

Network Working Group
Internet Draft
Expires: March 2004

Cheenu Srinivasan
Bloomberg L.P.

Arun Viswanathan
Force10 Networks, Inc.

Thomas D. Nadeau
Cisco Systems, Inc.

August 2003

Multiprotocol Label Switching (MPLS) Label Switching
Router (LSR) Management Information Base

[draft-ietf-mpls-lsr-mib-12.txt](#)

Status of this Memo

This document is an Internet-Draft and is in full conformance with all provisions of [Section 10 of RFC 2026](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at <http://www.ietf.org/ietf/lid-abstracts.txt>.

The list of Internet-Draft Shadow Directories can be accessed at <http://www.ietf.org/shadow.html>.

Abstract

This memo defines an portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects to configure and/or monitor a Multi-Protocol Label Switching (MPLS) Label Switching Router (LSR).

Table of Contents

	Abstract	1
1.	Introduction	2
2.	Terminology	2

3.	The SNMP Management Framework	3
4.	Outline	3
4.1	Summary of LSR MIB Module	3
5.	Brief Description of MIB Module Objects	4
5.1.	mplsInterfaceTable	4
5.2.	mplsInterfacePerfTable	4
5.3.	mplsInSegmentTable	4
5.4.	mplsInSegmentPerfTable	5
5.5.	mplsOutSegmentTable	5
5.6.	mplsOutSegmentPerfTable	5
5.7.	mplsXCTable	5
5.8.	mplsLabelStackTable	6
5.9	mplsInSegmentMapTable	6
6.	Use of 32-bit and 64-bit Counters	6
7.	Example of LSP Setup	6
8.	Application of the Interface Group to MPLS	8
8.1.	Support of the MPLS Layer by ifTable	8
9.	The Use of RowPointer	10
10.	MPLS Label Switching Router MIB Module Definitions	10
11.	Security Considerations	52
12.	Acknowledgments	54
13.	IANA Considerations	54
13.1.	IANA Considerations for MPLS-LSR-STD-MIB	54
14.	References	54
14.1.	Normative References	54
14.2.	Informative References	56
15.	Authors' Addresses	56
16.	Full Copyright Statement	56
17.	Intellectual Property Notice	57

[1.](#) Introduction

This memo defines an 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 Multi-Protocol Label Switching (MPLS)

[[RFC3031](#)] Label Switching Router (LSR).

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

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 [RFC 2119](#), reference [[RFC2119](#)].

2. Terminology

This document uses terminology from the document describing the MPLS architecture [[RFC3031](#)]. A label switched path (LSP) is

modeled as a connection consisting of one or more incoming segments (in-segments) and/or one or more outgoing segments (out-segments) at a LSR. The association or interconnection of the in-segments and out-segments is accomplished by using a cross-connect. We use the terminology "connection" and "LSP" interchangeably where the meaning is clear from the context.

in-segment	This is analagous to an MPLS label.
out-segment	This is analagous to an MPLS label.
cross-connect	This describes the conceptual connection between a set of in-segments and out-segments. Note that either set may be 0; that is, a cross-connect may connect only out-segments together with no in-segments in the case where an LSP is originating on an LSR.

3. The SNMP 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. Outline

Configuring LSPs through an LSR involves the following steps:

- Enabling MPLS on MPLS capable interfaces.
- Configuring in-segments and out-segments.
- Setting up the cross-connect table to associate segments and/or to indicate connection origination and termination.
- Optionally specifying label stack actions.
- Optionally specifying segment traffic parameters.

[4.1.](#) Summary of LSR MIB Module

The MIB objects for performing these actions consist of the

following tables:

- The interface table (mplsInterfaceTable), which is used for revealing the MPLS protocol on MPLS-capable interfaces.
- The in-segment (mplsInSegmentTable) and out-segment (mplsOutSegmentTable) tables, which are used for configuring LSP segments at an LSR.
- The cross-connect table (mplsXCTable), which is used to associate in and out segments together, in order to form a cross-connect.
- The label stack table (mplsLabelStackTable), which is used for specifying label stack operations.

Further, the MPLS in-segment and out-segment performance tables, `mplsInSegmentPerfTable` and `mplsOutSegmentPerfTable`, contain the objects necessary to measure the performance of LSPs, and `mplsInterfacePerfTable` has objects to measure MPLS performance on a per-interface basis.

These tables are described in the subsequent sections.

[5.](#) Brief Description of MIB Module Objects

Sections [5.1-5.2](#) describe objects pertaining to MPLS-capable interfaces of an LSR. The objects described in Sections [5.3-5.8](#), were derived from the Incoming Label Map (ILM) and Next Hop Label Forwarding Entry (NHLFE) as specified in the MPLS architecture document [[RFC3031](#)]. It is appropriate to note that the in-segment, out-segment, and cross-connect tables were modeled after similar tables found in [[RFC2515](#)].

[5.1.](#) `mplsInterfaceTable`

This table represents the interfaces that are MPLS capable. An LSR creates an entry in this table for every MPLS capable interface on that LSR.

[5.2.](#) `mplsInterfacePerfTable`

This table contains objects to measure the MPLS performance of MPLS capable interfaces and is an AUGMENT to `mplsInterfaceTable`.

[5.3.](#) `mplsInSegmentTable`

This table contains a description of the incoming MPLS segments

to an LSR and their associated parameters. This index for this table is `mplsInSegmentIndex`. The index structure of this table is specifically designed to handle many different MPLS implementations that manage their labels both in a distributed and centralized manner.

The table is designed to handle existing MPLS labels as well as future label strategies that may require labels longer than the ones defined in [RFC3031](#). In these cases, the object `mplsInSegmentLabelPtr` may be used indicate the first accessible object in a separate table that can be used to represent the label because it is too long to be represented in a single 32-bit value (`mplsInSegmentLabel`).

[5.4.](#) `mplsInSegmentPerfTable`

The MPLS in-Segment Performance Table has objects to measure the performance of an incoming segment configured on an LSR. It is an AUGMENT to `mplsInSegmentTable`. High capacity counters are provided for objects that are likely to wrap around quickly on high-speed interfaces.

[5.5.](#) `mplsOutSegmentTable`

The out-Segment Table contains a description of the outgoing MPLS segments at an LSR and their associated parameters.

[5.6.](#) `mplsOutSegmentPerfTable`

The MPLS out-Segment Table contains objects to measure the performance of an outgoing segment configured on an LSR. It is an AUGMENT to `mplsOutSegmentTable`. High capacity counters are provided for objects that are likely to wrap around quickly on high-speed interfaces.

[5.7.](#) `mplsXCTable`

The `mplsXCTable` specifies information for associating segments together in order to instruct the LSR to switch between the specified segments. It supports point-to-point, point-to-multi-point and multi-point-to-point connections.

The operational status object indicates the packet forwarding state of a cross-connect entry. For example, when the operational status objects is 'down' it indicates that the specified cross-connect entry will not forward packets. Likewise, when it is set to 'up' it indicates that packets will be forwarded.

The administrative status object indicates the forwarding state desired by the operator.

[5.8.](#) mplsLabelStackTable

The mplsLabelStackTable specifies the label stack to be pushed onto a packet, beneath the top label. Entries to this table are referred to from mplsXCTable.

[5.9](#) mplsInSegmentMapTable

The mplsInSegmentMapTable specifies the mapping from the mplsInSegmentIndex to the corresponding mplsInSegmentInterface and mplsInSegmentLabel objects. The purpose of this table is to provide the manager with an alternative means by which to locate in-segments. For instance, this table can be useful when tracing LSPs from LSR to LSR by first following the in-segment to out-segment, retrieving the outgoing label and out-going interface, and then proceeding to interrogate this table at the next-hop LSR to continue the trace.

[6.](#) 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.

[7.](#) Example of LSP Setup

In this section we provide a brief example of setting up an LSP using this MIB module's objects. While this example is not meant to illustrate every nuance of the MIB module, it is intended as an aid to understanding some of the key concepts. It is meant to be read after going through the MIB module itself.

Suppose that one would like to manually create a best-effort, unidirectional LSP. Assume that the LSP enters the LSR via MPLS interface A with ifIndex 12 and exits the LSR via MPLS interface B

with ifIndex 13. Let us assume that we do not wish to impose any additional label stack beneath the top label on the outgoing labeled packets. The following example illustrates which rows and corresponding objects might be created to accomplish this. 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. Note that the proper use of createAndGo(4) requires that all columns that do not have a DEFVAL to be specified in order for the SET to succeed. In the example below we have not specify all such columns for the sake of keeping the example short. Please keep in mind that all such fields must be send during a real SET operation. 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.

We first create a cross-connect entry that associates the desired segments together.

In mplsXCTable:

```
{
  mplsXCIndex           = 0x02,
  mplsXCInSegmentIndex  = 0x00000015,
  mplsXCOutSegmentIndex = 0x01,

  mplsXCLspId           = 0x0102 -- unique ID
  mplsXCLabelStackIndex = 0x00, -- only a single
                               -- outgoing label
  mplsXCRowStatus       = createAndGo(4)
}
```

Next, we create the appropriate in-segment and out-segment entries based on the cross-connect. Note that some agents may wish to automatically create the in and out-segments based on the cross-connect creation.


```

In mplsInSegmentTable:
{
    mplsInSegmentIndex          = 0x00000015

    mplsInSegmentLabel          = 21, -- incoming label
    mplsInSegmentNPop           = 1,
    mplsInSegmentInterface      = 12, -- incoming interface

    -- RowPointer MUST point to the first accesible column.
    mplsInSegmentLabelPtr       = 0.0,
    mplsInSegmentTrafficParamPtr = 0.0,

    mplsInSegmentRowStatus      = createAndGo(4)
}

```

```

}

In mplsOutSegmentTable:
{
    mplsOutSegmentIndex          = 0x01,
    mplsOutSegmentInterface      = 13, -- outgoing interface
    mplsOutSegmentPushTopLabel   = true(1),
    mplsOutSegmentTopLabel       = 22, -- outgoing label

    -- RowPointer MUST point to the first accesible column.
    mplsOutSegmentTrafficParamPtr = 0.0,
    mplsOutSegmentLabelPtr       = 0.0,

    mplsOutSegmentRowStatus      = createAndGo(4)
}

```

Note that the `mplsInSegmentXCIndex` and `mplsOutSegmentXCIndex` objects will automatically be populated with the string `0x02` when these segments are referred to from the corresponding cross- connect entry.

