or
              delete a row in this table.  When a row in this
              table is in active(1) state, no objects in that row
              can be modified by the agent except
              mplsTunnelCRLDPResRowStatus and
              mplsTunnelCRLDPResStorageType."
       ::= { mplsTunnelCRLDPResEntry 6 }

   mplsTunnelCRLDPResStorageType OBJECT-TYPE
       SYNTAX        StorageType
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
            "The storage type for this CR-LDP Resource entry.
             Conceptual rows having the value 'permanent'
             need not allow write-access to any columnar
             objects in the row."
       DEFVAL { volatile }
       ::= { mplsTunnelCRLDPResEntry 7 }


   -- Notifications.

   mplsTunnelNotificationEnable OBJECT-TYPE
       SYNTAX        TruthValue
       MAX-ACCESS    read-write
       STATUS        current
       DESCRIPTION
            "If this object is true, then it enables the
              generation of mplsTunnelUp and mplsTunnelDown
              traps, otherwise these traps are not emitted."
       DEFVAL { false }
       ::= { mplsTeObjects 11 }

   mplsTunnelUp NOTIFICATION-TYPE
       OBJECTS     {
          mplsTunnelAdminStatus,
          mplsTunnelOperStatus
       }
       STATUS      current
       DESCRIPTION
            "This notification is generated when a
              mplsTunnelOperStatus object for one of the
              configured tunnels is about to leave the down state
              and transition into some other state (but not into
              the notPresent state).  This other state is
              indicated by the included value of
              mplsTunnelOperStatus."
```

```
      ::= { mplsTeNotifications 1 }

   mplsTunnelDown NOTIFICATION-TYPE
      OBJECTS     {
         mplsTunnelAdminStatus,
         mplsTunnelOperStatus
      }
      STATUS      current
      DESCRIPTION
           "This notification is generated when a
             mplsTunnelOperStatus object for one of the
             configured tunnels is about to enter the down state
             from some other state (but not from the notPresent
             state).  This other state is indicated by the
             included value of mplsTunnelOperStatus."
      ::= { mplsTeNotifications 2 }

   mplsTunnelRerouted NOTIFICATION-TYPE
      OBJECTS     {
         mplsTunnelAdminStatus,
         mplsTunnelOperStatus
      }
      STATUS      current
      DESCRIPTION
           "This notification is generated when a tunnel is
             rerouted. If the mplsTunnelARHopTable is used, then
             this tunnel instance's entry in the
             mplsTunnelARHopTable MAY contain the new path for
             this tunnel some time after this trap is issued by
             the agent."
       ::= { mplsTeNotifications 3 }

   mplsTunnelReoptimized NOTIFICATION-TYPE
      OBJECTS     {
         mplsTunnelAdminStatus,
         mplsTunnelOperStatus
      }
      STATUS      current
      DESCRIPTION
           "This notification is generated when a tunnel is
             reoptimized. If the mplsTunnelARHopTable is used,
             then this tunnel instance's entry in the
             mplsTunnelARHopTable MAY contain the new path for
             this tunnel some time after this trap is issued by
             the agent."
       ::= { mplsTeNotifications 4 }

   -- End of notifications.
```

```
   -- Module compliance.

   mplsTeGroups
      OBJECT IDENTIFIER ::= { mplsTeConformance 1 }

   mplsTeCompliances
      OBJECT IDENTIFIER ::= { mplsTeConformance 2 }

   -- Compliance requirement for fully compliant implementations.

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

      MODULE IF-MIB -- The Interfaces Group MIB, RFC 2863.
         MANDATORY-GROUPS {
            ifGeneralInformationGroup,
            ifCounterDiscontinuityGroup
         }

      MODULE -- this module

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

         MANDATORY-GROUPS    {
            mplsTunnelGroup,
            mplsTunnelScalarGroup
         }

         GROUP mplsTunnelManualGroup
         DESCRIPTION
             "This group is mandatory for devices which support
              manual configuration of tunnels."

