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MPLS Traffic Engineering Management Information Base Using SMIv2

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Status of this Memo

Abstract

This memo defines an experimental portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects for Multi-Protocol Label Switching (MPLS) [MPLSArch, MPLSFW] based traffic engineering.

Open Issues

- Do we need to introduce a separate table of tunnel performance objects or is the current method of using the objects in mplsInSegmentTable and mplsOutSegmentTable [LSRMIB] to determine tunnel performance adequate? We think the latter since we need to be able to measure the individual performance of each tunnel segment anyway which will imply replicating all the segment related objects in this MIB; but this needs some more thought.

- Support for "make-before-break" tunnel re-routing using shared-explicit RSVP filters.

- Support for signalled COS value.

- Do we need objects to keep track of ownership of entries in various tables?

- More descriptive text and detailed example.

- Session attribute flag for fast-reroute.

1. Introduction

This memo defines an experimental 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 an Multi-Protocol Label Switching (MPLS) [MPLSArch, MPLSFW] based traffic engineering. This MIB should be used in conjunction with the companion document [LSRMIB] for MPLS based traffic engineering configuration and management.

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

This memo does not, in its draft form, specify a standard for the Internet community.

2. Terminology

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

An explicitly routed LSP (ERLSP) is referred to as an MPLS tunnel. It consists of one in-segment and/or one out-segment at the ingress/egress LSRs. 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 in performed using a cross-connect. These objects are defined in the MPLS Label Switch Router MIB [LSRMIB].

3. The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

- An overall architecture, described in RFC 2271 [SNMPArch].

- Mechanisms for describing and naming objects and events for the purpose of management. The first version of this Structure of Management Information (SMI) is called SMIv1 and described in RFC 1155 [SMIv1], RFC 1212 [SNMPv1MIBDef] and RFC 1215 [SNMPv1Traps]. The second version, called SMIv2, is described in RFC 1902 [SMIv2], RFC 1903 [SNMPv2TC] and RFC 1904 [SNMPv2Conf].

- Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in RFC 1157 [SNMPv1]. A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in RFC 1901 [SNMPv2c] and RFC 1906 [SNMPv2TM]. The third version of the message protocol is called SNMPv3 and described in RFC 1906 [SNMPv2TM], RFC 2272 [SNMPv3MP] and RFC 2274 [SNMPv3USM].

- Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in RFC 1157 [SNMPv1]. A second set of protocol operations and associated PDU formats is described in RFC 1905 [SNMPv2PO].

- A set of fundamental applications described in RFC 2273 [SNMPv3App] and the view-based access control mechanism described in RFC 2275 [SNMPv3VACM]. Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the mechanisms defined in the SMI. This memo specifies a MIB module that is compliant to the SMIv2. A MIB conforming to the SMIv1 can be produced through the appropriate translations. The resulting translated MIB must be semantically equivalent, except where objects or events are omitted because no translation is possible (use of Counter64). Some machine readable information in SMIv2 will be converted into textual descriptions in SMIv1 during the translation process.   However, this loss of machine readable information is not considered to change the semantics of the MIB.

3.1. Object Definitions

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the subset of Abstract Syntax Notation One (ASN.1) defined in the SMI. In particular, each object type is named by an OBJECT IDENTIFIER, an administratively assigned name. The object type together with an object instance serves to uniquely identify a specific instantiation of the object. For human convenience, we often use a textual string, termed the descriptor, to also refer to the object type.

4. Feature Checklist

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

- The MIB must support the configuration of point-to-point uni-directional tunnels.

- The MIB should be able to support the configuration of point-to-point bi-directional tunnels.

- The MIB should be able to support the configuration of multipoint-to-point unidirectional tunnels.

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

- The MIB should be able to support both manually configured MPLS tunnels as well as via LDP and/or RSVP signaling.

- It should be possible to support 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 loose and strict source routed hops.

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

5.1. Summary of Trafic Engineering MIB

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

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

- Tunnel hop table (mplsTunnelHopTable) for configuring strict and loose source routed MPLS tunnels hops.

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 [RSVPTun, CRLDP]. The tables support both manually configured and signalled tunnels. Moreover, they provide the capability to associate two uni-directional tunnels to form a single bi-directional tunnel.

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 tunnel segments, 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, mplsTunnelXCID. These segment and cross-connect related objects are defined in [LSRMIB].