8. Application of the Interface Group to MPLS

[RFC2863](#) defines generic managed objects for managing interfaces. This memo contains the media-specific extensions to the Interfaces Group for managing MPLS 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 Interfaces Stack Group defined in [RFC2863].

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

```

+-----+
| MPLS interface; ifType = mpls(166)  +
+-----+
|           Underlying Layer          +
+-----+

```

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

8.1. Support of the MPLS Layer by ifTable

Some specific interpretations of ifTable for the MPLS layer follow.

Object	Use for the MPLS layer
ifIndex	Each MPLS interface is represented by an ifEntry.
ifDescr	Description of the MPLS interface.
ifType	The value that is allocated for MPLS is 166.
ifSpeed	The total bandwidth in bits per second for use by the MPLS layer.
ifPhysAddress	Unused.

ifAdminStatus This variable indicates the administrator's intent as to whether MPLS should be enabled, disabled, or running in some diagnostic testing mode on this interface. Also see [[RFC2863](#)].

ifOperStatus This value reflects the actual operational status of MPLS on this interface.

ifLastChange See [[RFC2863](#)].

ifInOctets The number of received octets over the interface, i.e., the number of received, octets received as labeled packets.

ifOutOctets The number of transmitted octets over the interface, i.e., the number of octets transmitted as labeled packets.

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 interface 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](#)].

ifHCOctets The 64-bit version of ifOutOctets; supported if required by the compliance statements in [[RFC2863](#)].

ifAlias The non-volatile 'alias' name for the interface as specified by a network manager.

ifCounterDiscontinuityTime
See [[RFC2863](#)].

9. The Use of RowPointer

RowPointer is a textual convention used to identify a conceptual row in a MIB Table by pointing to the first accessible object in that row. In this MIB module, the trafficParamPtr object from either the mplsInSegmentTable or mplsOutSegmentTable SHOULD indicate the first accessible column in an entry in the MplsTunnelResourceEntry in the MPLS-TE-STD-MIB [[TEMIB](#)] to indicate the traffic parameter settings for this segment, if it represents an LSP used for a TE tunnel.

The trafficParamPtr object 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 segments can indicate resource sharing of such things as LSP queue space, etc.

10. MPLS Label Switching Router MIB Module Definitions

```
MPLS-LSR-STD-MIB DEFINITIONS ::= BEGIN
IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
    Integer32, Counter32, Unsigned32, Counter64, Gauge32,
    zeroDotZero
        FROM SNMPv2-SMI
    MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
        FROM SNMPv2-CONF
    TruthValue, RowStatus, StorageType, RowPointer,
    TimeStamp, TEXTUAL-CONVENTION
        FROM SNMPv2-TC
```

```
InterfaceIndexOrZero, ifGeneralInformationGroup,
ifCounterDiscontinuityGroup
    FROM IF-MIB
mplsStdMIB, MplsLSPID, MplsLabel, MplsBitRate,
MplsOwner
    FROM MPLS-TC-STD-MIB
AddressFamilyNumbers
    FROM IANA-ADDRESS-FAMILY-NUMBERS-MIB
InetAddress, InetAddressType
    FROM INET-ADDRESS-MIB
;
```

mplsLsrStdMIB MODULE-IDENTITY

```
LAST-UPDATED "200308061200Z" -- 06 August 2003 12:00:00 GMT
ORGANIZATION "Multiprotocol Label Switching (MPLS) Working Group"
CONTACT-INFO
```

```
"      Cheenu Srinivasan
      Blomberg L.P.
      Email: cheenu@bloomberg.net
```

```
      Arun Viswanathan
      Force10 Networks, Inc.
      Email: arunv@force10networks.com
```

```
      Thomas D. Nadeau
      Cisco Systems, Inc.
      Email: tnadeau@cisco.com
```

Comments about this document should be emailed directly to the MPLS working group mailing list at mpls@uu.net."

DESCRIPTION

"This MIB module contains managed object definitions for the Multiprotocol Label Switching (MPLS) Router as defined in: Rosen, E., Viswanathan, A., and R. Callon, Multiprotocol Label Switching Architecture, [RFC 3031](#), January 2001.

Copyright (C) The Internet Society (2003). This version of this MIB module is part of RFCXXX; see the RFC itself for full legal notices."

-- Revision history.

REVISION

```
"200308061200Z" -- 06 August 2003 12:00:00 GMT
```

DESCRIPTION

"Initial revision, published as part of RFC XXXX."
 ::= { mplsStdMIB 2 }

MPLS Working Group

Expires March 2004

[Page 11]

Internet Draft

MPLS-LSR-STD-MIB

August 06, 2003

-- Textual Conventions

MplsIndexType ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"This is an octet string that can be used as a table index in cases where a large addressable space is required such as on an LSR where many applications may be provisioning labels.

Note that the string containing the single octet with the value 0x00 is a reserved value used to represent special cases. When this textual convention is used as the SYNTAX of an object, the DESCRIPTION clause MUST specify if this special value is valid and if so what the special meaning is.

In systems that provide write access to the MPLS-LSR-STD MIB, mplsIndexType SHOULD be used as a simple multi-digit integer encoded as an octet string. No further overloading of the meaning of an index SHOULD be made.

In systems that do not offer write access to the MPLS-LSR-STD MIB, the mplsIndexType may contain implicit formatting that is specific to the implementation to convey additional information such as interface index, physical card or device, or application id. The interpretation of this additional formatting is implementation dependent and not covered in this document. Such formatting MUST NOT impact the basic functionality of read-only access to the MPLS-LSR-STD MIB by management applications that are not aware of the formatting rules."

SYNTAX OCTET STRING (SIZE(1..24))

MplsIndexNextType ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"When a MIB module is used for configuration, an object with this SYNTAX always contains a legal value (a non-zero-length string) for an index that is not currently used in the relevant table. The Command Generator (Network Management Application) reads this variable and uses the (non-zero-length string) value read when creating a new row with an SNMP SET.

When the SET is performed, 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.

Note that the string containing the single octet with the value 0x00 is a reserved value used to represent the special case where no additional indexes can be provisioned, or in systems that do not offer write access, objects defined using this textual convention MUST return the string containing the single octet with the value 0x00."

SYNTAX OCTET STRING (SIZE(1..24))

-- Top level components of this MIB module.

-- Notifications

mplsLsrNotifications OBJECT IDENTIFIER ::= { mplsLsrStdMIB 0 }

-- Tables, Scalars

mplsLsrObjects OBJECT IDENTIFIER ::= { mplsLsrStdMIB 1 }

-- Conformance

mplsLsrConformance OBJECT IDENTIFIER ::= { mplsLsrStdMIB 2 }

```

-- MPLS Interface Table.
mplsInterfaceTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF MplsInterfaceEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "This table specifies per-interface MPLS capability
         and associated information."
    ::= { mplsLsrObjects 1 }

mplsInterfaceEntry OBJECT-TYPE
    SYNTAX          MplsInterfaceEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "A conceptual row in this table is created
         automatically by an LSR for every interface capable
         of supporting MPLS and which is configured to do so.
         A conceptual row in this table will exist iff a
         corresponding entry in ifTable exists with ifType =
         mpls(166). If this associated entry in ifTable is
         operationally disabled (thus removing MPLS
         capabilities on that interface), the corresponding
         entry in this table MUST be deleted shortly thereafter.

```

An conceptual row with index 0 is created if the LSR supports per-platform labels. This conceptual row represents the per-platform label space and contains parameters that apply to all interfaces that participate in the per-platform label space. Other conceptual rows in this table represent MPLS interfaces that may participate in either the per-platform or per-interface label spaces, or both. Implementations that either only support per-platform labels, or have only them configured, may choose to return just the mplsInterfaceEntry of 0 and not return the other rows. This will greatly reduce the numebr of objects returned. Further information about label space participation of an interface is provided in the DESCRIPTION clause of mplsInterfaceLabelParticipationType."


```
INDEX { mplsInterfaceIndex }
 ::= { mplsInterfaceTable 1 }
```

```
MplsInterfaceEntry ::= SEQUENCE {
  mplsInterfaceIndex          InterfaceIndexOrZero,
  mplsInterfaceLabelMinIn    MplsLabel,
  mplsInterfaceLabelMaxIn    MplsLabel,
  mplsInterfaceLabelMinOut   MplsLabel,
  mplsInterfaceLabelMaxOut   MplsLabel,
  mplsInterfaceTotalBandwidth MplsBitRate,
  mplsInterfaceAvailableBandwidth MplsBitRate,
  mplsInterfaceLabelParticipationType BITS
}
```

```
mplsInterfaceIndex OBJECT-TYPE
  SYNTAX          InterfaceIndexOrZero
  MAX-ACCESS      not-accessible
  STATUS          current
  DESCRIPTION
    "This is a unique index for an entry in the
    MplsInterfaceTable. A non-zero index for an
    entry indicates the ifIndex for the corresponding
    interface entry of the MPLS-layer in the ifTable.
    The entry with index 0 represents the per-platform
    label space and contains parameters that apply to all
    interfaces that participate in the per-platform label
    space. Other entries defined in this table represent
    additional MPLS interfaces that may participate in either
    the per-platform or per-interface label spaces, or both."
  REFERENCE
    "RFC 2863 - The Interfaces Group MIB, McCloghrie, K.,
    and F. Kastenholz, June 2000"
  ::= { mplsInterfaceEntry 1 }
```

```
mplsInterfaceLabelMinIn OBJECT-TYPE
  SYNTAX          MplsLabel
  MAX-ACCESS      read-only
  STATUS          current
  DESCRIPTION
    "This is the minimum value of an MPLS label that this
```

```
    LSR is willing to receive on this interface."  
 ::= { mplsInterfaceEntry 2 }
```

mplsInterfaceLabelMaxIn OBJECT-TYPE

```
SYNTAX      MplsLabel  
MAX-ACCESS  read-only  
STATUS      current  
DESCRIPTION  
    "This is the maximum value of an MPLS label that this  
    LSR is willing to receive on this interface."  
 ::= { mplsInterfaceEntry 3 }
```

mplsInterfaceLabelMinOut OBJECT-TYPE

```
SYNTAX      MplsLabel  
MAX-ACCESS  read-only  
STATUS      current  
DESCRIPTION  
    "This is the minimum value of an MPLS label that this  
    LSR is willing to send on this interface."  
 ::= { mplsInterfaceEntry 4 }
```

mplsInterfaceLabelMaxOut OBJECT-TYPE

```
SYNTAX      MplsLabel  
MAX-ACCESS  read-only  
STATUS      current  
DESCRIPTION  
    "This is the maximum value of an MPLS label that this  
    LSR is willing to send on this interface."  
 ::= { mplsInterfaceEntry 5 }
```

mplsInterfaceTotalBandwidth OBJECT-TYPE

```
SYNTAX      MplsBitRate  
UNITS      "kilobits per second"  
MAX-ACCESS  read-only  
STATUS      current  
DESCRIPTION  
    "This value indicates the total amount of usable  
    bandwidth on this interface and is specified in  
    kilobits per second (Kbps). This variable is not  
    applicable when applied to the interface with index  
    0. When this value cannot be measured, this value  
    should contain the nominal bandwidth."  
 ::= { mplsInterfaceEntry 6 }
```

mplsInterfaceAvailableBandwidth OBJECT-TYPE

SYNTAX MplsBitRate

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This value indicates the total amount of available bandwidth available on this interface and is specified in kilobits per second (Kbps). This value is calculated as the difference between the amount of bandwidth currently in use and that specified in mplsInterfaceTotalBandwidth. This variable is not applicable when applied to the interface with index 0. When this value cannot be measured, this value should contain the nominal bandwidth."

