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T. Nadeau, Ed.
Cisco Systems, Inc.
A. Farrel, Ed.
Old Dog Consulting
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Generalized Multiprotocol Label Switching (GMPLS)
Traffic Engineering Management Information Base

Status of This Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

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Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects for Generalized Multiprotocol Label Switching (GMPLS)-based traffic engineering.

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects for modeling Generalized Multiprotocol Label Switching (GMPLS) [RFC3945] based traffic engineering (TE). The tables and objects defined in this document extend those defined in the equivalent document for MPLS traffic engineering [RFC3812], and management of GMPLS traffic engineering is built on management of MPLS traffic engineering.

The MIB modules in this document should be used in conjunction with the companion document [RFC4803] for GMPLS-based traffic engineering configuration and management.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14, [RFC2119].

1.1. Migration Strategy

MPLS-TE Label Switched paths (LSPs) may be modeled and managed using the MPLS-TE-STD-MIB module [RFC3812].

Label Switching Routers (LSRs) may be migrated to model and manage their TE LSPs using the MIB modules in this document in order to migrate the LSRs to GMPLS support, or to take advantage of additional MIB objects defined in these MIB modules that are applicable to MPLS-TE.

The GMPLS TE MIB module (GMPLS-TE-STD-MIB) defined in this document extends the MPLS-TE-STD-MIB module [RFC3812] through a series of augmentations and sparse augmentations of the MIB tables. The only additions are for support of GMPLS or to support the increased complexity of MPLS and GMPLS systems.

In order to migrate from MPLS-TE-STD-MIB support to GMPLS-TE-STD-MIB support, an implementation needs only to add support for the additional tables and objects defined in GMPLS-TE-STD-MIB. The `gmplTunnelLSPEncoding` may be set to `tunnelLspNotGmpls` to allow an MPLS-TE LSP tunnel to benefit from the additional objects and tables of GMPLS-LSR-STD-MIB without supporting the GMPLS protocols.

The companion document for modeling and managing GMPLS-based LSRs [RFC4803] extends the MPLS-LSR-STD-MIB module [RFC3813] with the same intentions.

Textual conventions are defined in [RFC3811] and the IANA-GMPLS-TC-MIB module.

2. Terminology

This document uses terminology from the MPLS architecture document [RFC3031], from the GMPLS architecture document [RFC3945], and from the MPLS Traffic Engineering MIB [RFC3812]. Some frequently used terms are described next.

An explicitly routed LSP (ERLSP) is referred to as a GMPLS tunnel. It consists of in-segment(s) and/or out-segment(s) at the egress/ingress LSRs, each segment being associated with one GMPLS-enabled interface. These are also referred to as tunnel segments.

Additionally, at an intermediate LSR, we model a connection as consisting of one or more in-segments and/or one or more out-segments. The binding or interconnection between in-segments and out-segments is performed using a cross-connect.

These segment and cross-connect objects are defined in the MPLS Label Switching Router MIB (MPLS-LSR-STD-MIB) [RFC3813], but see also the GMPLS Label Switching Router MIB (GMPLS-LSR-STD-MIB) [RFC4803] for the GMPLS-specific extensions to these objects.

3. The Internet-Standard Management Framework

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

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

4. Outline

Support for GMPLS traffic-engineered tunnels requires the following configuration.

- Setting up tunnels with appropriate MPLS configuration parameters using [RFC3812].
- Extending the tunnel definitions with GMPLS configuration parameters.
- Configuring loose and strict source routed tunnel hops.

These actions may need to be accompanied with corresponding actions using [RFC3813] and [RFC4803] to establish and configure tunnel segments, if this is done manually. Also, the in-segment and out-segment performance tables, `mplsInSegmentPerfTable` and `mplsOutSegmentPerfTable` [RFC3813], should be used to determine performance of the tunnels and tunnel segments, although it should be noted that those tables may not be appropriate for measuring performance on some types of GMPLS links.

4.1. Summary of GMPLS Traffic Engineering MIB Module

The following tables contain MIB objects for performing the actions listed above when they cannot be performed solely using MIB objects defined in MPLS-TE-STD-MIB [RFC3812].

- Tunnel table (gmplsTunnelTable) for providing GMPLS-specific tunnel configuration parameters.
- Tunnel hop, actual tunnel hop, and computed tunnel hop tables (gmplsTunnelHopTable, gmplsTunnelARHopTable, and gmplsTunnelCHopTable) for providing additional configuration of strict and loose source routed tunnel hops.
- Performance and error reporting tables (gmplsTunnelReversePerfTable and gmplsTunnelErrorTable).

These tables are described in the subsequent sections.

Additionally, the GMPLS-TE-STD-MIB module contains a new notification.