6.2. mplsTunnelHopTable

mplsTunnelHopTable is used to indicate the hops, strict or loose, for an MPLS tunnel defined in mplsTunnelTable, when it is established via signaling. Each row in this table is indexed primarily by the same index mplsTunnelIndex as the row of the corresponding tunnel in mplsTunnelTable. 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 per tunnel on this LSR.

7. MPLS Traffic Engineering MIB Definitions

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

IMPORTS
   MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
   experimental, Integer32, Counter32, Counter64, Gauge32, IpAddress
      FROM SNMPv2-SMI
   MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
      FROM SNMPv2-CONF
   TEXTUAL-CONVENTION, TruthValue, RowStatus
      FROM SNMPv2-TC
   ifIndex, InterfaceIndex, InterfaceIndexOrZero
      FROM IF-MIB
   BitRate, BurstSize
      FROM INTEGRATED-SERVICES-MIB;

mplsTeMIB MODULE-IDENTITY
   LAST-UPDATED "9906161200Z"  -- 16 June 1999 12:00:00 EST
   ORGANIZATION "Multiprotocol Label Switching (MPLS) Working Group"
   CONTACT-INFO
   "        Cheenu Srinivasan
     Postal: Tachion Network Technologies
             2 Meridian Road
             Eatontown, NJ 07724
     Tel:    +1 732 542 7750 x234
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     Postal: Lucent Technologies
             4D537, 101 Crawfords Corner Road
             Holmdel, NJ 07733
     Tel:    +1 732 332 5163
     Email:  arunv@lucent.com"
   DESCRIPTION
       "Proposed  MIB  module  for MPLS Traffic  Engineering
```

(TE) as defined in: Extensions to RSVP for LSP Tunnels, Awduche et al, Internet Draft <draft-mpls-rsvp-lsp-tunnel-02.txt>, March 1999; Constraint-

```
        Based  LSP Setup using LDP, Jamoussi, Internet Draft
        < draft-ietf-mpls-cr-ldp-01.txt>, Feb. 1999."
   ::= { experimental 95 }


-- Textual Conventions.

-- An MPLS label.
MplsLabel ::= TEXTUAL-CONVENTION
   STATUS        current
   DESCRIPTION
       "Represents an MPLS label.  Note that the contents of
        a  label  field are interpreted in an interface-type
        specific fashion.  For example, the label carried in
        the MPLS shim header is 20 bits wide and the top  12
        bits  must  be zero.  The frame relay label  can  be
        either 10, 17 or 23 bits wide depending on the  size
        of the DLCI field size and the top 22, 15, or 9 bits
        must  be  zero, respectively.  For an ATM interface,
        the  lowermost 16 bits are interpreted as  the  VCI,
        the  next  8 bits as the VPI and the remaining  bits
        must  be  zero.   Also  note the  permissible  label
        values  are  also a function of the interface  type.
        For  example,  the value 3 has special semantics  in
        the  control plane for an MPLS shim header label and
        is not a valid label value in the datapath."
   REFERENCE
       "1.  MPLS  Label Stack Encoding, Rosen et al,  draft-
        ietf-mpls-label-encaps-04.txt, April 1999.
       2.  Use  of  Label Switching on Frame Relay Networks,
        Conta et al, draft-ietf-mpls-fr-03.txt, Nov. 1998."
   SYNTAX Integer32

MplsTunnelIndex ::= TEXTUAL-CONVENTION
   STATUS        current
   DESCRIPTION
       "Index into mplsTunnelTable."
   SYNTAX        INTEGER (0..65535)

MplsTunnelCookie ::= TEXTUAL-CONVENTION
   STATUS        current
   DESCRIPTION
       "A  globally  unique identifier that is  assigned  to
        each ERLSP.  This is assigned at the head end of the
        ERLSP  and can be used by all LSRs to identify  this
        ERLSP.  At the head end this cookie is maintained in
        the  tunnel  table  as  mplsTunnelLocalCookie.   For
```

signalled tunnels this cookie is piggybacked by the signaling protocol to the remote end where the cookie is stored in the remote LSR's tunnel table as

```
        mplsTunnelRemoteCookie for the tunnel.  For creating
        bi-directional  tunnels  the  cookie  is   used   to
        associate   the   two  uni-directional   ERLSPs   as
        belonging to the same tunnel.