::= { mplsInterfaceEntry 7 }

mplsInterfaceLabelParticipationType OBJECT-TYPE

SYNTAX BITS {
 perPlatform (0),
 perInterface (1)
 }

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"If the value of the mplsInterfaceIndex for this entry is zero, then this entry corresponds to the per-platform label space for all interfaces configured to use that label space. In this case the perPlatform(0) bit MUST be set; the perInterface(1) bit is meaningless and MUST be ignored.

The remainder of this description applies to entries with a non-zero value of mplsInterfaceIndex.

If the perInterface(1) bit is set then the value of mplsInterfaceLabelMinIn, mplsInterfaceLabelMaxIn, mplsInterfaceLabelMinOut, and mplsInterfaceLabelMaxOut for this entry reflect the label ranges for this interface.

If only the perPlatform(0) bit is set, then the value of mplsInterfaceLabelMinIn, mplsInterfaceLabelMaxIn, mplsInterfaceLabelMinOut, and mplsInterfaceLabelMaxOut for this entry MUST be identical to the instance of these objects with index 0. These objects may only vary from the entry

with index 0 if both the perPlatform(0) and perInterface(1) bits are set.

In all cases, at a minimum one of the perPlatform(0) or

perInterface(1) bits MUST be set to indicate that at least one label space is in use by this interface. In all cases, agents MUST ensure that label ranges are specified consistently and MUST return an inconsistentValue error when they do not."

REFERENCE

"Rosen, E., Viswanathan, A., and R. Callon, Multiprotocol Label Switching Architecture, [RFC 3031](#), January 2001."

::= { mplsInterfaceEntry 8 }

-- End of mplsInterfaceTable

-- MPLS Interface Performance Table.

mplsInterfacePerfTable OBJECT-TYPE

SYNTAX SEQUENCE OF MplsInterfacePerfEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table provides MPLS performance information on a per-interface basis."

::= { mplsLsrObjects 2 }

mplsInterfacePerfEntry OBJECT-TYPE

SYNTAX MplsInterfacePerfEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table is created by the LSR for every interface capable of supporting MPLS. Its is an extension to the mplsInterfaceEntry table. Note that the discontinuity behavior of entries in this table MUST be based on the corresponding ifEntry's ifDiscontinuityTime."

```
AUGMENTS      { mplsInterfaceEntry }
              ::= { mplsInterfacePerfTable 1 }
```

```
MplsInterfacePerfEntry ::= SEQUENCE {
    -- incoming direction
    mplsInterfacePerfInLabelsInUse      Gauge32,
    mplsInterfacePerfInLabelLookupFailures Counter32,

    -- outgoing direction
    mplsInterfacePerfOutLabelsInUse     Gauge32,
    mplsInterfacePerfOutFragmentedPkts Counter32
}
```

mplsInterfacePerfInLabelsInUse OBJECT-TYPE

```
SYNTAX      Gauge32
MAX-ACCESS  read-only
STATUS      current
```

DESCRIPTION

"This object counts the number of labels that are in use at this point in time on this interface in the incoming direction. If the interface participates in only the per-platform label space, then the value of the instance of this object MUST be identical to the value of the instance with index 0. If the interface participates in the per-interface label space, then the instance of this object MUST represent the number of of per-interface labels that are in use on this interface."

```
::= { mplsInterfacePerfEntry 1 }
```

mplsInterfacePerfInLabelLookupFailures OBJECT-TYPE

```
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
```

DESCRIPTION

"This object counts the number of labeled packets that have been received on this interface and which were discarded because there was no matching cross-connect entry. This object MUST count on a per-interface basis regardless of which label space the

```
    interface participates in."
 ::= { mplsInterfacePerfEntry 2 }
```

mplsInterfacePerfOutLabelsInUse OBJECT-TYPE

```
SYNTAX          Gauge32
MAX-ACCESS      read-only
STATUS          current
```

DESCRIPTION

"This object counts the number of top-most labels in the outgoing label stacks that are in use at this point in time on this interface. This object MUST count on a per-interface basis regardless of which label space the interface participates in."

```
 ::= { mplsInterfacePerfEntry 3 }
```

mplsInterfacePerfOutFragmentedPkts OBJECT-TYPE

```
SYNTAX          Counter32
MAX-ACCESS      read-only
STATUS          current
```

DESCRIPTION

"This object counts the number of outgoing MPLS packets that required fragmentation before transmission on this interface. This object MUST count on a per-interface basis regardless of which

```
    label space the interface participates in."
 ::= { mplsInterfacePerfEntry 4 }
```

```
-- mplsInterfacePerf Table end.
```

mplsInSegmentIndexNext OBJECT-TYPE

```
SYNTAX          MplsIndexNextType
MAX-ACCESS      read-only
STATUS          current
```

DESCRIPTION

"This object contains the next available value to be used for mplsInSegmentIndex when creating entries in the mplsInSegmentTable. The special value of a string containing the single octet 0x00 indicates that no new entries can be created in this table. Agents not allowing managers to create entries

```

    in this table MUST set this object to this special
    value."
 ::= { mplsLsrObjects 3 }

-- in-segment table.
mplsInSegmentTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF MplsInSegmentEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "This table contains a description of the incoming MPLS
        segments (labels) to an LSR and their associated parameters.
        The index for this table is mplsInSegmentIndex.
        The index structure of this table is specifically designed
        to handle many different MPLS implementations that manage
        their labels both in a distributed and centralized manner.
        The table is also designed to handle existing MPLS labels
        as defined in RFC3031 as well as longer ones that may
        be necessary in the future.

        In cases where the label cannot fit into the
        mplsInSegmentLabel object, the mplsInSegmentLabelPtr
        will indicate this by being set to the first accessible
        column in the appropriate extension table's row.
        In this case an additional table MUST
        be provided and MUST be indexed by at least the indexes
        used by this table. In all other cases when the label is
        represented within the mplsInSegmentLabel object, the
        mplsInSegmentLabelPtr MUST be set to 0.0. Due to the
        fact that MPLS labels may not exceed 24 bits, the
        mplsInSegmentLabelPtr object is only a provision for
        future-proofing the MIB module. Thus, the definition
        of any extension tables is beyond the scope of this
        MIB module."

```

```

 ::= { mplsLsrObjects 4 }

mplsInSegmentEntry OBJECT-TYPE
    SYNTAX          MplsInSegmentEntry
    MAX-ACCESS      not-accessible
    STATUS          current

```

DESCRIPTION

"An entry in this table represents one incoming segment as is represented in an LSR's LFIB. An entry can be created by a network administrator or an SNMP agent, or an MPLS signaling protocol. The creator of the entry is denoted by `mplsInSegmentOwner`.

The value of `mplsInSegmentRowStatus` cannot be `active(1)` unless the `ifTable` entry corresponding to `mplsInSegmentInterface` exists. An entry in this table must match any incoming packets, and indicates an instance of `mplsXCEntry` based on which forwarding and/or switching actions are taken."

```
INDEX { mplsInSegmentIndex }  
 ::= { mplsInSegmentTable 1 }
```

```
MplsInSegmentEntry ::= SEQUENCE {  
    mplsInSegmentIndex          MplsIndexType,  
    mplsInSegmentInterface      InterfaceIndexOrZero,  
    mplsInSegmentLabel          MplsLabel,  
    mplsInSegmentLabelPtr       RowPointer,  
    mplsInSegmentNPop           Integer32,  
    mplsInSegmentAddrFamily     AddressFamilyNumbers,  
    mplsInSegmentXCIndex        MplsIndexType,  
    mplsInSegmentOwner          MplsOwner ,  
    mplsInSegmentTrafficParamPtr RowPointer,  
    mplsInSegmentRowStatus      RowStatus,  
    mplsInSegmentStorageType     StorageType  
}
```

```
mplsInSegmentIndex OBJECT-TYPE  
    SYNTAX      MplsIndexType  
    MAX-ACCESS  not-accessible  
    STATUS      current  
    DESCRIPTION  
        "The index for for this in-segment. The  
        string containing the single octet 0x00  
        MUST not be used as an index."  
    ::= { mplsInSegmentEntry 1 }
```

```
mplsInSegmentInterface OBJECT-TYPE  
    SYNTAX      InterfaceIndexOrZero  
    MAX-ACCESS  read-create
```


STATUS current

DESCRIPTION

"This object represents the interface index for the incoming MPLS interface. A value of zero represents all interfaces participating in the per-platform label space. This may only be used in cases where the incoming interface and label are associated with the same mplsXCEntry. Specifically, given a label and any incoming interface pair from the per-platform label space, the outgoing label/interface mapping remains the same. If this is not the case, then individual entries MUST exist that can then be mapped to unique mplsXCEntries."

::= { mplsInSegmentEntry 2 }

mplsInSegmentLabel OBJECT-TYPE

SYNTAX MplsLabel

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"If the corresponding instance of mplsInSegmentLabelPtr is zeroDotZero then this object MUST contain the incoming label associated with this in-segment. If not this object SHOULD be zero and MUST be ignored."