         GROUP mplsTunnelSignaledGroup
         DESCRIPTION
             "This group is mandatory for devices which support
              signaled tunnel set up."

         GROUP mplsTunnelIsNotIntfcGroup
         DESCRIPTION
             "This group is mandatory for devices which support
```

```
             tunnels that are not interfaces."

          GROUP mplsTunnelIsIntfcGroup
          DESCRIPTION
              "This group is mandatory for devices which support
               tunnels that are interfaces."

          GROUP mplsTunnelCRLDPResOptionalGroup
          DESCRIPTION
              "Objects in this group are required by
               implementations supporting the CR-LDP protocol for
               signalling of TE tunnels."

          GROUP mplsTeNotificationGroup
          DESCRIPTION "This group is mandatory for those implementations
                       which can implement the notifications
                       contained in this group."

          OBJECT       mplsTunnelRowStatus
          SYNTAX       RowStatus { active(1), notInService(2) }
          WRITE-SYNTAX RowStatus { active(1), notInService(2),
                                   createAndGo(4), destroy(6)
                                 }
          DESCRIPTION "Support for createAndWait and notReady is not
                       required."

          OBJECT      mplsTunnelHopRowStatus
          SYNTAX       RowStatus { active(1), notInService(2) }
          WRITE-SYNTAX RowStatus { active(1), notInService(2),
                                   createAndGo(4), destroy(6)
                                 }
          DESCRIPTION "Support for createAndWait and notReady is not
                       required."

          OBJECT      mplsTunnelCRLDPResRowStatus
          SYNTAX       RowStatus { active(1), notInService(2) }
          WRITE-SYNTAX RowStatus { active(1), notInService(2),
                                   createAndGo(4), destroy(6)
                                 }
          DESCRIPTION "Support for createAndWait and notReady is
                       not required."

       ::= { mplsTeCompliances 1 }

   -- Compliance requirement for read-only implementations.

   mplsTeModuleReadOnlyCompliance MODULE-COMPLIANCE
      STATUS current
```

```
      DESCRIPTION
           "Compliance requirement for implementations that only
            provide read-only support for MPLS-TE-STD-MIB.
            Such devices can then be monitored but cannot be
            configured using this MIB modules."

      MODULE -- this module

         -- mplsTunnelTable

         MANDATORY-GROUPS    {
            mplsTunnelGroup,
            mplsTunnelScalarGroup
         }

         GROUP mplsTunnelManualGroup
         DESCRIPTION
             "This group is mandatory for devices which support
              manual configuration of tunnels."

         GROUP mplsTunnelSignaledGroup
         DESCRIPTION
             "This group is mandatory for devices which support
              signaled tunnel set up."

         GROUP mplsTunnelIsNotIntfcGroup
         DESCRIPTION
             "This group is mandatory for devices which support
              tunnels that are not interfaces."

         GROUP mplsTunnelIsIntfcGroup
         DESCRIPTION
             "This group is mandatory for devices which support
              tunnels that are interfaces."

         GROUP mplsTunnelCRLDPResOptionalGroup
         DESCRIPTION
             "Objects in this group are required by
              implementations supporting the CR-LDP protocol for
              signalling of TE tunnels."

         GROUP mplsTeNotificationGroup
         DESCRIPTION "This group is mandatory for those implementations
                      which can implement the notifications
                      contained in this group."

         -- mplsTunnelTable
```

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

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

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

        OBJECT      mplsTunnelIfIndex
        DESCRIPTION
            "Write access is not required."

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

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

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

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

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

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

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

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

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

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

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

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

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

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

        OBJECT      mplsTunnelAdminStatus
        SYNTAX      INTEGER { up (1), down (2) }
        MIN-ACCESS  read-only
        DESCRIPTION
            "Only up and down states must be supported. Write
             access is not required."

        OBJECT      mplsTunnelRowStatus
```

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

        -- mplsTunnelHopTable

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

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

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

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

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

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

        OBJECT      mplsTunnelHopType
        SYNTAX      INTEGER { strict(1) }
        MIN-ACCESS  read-only
        DESCRIPTION
            "loose(2) need not be supported. Write access is
             not required."