        It  is recommended that the cookie value be assigned
        by  concatenating the head-end LSR's IP address with
        the  tunnel index.  For IPv4 addresses this  results
        in a 6-octet long cookie."
   SYNTAX        OCTET STRING (SIZE(6))

Ipv6Address ::= TEXTUAL-CONVENTION
   STATUS      current
   DESCRIPTION
       "IPv6 address."
   SYNTAX      OCTET STRING (SIZE(16))


-- Top level components of this MIB.

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



-- MPLS tunnel table.

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 1 }

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 LDP or  RSVP.
        Whenever an new entry is created with mplsTunnelIsIf
        set  to  true(1),  then  a  corresponding  entry  is
        created  in  ifTable  as well (see  RFC  2233).  The
        ifType   of  this  entry  is  mplsTunnel(150)   (see
        http://www.isi.edu/in-notes/iana/assignments/smi-
        numbers)."
   INDEX         {  mplsTunnelIndex  }
      ::= { mplsTunnelTable 1 }

MplsTunnelEntry ::= SEQUENCE {
      mplsTunnelIndex                 MplsTunnelIndex,
      mplsTunnelName                  DisplayString,
      mplsTunnelDescr                 DisplayString,
      mplsTunnelIsIf                  TruthValue,
      mplsTunnelIfIndex               InterfaceIndexOrZero,
      mplsTunnelDirection             INTEGER,
      mplsTunnelXCIndex               Integer32,
      mplsTunnelSignallingProto       INTEGER,
      mplsTunnelLocalCookie           MplsTunnelCookie,
      mplsTunnelRemoteCookie          MplsTunnelCookie,
      mplsTunnelIsMergeable           TruthValue,
      mplsTunnelSetupPrio             INTEGER,
      mplsTunnelHoldingPrio           INTEGER,
      mplsTunnelInMaxRate             BitRate,
      mplsTunnelInMeanRate            BitRate,
      mplsTunnelInMaxBurstSize        BurstSize,
      mplsTunnelOutMaxRate            BitRate,
      mplsTunnelOutMeanRate           BitRate,
      mplsTunnelOutMaxBurstSize       BurstSize,
      mplsTunnelIsPinned              TruthValue,
      mplsTunnelIsPersistent          TruthValue,
      mplsTunnelAdminStatus           INTEGER,
      mplsTunnelOperStatus            INTEGER,
      mplsTunnelRowStatus             RowStatus
   }

mplsTunnelIndex OBJECT-TYPE
   SYNTAX        Integer32
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Uniquely identifies this row."
   ::= { mplsTunnelEntry 1 }

mplsTunnelName OBJECT-TYPE
```

```
   SYNTAX        DisplayString
   MAX-ACCESS    read-create
   STATUS        current
DESCRIPTION
       "The 'canonical' name assigned to the tunnel that can
        be  used  to refer to it on the 'console' port.   If
        mplsTunnelIsIf  is  set  to  true  ifName   of   the
        interface corresponding to this tunnel should have a
        value   equal  to  mplsTunnelName.   Also  see   the
        description of ifName in RFC 2233."
   REFERENCE
       "RFC  2233  -  The Interfaces Group MIB using  SMIv2,
        McCloghrie and Kastenholtz, Nov. 1997"
   ::= { mplsTunnelEntry 2 }

mplsTunnelDescr OBJECT-TYPE
   SYNTAX        DisplayString
   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."
   ::= { mplsTunnelEntry 3 }

mplsTunnelIsIf OBJECT-TYPE
   SYNTAX        TruthValue
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Is this tunnel also an interface?"
   DEFVAL        { false }
   ::= { mplsTunnelEntry 4 }

mplsTunnelIfIndex OBJECT-TYPE
   SYNTAX        InterfaceIndexOrZero
   MAX-ACCESS    read-only
   STATUS        current
   DESCRIPTION
       "If this tunnel is an interface then the LSR assigned
        ifIndex.  Otherwise this is set to zero."
   DEFVAL        { 0 }
   ::= { mplsTunnelEntry 5 }

mplsTunnelDirection OBJECT-TYPE
   SYNTAX        INTEGER { in(1), out(2), in-out(3) }
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Whether   this  tunnel  is  unidirectional-incoming,
        unidirectional-outgoing, or bidirectional."
   ::= { mplsTunnelEntry 6 }

mplsTunnelXCIndex OBJECT-TYPE
   SYNTAX        Integer32
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Index into mplsXCTable identifying the segments that
        compose    this    tunnel,    their    characteristics,
        relationship etc."
   REFERENCE
       "  Srinivasan,  C.,  and A. Viswanathan,  MPLS  Label
        Switch  Router  Management  Information  Base  Using
        SMIv2,   Internet   Draft   <draft-ietf-mpls-lsr-mib-
        00.txt>, June 1999."
   DEFVAL        { 0 }
   ::= { mplsTunnelEntry 7 }