::= { mplsInSegmentEntry 3 }

mplsInSegmentLabelPtr OBJECT-TYPE

SYNTAX RowPointer

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"If the label for this segment cannot be represented fully within the mplsInSegmentLabel object, this object MUST point to the first accessible column of a conceptual row in an external table containing the label. In this case, the mplsInSegmentTopLabel object SHOULD be set to 0 and ignored. This object MUST be set to zeroDotZero otherwise."

DEFVAL { zeroDotZero }

::= { mplsInSegmentEntry 4 }

mplsInSegmentNPop OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The number of labels to pop from the incoming packet. Normally only the top label is popped from the packet and used for all switching decisions for that packet. This is indicated by setting this

object to the default value of 1. If an LSR supports popping of more than one label, this object MUST be set to that number. This object cannot be modified if mplsInSegmentRowStatus is active(1)."

DEFVAL { 1 }
 ::= { mplsInSegmentEntry 5 }

mplsInSegmentAddrFamily OBJECT-TYPE

SYNTAX AddressFamilyNumbers
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"The IANA address family of packets received on this segment, which is used at an egress LSR to deliver them to the appropriate layer 3 entity. A value of other(0) indicates that the family type is either unknown or undefined; this SHOULD NOT be used at an egress LSR. This object cannot be modified if mplsInSegmentRowStatus is active(1)."

REFERENCE

"See Internet Assigned Numbers Authority (IANA), ADDRESS FAMILY NUMBERS."

DEFVAL { other }
 ::= { mplsInSegmentEntry 6 }

mplsInSegmentXCIndex OBJECT-TYPE

SYNTAX MplsIndexType
MAX-ACCESS read-only
STATUS current

DESCRIPTION

"Index into mplsXCTable which identifies which cross-connect entry this segment is part of. The string containing the single octet 0x00 indicates that this entry is not referred to by any cross-connect entry. When a cross-connect entry is created which this in-segment is a part of, this object is automatically

updated to reflect the value of mplsXCIndex of that cross-connect entry."
 ::= { mplsInSegmentEntry 7 }

mplsInSegmentOwner OBJECT-TYPE

SYNTAX MplsOwner

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Denotes the entity that created and is responsible for managing this segment."

::= { mplsInSegmentEntry 8 }

mplsInSegmentTrafficParamPtr OBJECT-TYPE

MPLS Working Group

Expires March 2004

[Page 22]

Internet Draft

MPLS-LSR-STD-MIB

August 06, 2003

SYNTAX RowPointer

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This variable represents a pointer to the traffic parameter specification for this out-segment. This value may point at an entry in the mplsTunnelResourceTable in the MPLS-TE-STD-MIB (RFCnnnn)

RFC Editor: Please fill in RFC number.

to indicate which traffic parameter settings for this segment if it represents an LSP used for a TE tunnel.

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 segments can indicate resource sharing of such things as LSP queue space, etc.

This object cannot be modified if mplsInSegmentRowStatus is active(1). For entries in this table that are preserved after a re-boot, the agent MUST ensure that their integrity be preserved, or this object should be set to 0.0 if it cannot."

```
DEFVAL { zeroDotZero }
::= { mplsInSegmentEntry 9 }
```

mplsInSegmentRowStatus 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 has a row in the active(1) state, no objects in this row can be modified except the mplsInSegmentRowStatus and mplsInSegmentStorageType."

```
::= { mplsInSegmentEntry 10 }
```

mplsInSegmentStorageType OBJECT-TYPE

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

"This variable indicates the storage type for this object. The agent MUST ensure that this object's value remains consistent with the associated mplsXEntry. Conceptual rows having the value

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

REFERENCE

"See [RFC2579](#)."

```
DEFVAL { volatile }
::= { mplsInSegmentEntry 11 }
```

-- End of mplsInSegmentTable

-- in-segment performance table.

mplsInSegmentPerfTable OBJECT-TYPE

```
SYNTAX      SEQUENCE OF MplsInSegmentPerfEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
```

```
"This table contains statistical information for
incoming MPLS segments to an LSR."
 ::= { mplsLsrObjects 5 }
```

```
mplsInSegmentPerfEntry OBJECT-TYPE
    SYNTAX      MplsInSegmentPerfEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
```

```
    "An entry in this table contains statistical
    information about one incoming segment which is
    configured in the mplsInSegmentTable. The counters
    in this entry should behave in a manner similar to
    that of the interface.
    mplsInSegmentPerfDiscontinuityTime indicates the
    time of the last discontinuity in all of these
    objects."
```

```
    AUGMENTS { mplsInSegmentEntry }
    ::= { mplsInSegmentPerfTable 1 }
```

```
MplsInSegmentPerfEntry ::= SEQUENCE {
    mplsInSegmentPerfOctets      Counter32,
    mplsInSegmentPerfPackets    Counter32,
    mplsInSegmentPerfErrors     Counter32,
    mplsInSegmentPerfDiscards   Counter32,

    -- high capacity counter
    mplsInSegmentPerfHCOctets   Counter64,

    mplsInSegmentPerfDiscontinuityTime  TimeStamp
}
```

```
mplsInSegmentPerfOctets OBJECT-TYPE
    SYNTAX      Counter32
```

```
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
```

```
    "This value represents the total number of octets
    received by this segment. It MUST be equal to the
    least significant 32 bits of
```

```
    mplsInSegmentPerfHCOctets
    if mplsInSegmentPerfHCOctets is supported according to
    the rules spelled out in RFC2863."
 ::= { mplsInSegmentPerfEntry 1 }
```

```
mplsInSegmentPerfPackets OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION
        "Total number of packets received by this segment."
 ::= { mplsInSegmentPerfEntry 2 }
```

```
mplsInSegmentPerfErrors OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION
        "The number of errored packets received on this
        segment."
 ::= { mplsInSegmentPerfEntry 3 }
```

```
mplsInSegmentPerfDiscards OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION
        "The number of labeled packets received on this in-
        segment, which were chosen to be discarded even
        though no errors had been detected to prevent their
        being transmitted. One possible reason for
        discarding such a labeled packet could be to free up
        buffer space."
 ::= { mplsInSegmentPerfEntry 4 }
```

```
mplsInSegmentPerfHCOctets OBJECT-TYPE
    SYNTAX          Counter64
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION
        "The total number of octets received. This is the 64
        bit version of mplsInSegmentPerfOctets,
        if mplsInSegmentPerfHCOctets is supported according to
        the rules spelled out in RFC2863."
```

```
::= { mplsInSegmentPerfEntry 5 }
```

```
mplsInSegmentPerfDiscontinuityTime OBJECT-TYPE
```

```
SYNTAX      TimeStamp
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

```
DESCRIPTION
```

```
"The value of sysUpTime on the most recent occasion
at which any one or more of this segment's Counter32
or Counter64 suffered a discontinuity. If no such
discontinuities have occurred since the last re-
initialization of the local management subsystem,
then this object contains a zero value."
```

```
::= { mplsInSegmentPerfEntry 6 }
```

```
-- End of mplsInSegmentPerfTable.
```

```
-- out-segment table.
```

```
mplsOutSegmentIndexNext OBJECT-TYPE
```

```
SYNTAX      MplsIndexNextType
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

```
DESCRIPTION
```

```
"This object contains the next available value to
be used for mplsOutSegmentIndex when creating entries
in the mplsOutSegmentTable. The special value of a
string containing the single octet 0x00 indicates
indicates that no new entries can be created in this
table. Agents not allowing managers to create entries
in this table MUST set this object to this special
value."
```

```
::= { mplsLsrObjects 6 }
```

```
mplsOutSegmentTable OBJECT-TYPE
```

```
SYNTAX      SEQUENCE OF MplsOutSegmentEntry
```

```
MAX-ACCESS  not-accessible
```

```
STATUS      current
```

```
DESCRIPTION
```

```
"This table contains a representation of the outgoing
segments from an LSR."
```

```
::= { mplsLsrObjects 7 }
```

```
mplsOutSegmentEntry OBJECT-TYPE
```

```
SYNTAX      MplsOutSegmentEntry
```

MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"An entry in this table represents one outgoing

segment. An entry can be created by a network administrator, an SNMP agent, or an MPLS signaling protocol. The object `mplsOutSegmentOwner` indicates the creator of this entry. The value of `mplsOutSegmentRowStatus` cannot be `active(1)` unless the `ifTable` entry corresponding to `mplsOutSegmentInterface` exists.

Note that the indexing of this table uses a single, arbitrary index (`mplsOutSegmentIndex`) to indicate which out-segment (i.e.: label) is being switched to from which in-segment (i.e.: label) or in-segments. This is necessary because it is possible to have an equal-cost multi-path situation where two identical out-going labels are assigned to the same cross-connect (i.e.: they go to two different neighboring LSRs); thus, requiring two out-segments. In order to preserve the uniqueness of the references by the `mplsXCEntry`, an arbitrary integer must be used as the index for this table."

```
INDEX { mplsOutSegmentIndex }  
 ::= { mplsOutSegmentTable 1 }
```

```
MplsOutSegmentEntry ::= SEQUENCE {  
  mplsOutSegmentIndex           MplsIndexType,  
  mplsOutSegmentInterface       InterfaceIndexOrZero,  
  mplsOutSegmentPushTopLabel    TruthValue,  
  mplsOutSegmentTopLabel        MplsLabel,  
  mplsOutSegmentTopLabelPtr     RowPointer,  
  mplsOutSegmentNextHopAddrType InetAddressType,  
  mplsOutSegmentNextHopAddr     InetAddress,  
  mplsOutSegmentXCIndex         MplsIndexType,  
  mplsOutSegmentOwner           MplsOwner,  
  mplsOutSegmentTrafficParamPtr RowPointer,  
  mplsOutSegmentRowStatus       RowStatus,  
  mplsOutSegmentStorageType     StorageType
```


}

mplsOutSegmentIndex OBJECT-TYPE

SYNTAX MplsIndexType
MAX-ACCESS not-accessible
STATUS current

DESCRIPTION

"This value contains a unique index for this row. While a value of a string containing the single octet 0x00 is not valid as an index for entries in this table, it can be supplied as a valid value to index the mplsXCTable to represent entries for which no out-segment has been configured or exists."

::= { mplsOutSegmentEntry 1 }

mplsOutSegmentInterface OBJECT-TYPE

SYNTAX InterfaceIndexOrZero
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This value must contain the interface index of the outgoing interface. This object cannot be modified if mplsOutSegmentRowStatus is active(1). The mplsOutSegmentRowStatus cannot be set to active(1) until this object is set to a value corresponding to a valid ifEntry."