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

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

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

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

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

        -- mplsTunnelResourceTable

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

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

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

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

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

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

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

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

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

        -- mplsTunnelCRLDPResTable

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

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

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

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

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

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

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

     ::= { mplsTeCompliances 2 }


  -- Units of conformance.

  mplsTunnelGroup OBJECT-GROUP
     OBJECTS {
        mplsTunnelIndexNext,
        mplsTunnelName,
        mplsTunnelDescr,
        mplsTunnelOwner,
        mplsTunnelXCPointer,
        mplsTunnelIfIndex,
```

```
        mplsTunnelHopTableIndex,
        mplsTunnelARHopTableIndex,
        mplsTunnelCHopTableIndex,
        mplsTunnelAdminStatus,
        mplsTunnelOperStatus,
        mplsTunnelRowStatus,
        mplsTunnelNotificationEnable,
        mplsTunnelStorageType,
        mplsTunnelConfigured,
        mplsTunnelActive,
        mplsTunnelPrimaryInstance,
        mplsTunnelPrimaryUpTime,
        mplsTunnelPathChanges,
        mplsTunnelLastPathChange,
        mplsTunnelCreationTime,
        mplsTunnelStateTransitions,
        mplsTunnelIncludeAnyAffinity,
        mplsTunnelIncludeAllAffinity,
        mplsTunnelExcludeAnyAffinity,
        mplsTunnelPerfPackets,
        mplsTunnelPerfHCPackets,
        mplsTunnelPerfErrors,
        mplsTunnelPerfBytes,
        mplsTunnelPerfHCBytes,
        mplsTunnelResourcePointer,
        mplsTunnelInstancePriority,
        mplsTunnelPathInUse,
        mplsTunnelRole,
        mplsTunnelTotalUpTime,
        mplsTunnelInstanceUpTime,
        mplsTunnelResourceIndexNext,
        mplsTunnelResourceMaxRate,
        mplsTunnelResourceMeanRate,
        mplsTunnelResourceMaxBurstSize,
        mplsTunnelResourceMeanBurstSize,
        mplsTunnelResourceExBurstSize,
        mplsTunnelResourceFrequency,
        mplsTunnelResourceWeight,
        mplsTunnelResourceRowStatus,
        mplsTunnelResourceStorageType,
        mplsTunnelARHopAddrType,
        mplsTunnelARHopIpAddr,
        mplsTunnelARHopAddrUnnum,
        mplsTunnelARHopLspId,
        mplsTunnelCHopAddrType,
        mplsTunnelCHopIpAddr,
        mplsTunnelCHopIpPrefixLen,
        mplsTunnelCHopAsNumber,
```

```
         mplsTunnelCHopAddrUnnum,
         mplsTunnelCHopLspId,
         mplsTunnelCHopType
      }
      STATUS  current
      DESCRIPTION
           "Necessary, but not sufficient, set of objects to
            implement tunnels.  In addition, depending on the
            type of the tunnels supported (for example,
            manually configured or signaled, persistent or non-
            persistent, etc.), the following other groups
            defined below are mandatory: mplsTunnelManualGroup
            and/or mplsTunnelSignaledGroup,
            mplsTunnelIsNotIntfcGroup and/or
            mplsTunnelIsIntfcGroup."
      ::= { mplsTeGroups 1 }

   mplsTunnelManualGroup  OBJECT-GROUP
      OBJECTS { mplsTunnelSignallingProto }
      STATUS  current
      DESCRIPTION
           "Object(s) needed to implement manually configured
            tunnels."
      ::= { mplsTeGroups 2 }