mplsTunnelSignallingProto OBJECT-TYPE
   SYNTAX        INTEGER { none(1), ldp(2), rsvp(3) }
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "The  signaling protocol, if any, that  set  up  this
        tunnel."
   DEFVAL        { none }
   ::= { mplsTunnelEntry 8 }

mplsTunnelLocalCookie OBJECT-TYPE
   SYNTAX        MplsTunnelCookie
   MAX-ACCESS    read-only
   STATUS        current
   DESCRIPTION
       "The  local cookie assigned to the outgoing direction
        of this tunnel at this LSR."
   ::= { mplsTunnelEntry 9 }

mplsTunnelRemoteCookie OBJECT-TYPE
   SYNTAX        MplsTunnelCookie
   MAX-ACCESS    read-only
   STATUS        current
   DESCRIPTION
       "The remote cookie assigned to the incoming direction
        of tunnel by the remote (head-end) LSR."
   ::= { mplsTunnelEntry 10 }
```

```
mplsTunnelIsMergeable OBJECT-TYPE
   SYNTAX        TruthValue
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Whether  this  tunnel  can  be  merged  at  an   LSR
        downstream with another tunnel."
   DEFVAL        { true }
   ::= { mplsTunnelEntry 11 }

mplsTunnelSetupPrio OBJECT-TYPE
   SYNTAX        INTEGER (0..7)
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "The setup priority of this tunnel."
   REFERENCE
       "Extensions to RSVP for LSP Tunnels, Awduche  et  al,
        Internet  Draft <draft-mpls-rsvp-lsp-tunnel-02.txt>,
        March  1999., Constraint-Based LSP Setup using  LDP,
        Jamoussi,  Internet  Draft  <draft-ietf-mpls-cr-ldp-
        01.txt>, Feb. 1999."
   ::= { mplsTunnelEntry 12 }

mplsTunnelHoldingPrio OBJECT-TYPE
   SYNTAX        INTEGER (0..7)
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "The holding priority for this tunnel."
   REFERENCE
       "  Extensions to RSVP for LSP Tunnels, Awduche et al,
        Internet  Draft <draft-mpls-rsvp-lsp-tunnel-02.txt>,
        March  1999., Constraint-Based LSP Setup using  LDP,
        Jamoussi,  Internet  Draft  <draft-ietf-mpls-cr-ldp-
        01.txt>, Feb. 1999."
   ::= { mplsTunnelEntry 13 }

-- When resource allocation is performed as requested by
-- the following incoming TSpec objects, they are copied
-- into an entry in mplsTSpecTable [LSRMIB]: mplsTunnelInMaxRate
-- to mplsTSpecMaxRate, mplsTunnelInMeanRate to
-- mplsTSpecMeanRate, and mplsTunnelInMaxBurstSize
-- to mplsTSpecMaxBurstSize; mplsTSpecDirection of this
-- entry is set to in(1).  The mplsTSpecIndex value of this
-- entry is copied to  mplsInSegmentTSpecIndex of the
-- corresponding in-segment entry.

mplsTunnelInMaxRate OBJECT-TYPE
   SYNTAX        BitRate
   UNITS          "bits per second"
   MAX-ACCESS     read-create
   STATUS         current
   DESCRIPTION
       "The maximum incoming rate in bits/second.  Note that
        setting  mplsTunnelInMaxRate,  mplsTunnelInMeanRate,
        and  mplsTunnelInMaxBurstSize to 0  indicates  best-
        effort  treatment.   This object  is  copied  to  an
        instance  of mplsTSpecMaxRate in mplsTSpecTable  the
        index  of  which  is  copied into the  corresponding
        mplsInSegmentTSpecIndex."
   REFERENCE
       "MPLS Label Switch Router Management Information Base
        Using SMIv2, Srinivasan and Viswanathan, draft-ietf-
        mpls-lsr-mib-00.txt, June 1999."
   DEFVAL        { 0 }
   ::= { mplsTunnelEntry 14 }