::= { mplsOutSegmentEntry 2 }

mplsOutSegmentPushTopLabel OBJECT-TYPE

SYNTAX TruthValue
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This value indicates whether or not a top label should be pushed onto the outgoing packet's label stack. The value of this variable MUST be set to true(1) if the outgoing interface does not support pop-and-go (and no label stack remains). For example, on ATM interface, or if the segment represents a

tunnel origination. Note that it is considered an error in the case that mplsOutSegmentPushTopLabel is set to false, but the cross-connect entry which refers to this out-segment has a non-zero mplsLabelStackIndex. The LSR MUST ensure that this situation does not happen. This object cannot be modified if mplsOutSegmentRowStatus is active(1)."

DEFVAL { true }
 ::= { mplsOutSegmentEntry 3 }

mplsOutSegmentTopLabel OBJECT-TYPE

SYNTAX MplsLabel
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"If mplsOutSegmentPushTopLabel is true then this represents the label that should be pushed onto the top of the outgoing packet's label stack. Otherwise this value SHOULD be set to 0 by the management station and MUST be ignored by the agent. This object cannot be modified if mplsOutSegmentRowStatus is active(1)."

DEFVAL { 0 }
 ::= { mplsOutSegmentEntry 4 }

mplsOutSegmentTopLabelPtr OBJECT-TYPE

SYNTAX RowPointer
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"If the label for this segment cannot be represented fully within the mplsOutSegmentLabel object, this object MUST point to the first accessible column of a conceptual row in an external table containing the label. In this case, the mplsOutSegmentTopLabel object SHOULD be set to 0 and ignored. This object MUST be set to zeroDotZero otherwise."

DEFVAL { zeroDotZero }
 ::= { mplsOutSegmentEntry 5 }

mplsOutSegmentNextHopAddrType OBJECT-TYPE

SYNTAX InetAddressType
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"Indicates the next hop Internet address type.
Only values unknown(0), ipv4(1) or ipv6(2)
have to be supported.

A value of unknown(0) is allowed only when
the outgoing interface is of type point-to-point.
If any other unsupported values are attempted in a set
operation, the agent MUST return an inconsistentValue
error."

REFERENCE

"See [RFC3291](#)."

::= { mplsOutSegmentEntry 6 }

mplsOutSegmentNextHopAddr OBJECT-TYPE

SYNTAX InetAddress
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"The internet address of the next hop. The type of
this address is determined by the value of the
mplsOutSegmentNextHopAddrType object.

This object cannot be modified if
mplsOutSegmentRowStatus is active(1)."

::= { mplsOutSegmentEntry 7 }

mplsOutSegmentXCIndex OBJECT-TYPE

SYNTAX MplsIndexType
MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Index into mplsXCTable which identifies which cross-
connect entry this segment is part of. A value of
the string containing the single octet 0x00
indicates that this entry is not referred

to by any cross-connect entry. When a cross-connect entry is created which this out-segment is a part of, this object MUST be updated by the agent to reflect the value of mplsXCIndex of that cross-connect entry."

::= { mplsOutSegmentEntry 8 }

mplsOutSegmentOwner OBJECT-TYPE

SYNTAX MplsOwner

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Denotes the entity which created and is responsible for managing this segment."

::= { mplsOutSegmentEntry 9 }

mplsOutSegmentTrafficParamPtr OBJECT-TYPE

SYNTAX RowPointer

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This variable represents a pointer to the traffic parameter specification for this out-segment. This value may point at an entry in the MplsTunnelResourceEntry in the MPLS-TE-STD-MIB (RFCnnnn)

RFC Editor: Please fill in RFC number.

to indicate which traffic parameter settings for this segment if it represents an LSP used for a TE tunnel.

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 segments can indicate resource sharing of such things as LSP queue space, etc.

This object cannot be modified if mplsOutSegmentRowStatus is active(1). For entries in this table that are preserved after a re-boot, the agent MUST ensure that their integrity be preserved, or this object should be set to 0.0 if it cannot."

```
DEFVAL { zeroDotZero }
 ::= { mplsOutSegmentEntry 10 }
```

```
mplsOutSegmentRowStatus OBJECT-TYPE
```

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

```
"For creating, modifying, and deleting this row.
When a row in this table has a row in the active(1)
state, no objects in this row can be modified
except the mplsOutSegmentRowStatus or
mplsOutSegmentStorageType."
```

```
 ::= { mplsOutSegmentEntry 11 }
```

```
mplsOutSegmentStorageType OBJECT-TYPE
```

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

```
"This variable indicates the storage type for this
object. The agent MUST ensure that this object's value
remains consistent with the associated mplsXCEnt.
Conceptual rows having the value 'permanent'
need not allow write-access to any columnar
objects in the row."
```

```
DEFVAL { volatile }
 ::= { mplsOutSegmentEntry 12 }
```

```
-- End of mplsOutSegmentTable
```

```
-- out-segment performance table.
```

```
mplsOutSegmentPerfTable OBJECT-TYPE
```

```
SYNTAX          SEQUENCE OF MplsOutSegmentPerfEntry
MAX-ACCESS      not-accessible
STATUS          current
DESCRIPTION
```

```
"This table contains statistical information about
outgoing segments from an LSR. The counters in this
entry should behave in a manner similar to that of
the interface."
```

```
 ::= { mplsLsrObjects 8 }
```

```
mplsOutSegmentPerfEntry OBJECT-TYPE
```

SYNTAX MplsOutSegmentPerfEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

MPLS Working Group

Expires March 2004

[Page 31]

Internet Draft

MPLS-LSR-STD-MIB

August 06, 2003

"An entry in this table contains statistical information about one outgoing segment configured in mplsOutSegmentTable. The object mplsOutSegmentPerfDiscontinuityTime indicates the time of the last discontinuity in these objects. "
AUGMENTS { mplsOutSegmentEntry }
 ::= { mplsOutSegmentPerfTable 1 }

MplsOutSegmentPerfEntry ::= SEQUENCE {
 mplsOutSegmentPerfOctets Counter32,
 mplsOutSegmentPerfPackets Counter32,
 mplsOutSegmentPerfErrors Counter32,
 mplsOutSegmentPerfDiscards Counter32,

 -- HC counter
 mplsOutSegmentPerfHCOctets Counter64,

 mplsOutSegmentPerfDiscontinuityTime TimeStamp
 }

mplsOutSegmentPerfOctets OBJECT-TYPE

SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "This value contains the total number of octets sent on this segment. It MUST be equal to the least significant 32 bits of mplsOutSegmentPerfHCOctets if mplsOutSegmentPerfHCOctets is supported according to the rules spelled out in [RFC2863](#)."
 ::= { mplsOutSegmentPerfEntry 1 }

mplsOutSegmentPerfPackets OBJECT-TYPE

SYNTAX Counter32
MAX-ACCESS read-only
STATUS current

DESCRIPTION

"This value contains the total number of packets sent on this segment."

::= { mplsOutSegmentPerfEntry 2 }

mplsOutSegmentPerfErrors OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Number of packets that could not be sent due to errors on this segment."

::= { mplsOutSegmentPerfEntry 3 }

mplsOutSegmentPerfDiscards OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of labeled packets attempted to be transmitted on this out-segment, which were chosen to be discarded even though no errors had been detected to prevent their being transmitted. One possible reason for discarding such a labeled packet could be to free up buffer space."

::= { mplsOutSegmentPerfEntry 4 }

mplsOutSegmentPerfHCOctets OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Total number of octets sent. This is the 64 bit version of mplsOutSegmentPerfOctets, if mplsOutSegmentPerfHCOctets is supported according to the rules spelled out in [RFC2863](#)."

::= { mplsOutSegmentPerfEntry 5 }

mplsOutSegmentPerfDiscontinuityTime OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The value of sysUpTime on the most recent occasion at which any one or more of this segment's Counter32 or Counter64 suffered a discontinuity. If no such discontinuities have occurred since the last re-initialization of the local management subsystem, then this object contains a zero value."
 ::= { mplsOutSegmentPerfEntry 6 }

-- End of mplsOutSegmentPerfTable.

-- Cross-connect table.

mplsXCIndexNext OBJECT-TYPE
SYNTAX MplsIndexNextType
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object contains the next available value to be used for mplsXCIndex when creating entries in the mplsXCTable. A special value of the zero length

string indicates that no more new entries can be created in the relevant table. Agents not allowing managers to create entries in this table MUST set this value to the zero length string."
 ::= { mplsLsrObjects 9 }

mplsXCTable OBJECT-TYPE
SYNTAX SEQUENCE OF MplsXCEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"This table specifies information for switching between LSP segments. It supports point-to-point, point-to-multipoint and multipoint-to-point connections. mplsLabelStackTable specifies the label stack information for a cross-connect LSR and

is referred to from mplsXCTable."
 ::= { mplsLsrObjects 10 }

mplsXCEntry OBJECT-TYPE

SYNTAX MplsXCEntry
MAX-ACCESS not-accessible
STATUS current

DESCRIPTION

"A row in this table represents one cross-connect entry. It is indexed by the following objects:

- cross-connect index mplsXCIndex that uniquely identifies a group of cross-connect entries
- in-segment index, mplsXCInSegmentIndex
- out-segment index, mplsXCOutSegmentIndex

LSPs originating at this LSR:

These are represented by using the special value of mplsXCInSegmentIndex set to the string containing a single octet 0x00. In this case the mplsXCOutSegmentIndex MUST not be the string containing a single octet 0x00.

LSPs terminating at this LSR:

These are represented by using the special value mplsXCOutSegmentIndex set to the string containing a single octet 0x00.

Special labels:

Entries indexed by the strings containing the reserved MPLS label values as a single octet 0x00

through 0x0f (inclusive) imply LSPs terminating at this LSR. Note that situations where LSPs are terminated with incoming label equal to the string containing a single octet 0x00 can be distinguished from LSPs originating at this LSR because the mplsXCOutSegmentIndex equals the string containing the

single octet 0x00.