   mplsTunnelSignaledGroup OBJECT-GROUP
      OBJECTS {
         mplsTunnelSetupPrio,
         mplsTunnelHoldingPrio,
         mplsTunnelSignallingProto,
         mplsTunnelLocalProtectInUse,
         mplsTunnelSessionAttributes,
         mplsTunnelHopListIndexNext,
         mplsTunnelHopAddrType,
         mplsTunnelHopIpAddr,
         mplsTunnelHopIpPrefixLen,
         mplsTunnelHopAddrUnnum,
         mplsTunnelHopAsNumber,
         mplsTunnelHopLspId,
         mplsTunnelHopType,
         mplsTunnelHopInclude,
         mplsTunnelHopPathOptionName,
         mplsTunnelHopEntryPathComp,
         mplsTunnelHopRowStatus,
         mplsTunnelHopStorageType
      }
      STATUS  current
      DESCRIPTION
```

```
            "Objects needed to implement signaled tunnels."
      ::= { mplsTeGroups 3 }

   mplsTunnelScalarGroup OBJECT-GROUP
      OBJECTS {
         mplsTunnelConfigured,
         mplsTunnelActive,
         mplsTunnelTEDistProto,
         mplsTunnelMaxHops,
         mplsTunnelNotificationMaxRate
      }
      STATUS  current
      DESCRIPTION
           "Scalar object needed to implement MPLS tunnels."
      ::= { mplsTeGroups 4 }

   mplsTunnelIsIntfcGroup OBJECT-GROUP
      OBJECTS { mplsTunnelIsIf }
      STATUS  current
      DESCRIPTION
           "Objects needed to implement tunnels that are
             interfaces."
      ::= { mplsTeGroups 5 }

   mplsTunnelIsNotIntfcGroup OBJECT-GROUP
      OBJECTS { mplsTunnelIsIf }
      STATUS  current
      DESCRIPTION
           "Objects needed to implement tunnels that are not
             interfaces."
      ::= { mplsTeGroups 6 }

   mplsTunnelCRLDPResOptionalGroup OBJECT-GROUP
      OBJECTS {
         mplsTunnelCRLDPResMeanBurstSize,
         mplsTunnelCRLDPResExBurstSize,
         mplsTunnelCRLDPResFrequency,
         mplsTunnelCRLDPResWeight,
         mplsTunnelCRLDPResFlags,
         mplsTunnelCRLDPResRowStatus,
         mplsTunnelCRLDPResStorageType
      }
      STATUS  current
      DESCRIPTION
           "Set of objects implemented for resources applicable
             for tunnels signaled using CR-LDP."
      ::= { mplsTeGroups 7 }
```

```
   mplsTeNotificationGroup NOTIFICATION-GROUP
      NOTIFICATIONS {
         mplsTunnelUp,
         mplsTunnelDown,
         mplsTunnelRerouted,
         mplsTunnelReoptimized
      }
      STATUS  current
      DESCRIPTION
           "Set of notifications implemented in this module.
             None is mandatory."
      ::= { mplsTeGroups 8 }

   END
```

12. Security Considerations

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 mplsTunnelTable, mplsTunnelHopTable, mplsTunnelResourceTable, and mplsTunnelCRLDPResTable collectively contain objects to provision MPLS 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 mplsTunnelTable, mplsTunnelHopTable, mplsTunnelResourceTable, mplsTunnelARHopTable, mplsTunnelCHopTable, mplsTunnelPerfTable, and mplsTunnelCRLDPResTable collectively show the MPLS-TE tunnel network topology and its performance 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 support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED that SNMPv3 be deployed and cryptographic security enabled. 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 only those principals (users) that have legitimate rights to those objects.

13. Acknowledgments

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Comments should be made directly to the MPLS mailing list at mpls@uu.net.

14. IANA Considerations

As described in [MPLSMGMT] 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 [RFC2434].

14.1. IANA Considerations for MPLS-TE-STD-MIB

The IANA has assigned { mplsStdMIB 3 } to the MPLS-TE-STD-MIB module specified in this document.

15. References

15.1. Normative References

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