mplsTunnelInMeanRate OBJECT-TYPE
   SYNTAX        BitRate
   UNITS         "bits per second"
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "This   object   is   copied  to   an   instance   of
        mplsTSpecMeanRate  in mplsTSpecTable  the  index  of
        which    is    copied    into    the    corresponding
        mplsInSegmentTSpecIndex."
   REFERENCE
       "MPLS Label Switch Router Management Information Base
        Using SMIv2, Srinivasan and Viswanathan, draft-ietf-
        mpls-lsr-mib-00.txt, June 1999."
   DEFVAL        { 0 }
   ::= { mplsTunnelEntry 15 }

mplsTunnelInMaxBurstSize OBJECT-TYPE
   SYNTAX        BurstSize
   UNITS         "bytes"
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "The  maximum  burst size in bytes.  This  object  is
        copied    to   mplsInSegmentMaxBurstSize   of    the
        corresponding in-segment."
   REFERENCE
       "MPLS Label Switch Router Management Information Base
        Using SMIv2, Srinivasan and Viswanathan, draft-ietf-
        mpls-lsr-mib-00.txt, June 1999."
   DEFVAL        { 0 }
   ::= { mplsTunnelEntry 16 }
```

```
-- When resource allocation is performed as requested by
-- the following outgoing TSpec objects, they are copied
-- into an entry in mplsTSpecTable [LSRMIB]: mplsTunnelOutMaxRate
-- to mplsTSpecMaxRate, mplsTunnelOutMeanRate to
-- mplsTSpecMeanRate, and mplsTunnelOutMaxBurstSize
-- to mplsTSpecMaxBurstSize; mplsTSpecDirection of this
-- entry is set to out(2).  The mplsTSpecIndex value of this
-- entry is copied to mplsOutSegmentTSpecIndex of the
-- corresponding out-segment entry.

mplsTunnelOutMaxRate OBJECT-TYPE
   SYNTAX        BitRate
   UNITS         "bits per second"
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "The maximum outgoing rate in bits/second.  Note that
        setting mplsTunnelOutMaxRate, mplsTunnelOutMeanRate,
        and  mplsTunnelOutMaxBurstSize to 0 indicates  best-
        effort   treatment.   This  object  is   copied   to
        mplsOutSegmentMaxRate  of  the  corresponding   out-
        segment."
   REFERENCE
       "MPLS Label Switch Router Management Information Base
        Using SMIv2, Srinivasan and Viswanathan, draft-ietf-
        mpls-lsr-mib-00.txt, June 1999."
   DEFVAL        { 0 }
   ::= { mplsTunnelEntry 17 }

mplsTunnelOutMeanRate OBJECT-TYPE
   SYNTAX        BitRate
   UNITS         "bits per second"
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "The  mean outgoing rate in bits/second.  This object
        is   copied   to   mplsOutSegmentMeanRate   of   the
        corresponding out-segment."
   REFERENCE
       "MPLS Label Switch Router Management Information Base
        Using SMIv2, Srinivasan and Viswanathan, draft-ietf-
        mpls-lsr-mib-00.txt, June 1999."
   DEFVAL        { 0 }
   ::= { mplsTunnelEntry 18 }

mplsTunnelOutMaxBurstSize OBJECT-TYPE
   SYNTAX        BurstSize
   UNITS         "bytes"
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "The  maximum  burst size in bytes.  This  object  is
```

```
        copied   to   mplsOutSegmentMaxBurstSize   of    the
        corresponding out-segment."
   REFERENCE
       "MPLS Label Switch Router Management Information Base
        Using SMIv2, Srinivasan and Viswanathan, draft-ietf-
        mpls-lsr-mib-00.txt, June 1999."
   DEFVAL        { 0 }
   ::= { mplsTunnelEntry 19 }

mplsTunnelIsPinned OBJECT-TYPE
   SYNTAX        TruthValue
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Indicates  whether  the loose-routed  hops  of  this
        tunnel are to be pinned."
   DEFVAL        { false }
   ::= { mplsTunnelEntry 20 }

mplsTunnelIsPersistent OBJECT-TYPE
   SYNTAX        TruthValue
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Indicates  whether  this tunnel should  be  restored
        automatically after failures."
   DEFVAL        { true }
   ::= { mplsTunnelEntry 21 }

mplsTunnelAdminStatus OBJECT-TYPE
   SYNTAX        INTEGER {
         up(1),     -- ready to pass packets
         down(2),
         testing(3) -- in some test mode
      }
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Desired status of this tunnel."
   ::= { mplsTunnelEntry 22 }

mplsTunnelOperStatus OBJECT-TYPE
   SYNTAX        INTEGER {
         up(1),          -- ready to pass packets
         down(2),
         testing(3),     -- in some test mode
         unknown(4),     -- status cannot be determined for some
```