An entry can be created by a network administrator or by an SNMP agent as instructed by an MPLS signaling protocol."

```
INDEX { mplsXCIndex, mplsXCInSegmentIndex,  
        mplsXCOutSegmentIndex }  
 ::= { mplsXCTable 1 }
```

```
MplsXCEntry ::= SEQUENCE {  
    mplsXCIndex           MplsIndexType,  
    mplsXCInSegmentIndex MplsIndexType,  
    mplsXCOutSegmentIndex MplsIndexType,  
    mplsXCLspId          MplsLSPID,  
    mplsXCLabelStackIndex MplsIndexType,  
    mplsXCOwner          MplsOwner ,  
    mplsXCRowStatus      RowStatus,  
    mplsXCStorageType    StorageType,  
    mplsXCAdminStatus    INTEGER,  
    mplsXCOperStatus     INTEGER  
}
```

```
mplsXCIndex OBJECT-TYPE  
SYNTAX      MplsIndexType  
MAX-ACCESS  not-accessible  
STATUS      current  
DESCRIPTION  
    "Primary index for the conceptual row identifying a  
    group of cross-connect segments. The string  
    containing a single octet 0x00 is an invalid index."  
 ::= { mplsXCEntry 1 }
```

```
mplsXCInSegmentIndex OBJECT-TYPE  
SYNTAX      MplsIndexType  
MAX-ACCESS  not-accessible  
STATUS      current  
DESCRIPTION  
    "Incoming label index.  
    If this object is set to the string containing  
    a single octet 0x00, this indicates a special  
    case outlined in the table's description above.  
    In this case no corresponding mplsInSegmentEntry  
    shall exist."  
 ::= { mplsXCEntry 2 }
```

mplsXCOutSegmentIndex OBJECT-TYPE

SYNTAX MplsIndexType
MAX-ACCESS not-accessible
STATUS current

DESCRIPTION

"Index of out-segment for LSPs not terminating on this LSR if not set to the string containing the single octet 0x00. If the segment identified by this entry is terminating, then this object MUST be set to the string containing a single octet 0x00 to indicate that no corresponding mplsOutSegmentEntry shall exist."

::= { mplsXCEntry 3 }

mplsXCLspId OBJECT-TYPE

SYNTAX MplsLSPID
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This value identifies the label switched path that this cross-connect entry belongs to. This object cannot be modified if mplsXCRowStatus is active(1) except for this object."

::= { mplsXCEntry 4 }

mplsXCLabelStackIndex OBJECT-TYPE

SYNTAX MplsIndexType
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"Primary index into mplsLabelStackTable identifying a stack of labels to be pushed beneath the top label. Note that the top label identified by the out-segment ensures that all the components of a multipoint-to-point connection have the same outgoing label. A value of the string containing the single octet 0x00 indicates that no labels are to be stacked beneath the top label. This object cannot be modified if mplsXCRowStatus is active(1)."

::= { mplsXCEntry 5 }

mplsXCOwner OBJECT-TYPE

SYNTAX MplsOwner
MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Denotes the entity that created and is responsible for managing this cross-connect."

::= { mplsXCEnterY 6 }

mplsXCRowStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"For creating, modifying, and deleting this row. When a row in this table has a row in the active(1) state, no objects in this row except this object and the mplsXCStorageType can be modified. Modification of mplsXCStorageType MUST be done as specified in the description of that object."

::= { mplsXCEnterY 7 }

mplsXCStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This variable indicates the storage type for this object. The agent MUST ensure that the associated in and out segments also have the same StorageType value and are restored consistently upon system restart. This value SHOULD be set to permanent(4) if created as a result of a static LSP configuration.

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

DEFVAL { volatile }

::= { mplsXCEnterY 8 }

mplsXCAdminStatus 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
    "The desired operational status of this segment."
DEFVAL { up }
::= { mplsXCEnt 9 }
```

mplsXCOperStatus OBJECT-TYPE

```
SYNTAX          INTEGER {
    up(1),          -- ready to pass packets
    down(2),
}
```

MPLS Working Group

Expires March 2004

[Page 37]

Internet Draft

MPLS-LSR-STD-MIB

August 06, 2003

```
        testing(3),          -- in some test mode
        unknown(4),         -- status cannot be determined
                             -- for some reason.
        dormant(5),
        notPresent(6),      -- some component is missing
        lowerLayerDown(7)  -- down due to the state of
                             -- lower layer interfaces
    }
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION
    "The actual operational status of this cross-
    connect."
::= { mplsXCEnt 10 }
```

-- End of mplsXCTable

-- Label stack table.

mplsMaxLabelStackDepth OBJECT-TYPE

```
SYNTAX          Unsigned32 (1..2147483647)
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION
```

```
    "The maximum stack depth supported by this LSR."
```

```
::= { mplsLsrObjects 11 }
```

```
mplsLabelStackIndexNext OBJECT-TYPE
```

```
SYNTAX MplsIndexNextType
```

```
MAX-ACCESS read-only
```

```
STATUS current
```

```
DESCRIPTION
```

"This object contains the next available value to be used for mplsLabelStackIndex when creating entries in the mplsLabelStackTable. The special string containing the single octet 0x00 indicates that no more new entries can be created in the relevant table. Agents not allowing managers to create entries in this table MUST set this value to the string containing the single octet 0x00."

```
::= { mplsLsrObjects 12 }
```

```
mplsLabelStackTable OBJECT-TYPE
```

```
SYNTAX SEQUENCE OF MplsLabelStackEntry
```

```
MAX-ACCESS not-accessible
```

```
STATUS current
```

```
DESCRIPTION
```

"This table specifies the label stack to be pushed onto a packet, beneath the top label. Entries into

this table are referred to from mplsXCTable."
::= { mplsLsrObjects 13 }

```
mplsLabelStackEntry OBJECT-TYPE
```

```
SYNTAX MplsLabelStackEntry
```

```
MAX-ACCESS not-accessible
```

```
STATUS current
```

```
DESCRIPTION
```

"An entry in this table represents one label which is to be pushed onto an outgoing packet, beneath the top label. An entry can be created by a network administrator or by an SNMP agent as instructed by an MPLS signaling protocol."

```
INDEX { mplsLabelStackIndex, mplsLabelStackLabelIndex }
```

```
::= { mplsLabelStackTable 1 }
```

```

MplsLabelStackEntry ::= SEQUENCE {
    mplsLabelStackIndex          MplsIndexType,
    mplsLabelStackLabelIndex     Unsigned32,
    mplsLabelStackLabel          MplsLabel,
    mplsLabelStackLabelPtr       RowPointer,
    mplsLabelStackRowStatus      RowStatus,
    mplsLabelStackStorageType    StorageType
}

```

mplsLabelStackIndex OBJECT-TYPE

```

SYNTAX          MplsIndexType
MAX-ACCESS      not-accessible
STATUS          current

```

DESCRIPTION

"Primary index for this row identifying a stack of labels to be pushed on an outgoing packet, beneath the top label. An index containing the string with a single octet 0x00 MUST not be used."

```
 ::= { mplsLabelStackEntry 1 }
```

mplsLabelStackLabelIndex OBJECT-TYPE

```

SYNTAX          Unsigned32 (1..2147483647)
MAX-ACCESS      not-accessible
STATUS          current

```

DESCRIPTION

"Secondary index for this row identifying one label of the stack. Note that an entry with a smaller mplsLabelStackLabelIndex would refer to a label higher up the label stack and would be popped at a downstream LSR before a label represented by a higher mplsLabelStackLabelIndex at a downstream LSR."

```
 ::= { mplsLabelStackEntry 2 }
```

mplsLabelStackLabel OBJECT-TYPE

```

SYNTAX          MplsLabel
MAX-ACCESS      read-create
STATUS          current

```

DESCRIPTION

"The label to pushed."

```
::= { mplsLabelStackEntry 3 }
```

mplsLabelStackLabelPtr OBJECT-TYPE

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

DESCRIPTION

"If the label for this segment cannot be represented fully within the mplsLabelStackLabel object, this object MUST point to the first accessible column of a conceptual row in an external table containing the label. In this case, the mplsLabelStackLabel object SHOULD be set to 0 and ignored. This object MUST be set to zeroDotZero otherwise."

```
DEFVAL { zeroDotZero }
```

```
::= { mplsLabelStackEntry 4 }
```

mplsLabelStackRowStatus OBJECT-TYPE

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

DESCRIPTION

"For creating, modifying, and deleting this row. When a row in this table has a row in the active(1) state, no objects in this row except this object and the mplsLabelStackStorageType can be modified."

```
::= { mplsLabelStackEntry 5 }
```

mplsLabelStackStorageType OBJECT-TYPE

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

DESCRIPTION

"This variable indicates the storage type for this object. This object cannot be modified if mplsLabelStackRowStatus is active(1). No objects are required to be writable for rows in this table with this object set to permanent(4).

The agent MUST ensure that all related entries in this table retain the same value for this object. Agents MUST ensure that the storage type for all entries related to a particular mplsXEntry


```
        retain the same value for this object as the
        mplsXCEntry's StorageType."
DEFVAL { volatile }
::= { mplsLabelStackEntry 6 }

-- End of mplsLabelStackTable

-- Begin mplsInSegmentMapTable

mplsInSegmentMapTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF MplsInSegmentMapEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "This table specifies the mapping from the
        mplsInSegmentIndex to the corresponding
        mplsInSegmentInterface and mplsInSegmentLabel
        objects. The purpose of this table is to
        provide the manager with an alternative
        means by which to locate in-segments."
    ::= { mplsLsrObjects 14 }

mplsInSegmentMapEntry OBJECT-TYPE
    SYNTAX          MplsInSegmentMapEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "An entry in this table represents one interface
        and incoming label pair.

        In cases where the label cannot fit into the
        mplsInSegmentLabel object, the mplsInSegmentLabelPtr
        will indicate this by being set to the first accessible
        column in the appropriate extension table's row,
        and the mplsInSegmentLabel SHOULD be set to 0.
        In all other cases when the label is
        represented within the mplsInSegmentLabel object, the
        mplsInSegmentLabelPtr MUST be 0.0.