```
                                -- reason
         dormant(5),
         notPresent(6),  -- some component is missing
         lowerLayerNotPresent(7)
                        -- down due to the state of
                        -- lower layer interfaces
      }
   MAX-ACCESS    read-only
   STATUS        current
   DESCRIPTION
       "The  operational status of this tunnel, typically  a
        function of the state of individual segments of this
        tunnel, among other things."
   ::= { mplsTunnelEntry 23 }

mplsTunnelRowStatus OBJECT-TYPE
   SYNTAX        RowStatus
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "For controlling the state of this row."
   ::= { mplsTunnelEntry 24 }

-- End of mplsTunnelTable


-- Maximum number of tunnel hops supported.

mplsTunnelMaxHops OBJECT-TYPE
   SYNTAX        RowStatus
   MAX-ACCESS    read-only
   STATUS        current
   DESCRIPTION
       "The maximum number of hops that can be specified for
        a tunnel on this device."
   ::= { mplsTeObjects 2 }


-- Tunnel hop table.

mplsTunnelHopTable  OBJECT-TYPE
   SYNTAX        SEQUENCE OF MplsTunnelEntry
   MAX-ACCESS    not-accessible
   STATUS        current
   DESCRIPTION
       "The mplsTunnelHopTable is used to indicate the hops,
        strict  or  loose,  for an MPLS  tunnel  defined  in
        mplsTunnelTable,   when  it   is   established   via
        signaling, for the outgoing direction of the tunnel.
        Each  row in this table is indexed primarily by  the
        same  index,  mplsTunnelIndex, as  the  row  of  the
```

corresponding tunnel in mplsTunnelTable. Each row also has a secondary index mplsTunnelHopIndex

```
        corresponding  to  the  next  hop  that   this   row
        corresponds to.  The first row in the table  is  the
        first hop after the origination point of the tunnel.
        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 3 }

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
        signalled ERLSP set up by LDP or RSVP."
   INDEX         {  mplsTunnelIndex, mplsTunnelHopIndex  }
      ::= { mplsTunnelHopTable 1 }

MplsTunnelHopEntry ::= SEQUENCE {
      mplsTunnelHopIndex               Integer32,
      mplsTunnelHopAddrType            INTEGER,
      mplsTunnelHopIpv4Addr            IpAddress,
      mplsTunnelHopIpv4PrefixLen       INTEGER,
      mplsTunnelHopIpv6Addr            Ipv6Address,
      mplsTunnelHopIpv6PrefixLen       INTEGER,
      mplsTunnelHopAsNumber            INTEGER,
      mplsTunnelHopStrictOrLoose       INTEGER,
      mplsTunnelHopRowStatus           RowStatus
   }

mplsTunnelHopIndex OBJECT-TYPE
   SYNTAX        Integer32
   MAX-ACCESS    not-accessible
   STATUS        current
   DESCRIPTION
       "Secondary  index  into  this table  identifying  the
        particular hop."
   ::= { mplsTunnelHopEntry 1 }

mplsTunnelHopAddrType OBJECT-TYPE
   SYNTAX        INTEGER { ipV4(1), ipV6(2), asNumber(3) }
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
```

```
       "Address type of this hop."
   DEFVAL        { ipV4 }
   ::= { mplsTunnelHopEntry 2 }
```

```
mplsTunnelHopIpv4Addr OBJECT-TYPE
   SYNTAX        IpAddress
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "If mplsTunnelHopAddrType is ipV4(1), IPv4 address of
        this  hop.  This object is not significant otherwise
        and should return a value of 0."
   ::= { mplsTunnelHopEntry 3 }

mplsTunnelHopIpv4PrefixLen OBJECT-TYPE
   SYNTAX        INTEGER (1..32)
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "If  mplsTunnelHopAddrType is ipV4(1), prefix  length
        for  this  hop's IPv4 address.  This object  is  not
        significant otherwise and should return a  value  of
        0."
   ::= { mplsTunnelHopEntry 4 }

mplsTunnelHopIpv6Addr OBJECT-TYPE
   SYNTAX        Ipv6Address
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "If   mplsTunnelHopAddrType  is  ipV6(2),  the   IPv6
        address of this hop.  This object is not significant
        otherwise and should return a value of 0."
   ::= { mplsTunnelHopEntry 5 }

mplsTunnelHopIpv6PrefixLen OBJECT-TYPE
   SYNTAX        INTEGER (1..128)
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "If  mplsTunnelHopAddrType is ipV6(2), prefix  length
        for  this  hop's IPv6 address.  This object  is  not
        significant otherwise and should return a  value  of
        0."
   ::= { mplsTunnelHopEntry 6 }

mplsTunnelHopAsNumber OBJECT-TYPE
   SYNTAX        INTEGER (0..65535)
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "If  mplsTunnelHopAddrType  is  asNumber(3),  the  AS
        number  this  hop.  This object is  not  significant
        otherwise and should return a value of 0."
   ::= { mplsTunnelHopEntry 7 }

mplsTunnelHopStrictOrLoose OBJECT-TYPE
   SYNTAX        INTEGER { strict(1), loose(2) }
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "Whether this is a strict or loose hop."
   ::= { mplsTunnelHopEntry 8 }

mplsTunnelHopRowStatus OBJECT-TYPE
   SYNTAX        RowStatus
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
       "For creating, modifying and deleting this row."
   ::= { mplsTunnelHopEntry 9 }

-- End of mplsTunnelHopTable


-- Notifications.

mplsTunnelUp NOTIFICATION-TYPE
   OBJECTS     { mplsTunnelIndex, 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     { mplsTunnelIndex, 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 }
```

```
-- End of notifications.


-- Module compliance.

mplsTeGroups
   OBJECT IDENTIFIER ::= { mplsTeConformance 1 }

mplsTeCompliances
   OBJECT IDENTIFIER ::= { mplsTeConformance 2 }

mplsTeModuleCompliance MODULE-COMPLIANCE
   STATUS current
   DESCRIPTION
       "Compliance  statement for agents  that  support  the
        MPLS TE MIB."
   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 }

      GROUP mplsTunnelManualGroup
      DESCRIPTION
          "This   group  is  mandatory  for  devices  which
           support  manual  configuration  of  tunnels,  in
           addition   to  mplsTunnelGroup.   The  following
           constraints   apply:   mplsTunnelSignallingProto
           should  be  at least read-only with a  value  of
           none(1)."

      GROUP mplsTunnelSignalledGroup
      DESCRIPTION
          "This   group  is  mandatory  for  devices  which
           support signalled tunnel set up, in addition  to
           mplsTunnelGroup.    The  following   constraints
           apply:  mplsTunnelSignallingProto should  be  at
           least read-only returning a value of ldp(2),  or
           rsvp(3)."