        Implementors need to be aware that if the value of
        the mplsInSegmentMapLabelPtrIndex (an OID) has more
        than 111 sub-identifiers, then OIDs of column
        instances in this table will have more than 128
        sub-identifiers and cannot be accessed using SNMPv1,
        SNMPv2c, or SNMPv3."
    INDEX { mplsInSegmentMapInterface,
```

```
        mplsInSegmentMapLabel,
        mplsInSegmentMapLabelPtrIndex }
 ::= { mplsInSegmentMapTable 1 }
```

```
MplsInSegmentMapEntry ::= SEQUENCE {
    mplsInSegmentMapInterface      InterfaceIndexOrZero,
    mplsInSegmentMapLabel          MplsLabel,
    mplsInSegmentMapLabelPtrIndex  RowPointer,
    mplsInSegmentMapIndex          MplsIndexType
}
```

```
mplsInSegmentMapInterface OBJECT-TYPE
    SYNTAX      InterfaceIndexOrZero
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "This index contains the same value as the
         mplsInSegmentIndex in the mplsInSegmentTable."
 ::= { mplsInSegmentMapEntry 1 }
```

```
mplsInSegmentMapLabel OBJECT-TYPE
    SYNTAX      MplsLabel
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "This index contains the same value as the
         mplsInSegmentLabel in the mplsInSegmentTable."
 ::= { mplsInSegmentMapEntry 2 }
```

```
mplsInSegmentMapLabelPtrIndex OBJECT-TYPE
    SYNTAX      RowPointer
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "This index contains the same value as the
         mplsInSegmentLabelPtr.
```

If the label for the InSegment cannot be represented fully within the mplsInSegmentLabel object, this index MUST point to the first accessible

column of a conceptual row in an external table containing the label. In this case, the mplsInSegmentTopLabel object SHOULD be set to 0 and ignored. This object MUST be set to zeroDotZero otherwise."
 ::= { mplsInSegmentMapEntry 3 }

mplsInSegmentMapIndex OBJECT-TYPE

SYNTAX MplsIndexType

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The mplsInSegmentIndex that corresponds to the mplsInSegmentInterface and mplsInSegmentLabel, or the mplsInSegmentInterface

and mplsInSegmentLabelPtr, if applicable.
The string containing the single octet 0x00
MUST not be returned."
 ::= { mplsInSegmentMapEntry 4 }

-- End mplsInSegmentMapTable

-- Notification Configuration

mplsXCNotificationsEnable OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"If this object is set to true(1), then it enables the emission of mplsXCUp and mplsXCDown notifications; otherwise these notifications are not emitted."

REFERENCE

"See also [RFC3413](#) for explanation that notifications are under the ultimate control of the MIB modules in this document."

DEFVAL { false }

::= { mplsLsrObjects 15 }

-- Cross-connect.

mplsXCUp NOTIFICATION-TYPE

```
OBJECTS      { mplsXCOperStatus, -- start of range
               mplsXCOperStatus  -- end of range
            }
```

STATUS current

DESCRIPTION

"This notification is generated when the mplsXCOperStatus object for one or more contiguous entries in mplsXCTable are about to enter the up(1) state from some other state. The included values of mplsXCOperStatus MUST both be set equal to this new state (i.e: up(1)). The two instances of mplsXCOperStatus in this notification indicate the range of indexes that are affected. Note that all the indexes of the two ends of the range can be derived from the instance identifiers of these two objects. For cases where a contiguous range of cross-connects have transitioned into the up(1) state at roughly the same time, the device SHOULD issue a single notification for each range of contiguous indexes in an effort to minimize the emission of a large number of notifications. If a notification has to be

issued for just a single cross-connect entry, then the instance identifier (and values) of the two mplsXCOperStatus objects MUST be the identical."
 ::= { mplsLsrNotifications 1 }

mplsXCDown NOTIFICATION-TYPE

```
OBJECTS      {
               mplsXCOperStatus, -- start of range
               mplsXCOperStatus  -- end of range
            }
```

STATUS current

DESCRIPTION

"This notification is generated when the mplsXCOperStatus object for one or more contiguous entries in mplsXCTable are about to enter the down(2) state from some other state. The included values

```

of mplsXCOperStatus MUST both be set equal to this
down(2) state. The two instances of mplsXCOperStatus
in this notification indicate the range of indexes
that are affected. Note that all the indexes of the
two ends of the range can be derived from the
instance identifiers of these two objects. For
cases where a contiguous range of cross-connects
have transitioned into the down(2) state at roughly
the same time, the device SHOULD issue a single
notification for each range of contiguous indexes in
an effort to minimize the emission of a large number
of notifications. If a notification has to be
issued for just a single cross-connect entry, then
the instance identifier (and values) of the two
mplsXCOperStatus objects MUST be identical."
 ::= { mplsLsrNotifications 2 }

-- End of notifications.

-- Module compliance.

mplsLsrGroups
  OBJECT IDENTIFIER ::= { mplsLsrConformance 1 }

mplsLsrCompliances
  OBJECT IDENTIFIER ::= { mplsLsrConformance 2 }

-- Compliance requirement for fully compliant implementations.

mplsLsrModuleFullCompliance MODULE-COMPLIANCE
  STATUS          current
  DESCRIPTION     "Compliance statement for agents that provide full
                  support for MPLS-LSR-STD-MIB. Such devices can

```

then be monitored and also be configured using
this MIB module."

```

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

```

```
    ifCounterDiscontinuityGroup
}
```

```
MODULE -- This module.
```

```
MANDATORY-GROUPS {
    mplsInterfaceGroup,
    mplsInSegmentGroup,
    mplsOutSegmentGroup,
    mplsXCGroup,
    mplsPerfGroup
}
```

```
GROUP          mplsLabelStackGroup
DESCRIPTION    "This group is only mandatory for LSRs that wish to
                support the modification of LSP label stacks.
                "
```

```
GROUP          mplsHCInSegmentPerfGroup
DESCRIPTION    "This group is mandatory for those in-segment entries
                for which the object mplsInSegmentOutOctets wraps
                around too quickly based on the criteria specified in
                RFC 2863 for high-capacity counters.
                "
```

```
GROUP          mplsHCOutSegmentPerfGroup
DESCRIPTION    "This group is mandatory for those out-segment entries
                for which the object mplsOutSegmentPerfOctets wraps
                around too quickly based on the criteria specified in
                RFC 2863 for high-capacity counters.
                "
```

```
GROUP          mplsLsrNotificationGroup
DESCRIPTION    "This group is only mandatory for those implementations
                which can efficiently implement the notifications
                contained in this group."
```

```
OBJECT          mplsInSegmentRowStatus
SYNTAX          RowStatus { active(1), notInService(2) }
WRITE-SYNTAX    RowStatus { active(1), notInService(2),
                            createAndGo(4), destroy(6)
                            }
```

```
DESCRIPTION    "Support for notInService, createAndWait and notReady
                is not required.
                "
```

```
OBJECT      mplsOutSegmentNextHopAddrType
SYNTAX      InetAddressType { unknown(0), ipv4(1), ipv6(2) }
MIN-ACCESS  read-only
DESCRIPTION "Write access is not required.  Only unknown(0),
            ipv4(1) and ipv6(2) support is required.
            "
```

```
OBJECT      mplsOutSegmentNextHopAddr
SYNTAX      InetAddress (SIZE(0|4|16))
MIN-ACCESS  read-only
DESCRIPTION "Write access is not required.  An implementation is
            only required to support unknown(0), ipv4(1) and
            ipv6(2) sizes."
```

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

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

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

```
::= { mplsLsrCompliances 1 }
```

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

mplsLsrModuleReadOnlyCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION "Compliance requirement for implementations that only provide read-only support for MPLS-LSR-STD-MIB. Such

MPLS Working Group

Expires March 2004

[Page 46]

Internet Draft

MPLS-LSR-STD-MIB

August 06, 2003

devices can then be monitored but cannot be configured using this MIB modules.

"

MODULE IF-MIB -- The interfaces Group MIB, [RFC 2863](#)

```
MANDATORY-GROUPS {
    ifGeneralInformationGroup,
    ifCounterDiscontinuityGroup
}
```

MODULE -- This module

```
MANDATORY-GROUPS {
    mplsInterfaceGroup,
    mplsInSegmentGroup,
    mplsOutSegmentGroup,
    mplsXCGroup,
    mplsPerfGroup
}
```

GROUP mplsLabelStackGroup

DESCRIPTION "This group is only mandatory for LSRs that wish to support the modification of LSP label stacks.

"

GROUP mplsHCInSegmentPerfGroup

DESCRIPTION "This group is mandatory for those in-segment entries for which the object mplsInSegmentOutOctets wraps around too quickly based on the criteria specified in [RFC 2863](#) for high-capacity counters.

"

GROUP mplsHCOutSegmentPerfGroup

DESCRIPTION "This group is mandatory for those out-segment entries for which the object mplsOutSegmentPerfOctets wraps around too quickly based on the criteria specified in [RFC 2863](#) for high-capacity counters.


```
"
GROUP      mplsLsrNotificationGroup
DESCRIPTION "This group is only mandatory for those implementations
            which can efficiently implement the notifications
            contained in this group.
"
```

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

OBJECT     mplsInSegmentLabelPtr
```

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

```
OBJECT     mplsInSegmentNPop
SYNTAX     Integer32 (1..1)
MIN-ACCESS read-only
DESCRIPTION "Write access is not required. This object
            SHOULD be set to 1 if it is read-only.
"
```

```
OBJECT     mplsInSegmentAddrFamily
MIN-ACCESS read-only
DESCRIPTION "Write access is not required. A value of other(0)
            should be supported because there may be cases where
            the agent may not know about or support any address
            types.
"
```

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

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

```

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

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

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

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

OBJECT      mplsOutSegmentNextHopAddrType
SYNTAX      InetAddressType { unknown(0), ipv4(1), ipv6(2) }
MIN-ACCESS  read-only
DESCRIPTION "Write access is not required. Only unknown(0),
            ipv4(1) and ipv6(2) support is required.
            "

```

```

OBJECT      mplsOutSegmentNextHopAddr
SYNTAX      InetAddress (SIZE(0|4|16))
MIN-ACCESS  read-only
DESCRIPTION "Write access is not required. An implementation is
            only required to support unknown(0), ipv4(1) and
            ipv6(2) sizes."

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

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

```

```

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

OBJECT      mplsXCAdminStatus
MIN-ACCESS  read-only
DESCRIPTION "Read only support is required."

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

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

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

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

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

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

```

```
 ::= { mplsLsrCompliances 2 }
```

```
-- Units of conformance.
```

```
mplsInterfaceGroup OBJECT-GROUP
```

```

OBJECTS {
    mplsInterfaceLabelMinIn,
    mplsInterfaceLabelMaxIn,
    mplsInterfaceLabelMinOut,
    mplsInterfaceLabelMaxOut,
    mplsInterfaceTotalBandwidth,
    mplsInterfaceAvailableBandwidth,
    mplsInterfaceLabelParticipationType
}
STATUS current
DESCRIPTION
    "Collection of objects needed for MPLS interface
    and interface performance information."
::= { mplsLsrGroups 1 }

```

mplsInSegmentGroup OBJECT-GROUP

```

OBJECTS {
    mplsInSegmentIndexNext,
    mplsInSegmentInterface,
    mplsInSegmentLabel,
    mplsInSegmentLabelPtr,
    mplsInSegmentNPop,
    mplsInSegmentAddrFamily,
    mplsInSegmentXCIndex,
    mplsInSegmentOwner,
    mplsInSegmentRowStatus,
    mplsInSegmentStorageType,
    mplsInSegmentTrafficParamPtr,
    mplsInSegmentMapIndex
}
STATUS current
DESCRIPTION
    "Collection of objects needed to implement an in-
    segment."
::= { mplsLsrGroups 2 }

```

mplsOutSegmentGroup OBJECT-GROUP

```

OBJECTS {
    mplsOutSegmentIndexNext,
    mplsOutSegmentInterface,
    mplsOutSegmentPushTopLabel,
    mplsOutSegmentTopLabel,
    mplsOutSegmentTopLabelPtr,
    mplsOutSegmentNextHopAddrType,

```

```
    mplsOutSegmentNextHopAddr,
    mplsOutSegmentXCIndex,
    mplsOutSegmentOwner,
    mplsOutSegmentPerfOctets,
    mplsOutSegmentPerfDiscards,
    mplsOutSegmentPerfErrors,
    mplsOutSegmentRowStatus,
    mplsOutSegmentStorageType,
    mplsOutSegmentTrafficParamPtr
}
STATUS current
DESCRIPTION
    "Collection of objects needed to implement an out-
    segment."
 ::= { mplsLsrGroups 3 }
```

```
mplsXCGroup OBJECT-GROUP
OBJECTS {
    mplsXCIndexNext,
    mplsXCLspId,
    mplsXCLabelStackIndex,
    mplsXCOwner,
    mplsXCStorageType,
    mplsXCAdminStatus,
    mplsXCOperStatus,
    mplsXCRowStatus,
    mplsXCNotificationsEnable
}
STATUS current
DESCRIPTION
    "Collection of objects needed to implement a
    cross-connect entry."
 ::= { mplsLsrGroups 4 }
```

```
mplsPerfGroup OBJECT-GROUP
OBJECTS {
    mplsInSegmentPerfOctets,
    mplsInSegmentPerfPackets,
    mplsInSegmentPerfErrors,
    mplsInSegmentPerfDiscards,
    mplsInSegmentPerfDiscontinuityTime,
    mplsOutSegmentPerfOctets,
    mplsOutSegmentPerfPackets,
    mplsOutSegmentPerfDiscards,
    mplsOutSegmentPerfDiscontinuityTime,
    mplsInterfacePerfInLabelsInUse,
```

```
mplsInterfacePerfInLabelLookupFailures,  
mplsInterfacePerfOutFragmentedPkts,  
mplsInterfacePerfOutLabelsInUse  
}
```

```
STATUS current  
DESCRIPTION  
    "Collection of objects providing performance  
    information  
    about an LSR."  
 ::= { mplsLsrGroups 5 }
```

```
mplsHCInSegmentPerfGroup OBJECT-GROUP  
OBJECTS { mplsInSegmentPerfHCOctets }  
STATUS current  
DESCRIPTION  
    "Object(s) providing performance information  
    specific to out-segments for which the object  
    mplsInterfaceInOctets wraps around too quickly."  
 ::= { mplsLsrGroups 6 }
```

```
mplsHCOutSegmentPerfGroup OBJECT-GROUP  
OBJECTS { mplsOutSegmentPerfHCOctets }  
STATUS current  
DESCRIPTION  
    "Object(s) providing performance information  
    specific to out-segments for which the object  
    mplsInterfaceOutOctets wraps around too  
    quickly."  
 ::= { mplsLsrGroups 7 }
```

```
mplsLabelStackGroup OBJECT-GROUP  
OBJECTS {  
    mplsLabelStackLabel,  
    mplsLabelStackLabelPtr,  
    mplsLabelStackRowStatus,  
    mplsLabelStackStorageType,  
    mplsMaxLabelStackDepth,  
    mplsLabelStackIndexNext  
}
```

```
STATUS current
DESCRIPTION
    "Objects needed to support label stacking."
 ::= { mplsLsrGroups 8 }
```

```
mplsLsrNotificationGroup NOTIFICATION-GROUP
NOTIFICATIONS {
    mplsXCUp,
    mplsXCDown
}
STATUS current
DESCRIPTION
    "Set of notifications implemented in this
    module."
```

```
 ::= { mplsLsrGroups 9 }
END
```

11. Security Considerations

It is clear that this MIB module is potentially useful for monitoring of MPLS LSRs. This MIB can also be used for 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:

- o the mplsLsrInSegmentTable, mplsLsrOutSegmentTable, mplsXCTable, mplsOutSegmentPerfTable, mplsInterfacePerfTable, and mplsInSegmentPerfTable collectively contain objects to provision MPLS interfaces, LSPs and their associated parameters on an Label Switching Router (LSR). Unauthorized access to objects in these tables, could result in disruption of traffic

on the network. This is especially true if an LSP 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 module. 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:

- o the mplsLsrInSegmentTable, mplsLsrOutSegmentTable, mplsXCTable, mplsOutSegmentPerfTable, mplsInterfacePerfTable, and mplsInSegmentPerfTable collectively show the LSP 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 to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an

instance of this MIB module, is properly configured to give access to the objects only to those principals "users" that have legitimate rights to indeed GET or SET "change/create/delete" them.

12. Acknowledgments

We wish to thank Ron Bonica, Adrian Farrel, Eric Gray, Tim Mancour, Keith McCloghrie, Bala Rajagopalan, Dan Tappan, Vasanthi Thirumalai, Joseph Benoit, Mike Piecuch, Joan Cucchiara. A special thanks to Bert Wijnen and Mike MacFaden for really getting the MIB module into shape.

13. IANA Considerations

As described in [MPLSMGMT] and as requested in the MPLS-TC-STD-MIB [MPLSTCMIB], 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](#)].

13.1. IANA Considerations for MPLS-LSR-STD-MIB

The IANA is requested to assign { mplsStdMIB 2 } to the MPLS-LSR-STD-MIB module specified in this document.

14. References

14.1. Normative References

- [RFC2119] S. Bradner, "Key Words for use in RFCs to Indicate Requirement Levels", [RFC 2119](#), [BCP 14](#), March 1997.
- [RFC2515] Tesink, K., et al., "Definitions of Managed Objects

for ATM Management", [RFC 2515](#), February 1999.

- [RFC2578] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and S. Waldbusser, "Structure of Management Information Version 2 (SMIV2)", STD 58, [RFC 2578](#), April 1999.

- [RFC2579] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and S. Waldbusser, "Textual Conventions for SMIV2", STD 58, [RFC 2579](#), April 1999.
- [RFC2580] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and S. Waldbusser, "Conformance Statements for SMIV2", STD 58, [RFC 2580](#), April 1999.
- [RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", [RFC 2863](#), June 2000.
- [RFC3031] Rosen, E., Viswanathan, A., and R. Callon, "Multiprotocol Label Switching Architecture", [RFC 3031](#), January 2001.
- [RFC3291] Daniele, M., Haberman, B., Routhier., S., Schoenwaelder., J., "Textual Conventions for Internet Network Addresses", [RFC3291](#), May 2002.
- [RFC3411] Harrington, D., Presuhn, R., and B. Wijnen, "An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks", [RFC 3411](#), December 2002.
- [TEMIB] Srinivasan, C., Viswanathan, A. and Nadeau, T., "MPLS Traffic Engineering Management Information Base ", Internet Draft <[draft-ietf-mpls-te-mib-09.txt](#)>, November 2002.
- [TCMIB] Nadeau, T., Cucchiara, J., Srinivasan, C., Viswanathan, A., Sjostrand, H. and K. Kompella, "Definition of Textual Conventions and OBJECT-IDENTITIES for Multi-Protocol Label Switching (MPLS) Management", Internet Draft <[draft-ietf-mpls-tc-mib-06.txt](#)>, April 2003.
- [IANAFamily] Internet Assigned Numbers Authority (IANA), ADDRESS FAMILY NUMBERS, (<http://www.isi.edu/in-notes/iana/assignments/address-family-numbers>), for MIB see: <ftp://ftp.isi.edu/mib/iana.mib/ianaaddressfamilynumbers.mib>

14.2. Informative References

- [RFC2026] S. Bradner, "The Internet Standards Process -- Revision 3", [RFC 2026](#), October 1996.
- [RFC3413] Levi, D., Meyer, P., Stewart, B., "SNMP Applications", [RFC 3413](#), December 2002.
- [RFC3410] Case, J., Mundy, R., Partain, D. and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", [RFC 3410](#), December 2002.

15. Authors' Addresses

Cheenu Srinivasan
Bloomberg L.P.
499 Park Ave., New York, NY 10022
Phone: +1-212-893-3682
Email: cheenu@bloomberg.net

Arun Viswanathan
Force10 Networks, Inc.
1440 McCarthy Blvd
Milpitas, CA 95035
Phone: +1-408-571-3516
Email: arunv@force10networks.com

Thomas D. Nadeau
Cisco Systems, Inc.
300 Beaver Brook Road
Boxboro, MA 01719
Phone: +1-978-936-1470
Email: tnadeau@cisco.com

16. Full Copyright Statement

Copyright (C) The Internet Society (2003). All Rights Reserved.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published and distributed, in whole or in part, without

restriction of any kind, provided that the above copyright notice and this paragraph are included on all such copies and derivative works. However, this document itself may not be modified in any way, such as by removing the copyright notice or references to the Internet Society or other Internet organizations, except as needed for the purpose of developing Internet standards in which case the procedures for copyrights defined in the Internet Standards process must be followed, or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by the Internet Society or its successors or assigns. This document and the information contained herein is provided on an "AS IS" basis and THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

17. Intellectual Property Notice

The IETF takes no position regarding the validity or scope of any intellectual property or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; neither does it represent that it has made any effort to identify any such rights. Information on the IETF's procedures with respect to rights in standards-track and standards-related documentation can be found in [BCP-11](#) [[RFC2028](#)]. Copies of claims of rights made available for publication and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementors or users of this specification can be obtained from the IETF Secretariat. The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary

rights that may cover technology that may be required to practice this standard. Please address the information to the IETF Executive Director.