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

support tunnels that are not interfaces, in
addition to mplsTunnelGroup. The following

```
                 constraints apply: mplsTunnelIsIf must at  least
                 be read-only returning false(1)."

          GROUP mplsTunnelIsIntfcGroup
          DESCRIPTION
                "This   group  is  mandatory  for  devices  which
                 support tunnels that are interfaces, in addition
                 to  mplsTunnelGroup.  The following  constraints
                 apply: mplsTunnelIsIf must at least be read-only
                 returning true(2)."

          GROUP mplsTunnelIsPersistentGroup
          DESCRIPTION
                "This   group  is  mandatory  for  devices  which
                 support  persistent  tunnels,  in  addition   to
                 mplsTunnelGroup.    The  following   constraints
                 apply:  mplsTunnelIsPersistent must at least  be
                 read-only returning true(2)."

          GROUP mplsTunnelIsNotPersistentGroup
          DESCRIPTION
                "This   group  is  mandatory  for  devices  which
                 support  non-persistent tunnels, in addition  to
                 mplsTunnelGroup.    The  following   constraints
                 apply:  mplsTunnelIsPersistent must at least  be
                 read-only returning false(1)."


          -- mplsTunnelTable

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

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

      OBJECT      mplsTunnelDirection
      SYNTAX      INTEGER { out(2) }
      MIN-ACCESS  read-only
      DESCRIPTION
          "The  values  in(1)  and in-out(3)  need  not  be
           supported."

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

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

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

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

      OBJECT      mplsTunnelIsMergeable
      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      mplsTunnelInMaxRate
```

```
        MIN-ACCESS  read-only
        DESCRIPTION
```

```
          "Write access is not required."

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

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

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

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

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

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

      OBJECT      mplsTunnelIsPersistent
      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 need to be  supported.
           Write access is not required."

      OBJECT      mplsTunnelOperStatus
      SYNTAX      INTEGER { up (1), down (2) }
      MIN-ACCESS  read-only
      DESCRIPTION
```

```
          "Only  up  and down states need to be  supported.
           Write access is not required."
```

```
      OBJECT      mplsTunnelRowStatus
      SYNTAX      INTEGER { active(1), notInService(2),
                       createAndGo(4), destroy(6) }
      MIN-ACCESS  read-only
      DESCRIPTION
          "The notReady(3) and createAndWait(5) states need
           not be supported. Write access is not required."


      -- mplsTunnelHopTable

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

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

      OBJECT      mplsTunnelHopIpv4Addr
      MIN-ACCESS  read-only
      DESCRIPTION
          "Write access is not required."

      OBJECT      mplsTunnelHopIpv4PrefixLen
      MIN-ACCESS  read-only
      DESCRIPTION
          "Write access is not required."

      OBJECT      mplsTunnelHopIpv6Addr
      MIN-ACCESS  read-only
      DESCRIPTION
          "Write access is not required."

      OBJECT      mplsTunnelHopIpv6PrefixLen
      MIN-ACCESS  read-only
      DESCRIPTION
          "Write access is not required."

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

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

      OBJECT      mplsTunnelHopRowStatus
      SYNTAX      INTEGER { active(1), notInService(2),
                       createAndGo(4), destroy(6) }
      MIN-ACCESS  read-only
      DESCRIPTION
          "The notReady(3) and createAndWait(5) states need
           not be supported. Write access is not required."


   ::= { mplsTeCompliances 1 }


-- Units of conformance.

mplsTunnelGroup OBJECT-GROUP
   OBJECTS { mplsTunnelIndex, mplsTunnelName,
             mplsTunnelDirection, mplsTunnelXCIndex,
             mplsTunnelIfIndex,
             mplsTunnelAdminStatus, mplsTunnelOperStatus,
             mplsTunnelRowStatus }
   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   signalled,  persistent   or   non-
        persistent,   etc.),  the  following  other   groups
        defined  below  are mandatory: mplsTunnelManualGroup
        and/or                    mplsTunnelSignalledGroup,
        mplsTunnelIsNotIntfcGroup                     and/or
        mplsTunnelIsIntfcGroup,      mplsTunnelIsPersistent
        and/or mplsTunnelIsNotPersistent."
   ::= { mplsTeGroups 1 }

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

mplsTunnelSignalledGroup OBJECT-GROUP
   OBJECTS { mplsTunnelSignallingProto,
             mplsTunnelLocalCookie, mplsTunnelRemoteCookie,
             mplsTunnelHopIndex, mplsTunnelHopAddrType,
             mplsTunnelHopIpv4Addr, mplsTunnelHopIpv4PrefixLen,
             mplsTunnelHopIpv6Addr, mplsTunnelHopIpv6PrefixLen,
             mplsTunnelHopStrictOrLoose, mplsTunnelHopRowStatus }
   STATUS  current
   DESCRIPTION
       "Object needed to implement signalled tunnels."
   ::= { mplsTeGroups 3 }

mplsTunnelIsIntfcGroup OBJECT-GROUP
   OBJECTS { mplsTunnelIsIf }
   STATUS  current
   DESCRIPTION
       "Objects   needed  to  implement  tunnels  that   are
        interfaces."
   ::= { mplsTeGroups 4 }

mplsTunnelIsNotIntfcGroup OBJECT-GROUP
   OBJECTS { mplsTunnelIsIf }
   STATUS  current
   DESCRIPTION
       "Objects  needed to implement tunnels  that  are  not
        interfaces."
   ::= { mplsTeGroups 5 }

mplsTunnelIsPersistentGroup OBJECT-GROUP
   OBJECTS { mplsTunnelIsPersistent }
   STATUS  current
   DESCRIPTION
       "Objects needed to support persistent tunnels."
   ::= { mplsTeGroups 6 }

mplsTunnelIsNotPersistentGroup OBJECT-GROUP
   OBJECTS { mplsTunnelIsPersistent }
   STATUS  current
   DESCRIPTION
       "Objects needed to support non-persistent tunnels."
   ::= { mplsTeGroups 7 }

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

-- End of MPLS-TE-MIB
```

END

8. Security Considerations

The MIB specified in this document does not raise any security issues other than those present in the MPLS architecture [MPLSArch] or those imposed by SNMP itself.

9. Acknowledgments

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