- The GMPLS Tunnel Down Notification (gmplsTunnelDown) should be used for all GMPLS tunnels in place of the mplsTunnelDown notification defined in [RFC3812]. An implementation must not issue both the gmplsTunnelDown and the mplsTunnelDown notifications for the same event. As well as indicating that a tunnel has transitioned to operational down state, this new notification indicates the cause of the failure.

5. Brief Description of GMPLS TE MIB Objects

The objects described in this section support the functionality described in [RFC3473] and [RFC3472] for GMPLS tunnels. The tables support both manually configured and signaled tunnels.

5.1. gmplsTunnelTable

The gmplsTunnelTable extends the MPLS traffic engineering MIB module (MPLS-TE-STD-MIB [RFC3812]) to allow GMPLS tunnels to be created between an LSR and a remote endpoint, and existing GMPLS tunnels to be reconfigured or removed.

Note that we only support point-to-point tunnel segments, although multipoint-to-point and point-to-multipoint connections are supported by an LSR acting as a cross-connect.

Each tunnel can thus have one out-segment originating at an LSR and/or one in-segment terminating at that LSR.

Three objects within this table utilize enumerations in order to map to enumerations that are used in GMPLS signaling. In order to protect the GMPLS-TE-STD-MIB module from changes (in particular, extensions) to the range of enumerations supported by the signaling

protocols, these MIB objects use textual conventions with values maintained by IANA. For further details, see the IANA Considerations section of this document.

5.2. gmplsTunnelHopTable

The gmplsTunnelHopTable is used to indicate additional parameters for the hops, strict or loose, of a GMPLS tunnel defined in the gmplsTunnelTable, when it is established using signaling. Multiple tunnels may share hops by pointing to the same entry in this table.

5.3. gmplsTunnelARHopTable

The gmplsTunnelARHopTable is used to indicate the actual hops traversed by a tunnel as reported by the signaling protocol after the tunnel is set up. The support of this table is optional since not all GMPLS signaling protocols support this feature.

5.4. gmplsTunnelCHopTable

The gmplsTunnelCHopTable lists the actual hops computed by a constraint-based routing algorithm based on the gmplsTunnelHopTable. The support of this table is optional since not all implementations support computation of hop lists using a constraint-based routing protocol.

5.5. gmplsTunnelErrorTable

The gmplsTunnelErrorTable provides access to information about the last error that occurred on each tunnel known about by the MIB. It indicates the nature of the error and when and how it was reported, and it can give recovery advice through an admin string.

5.6. gmplsTunnelReversePerfTable

The gmplsTunnelReversePerfTable provides additional counters to measure the performance of bidirectional GMPLS tunnels in which packets are visible. It supplements the counters in mplsTunnelPerfTable and augments gmplsTunnelTable.

Note that not all counters may be appropriate or available for some types of tunnel.

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

64-bit counters are provided in the GMPLS-TE-STD-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.

6. Cross-referencing to the gmplsLabelTable

The gmplsLabelTable is found in the GMPLS-LABEL-STD-MIB module in [RFC4803] and provides a way to model labels in a GMPLS system where labels might not be simple 32-bit integers.

The hop tables in this document (gmplsTunnelHopTable, gmplsTunnelCHopTable, and gmplsTunnelARHopTable) and the segment tables in [RFC3813] (mplsInSegmentTable and mplsOutSegmentTable) contain objects with syntax MplsLabel.

MplsLabel (defined in [RFC3811]) is a 32-bit integer that is capable of representing any MPLS Label and most GMPLS Labels. However, some GMPLS Labels are larger than 32 bits and may be of arbitrary length. Furthermore, some labels that may be safely encoded in 32 bits are constructed from multiple sub-fields. Additionally, some GMPLS technologies support the concatenation of individual labels to represent a data flow carried as multiple sub-flows.

These GMPLS cases require that something other than a simple 32-bit integer be made available to represent the labels. This is achieved through the gmplsLabelTable contained in the GMPLS-LABEL-STD-MIB [RFC4803].

The tables in this document and [RFC3813] that include objects with syntax MplsLabel also include companion objects that are row pointers. If the row pointer is set to zeroDotZero (0.0), then an object of syntax MplsLabel contains the label encoded as a 32-bit integer. But otherwise the row pointer indicates a row in another MIB table that includes the label. In these cases, the row pointer may indicate a row in the gmplsLabelTable.

This provides both a good way to support legacy systems that implement MPLS-TE-STD-MIB [RFC3812], and a significant simplification in GMPLS systems that are limited to a single, simple label type.

Note that gmplsLabelTable supports concatenated labels through the use of a label sub-index (gmplsLabelSubindex).

7. Example of GMPLS Tunnel Setup

This section contains an example of which MIB objects should be modified to create a GMPLS tunnel. This example shows a best effort, loosely routed, bidirectional traffic engineered tunnel, which spans two hops of a simple network, uses Generalized Label requests with Lambda encoding, has label recording and shared link layer protection. Note that these objects should be created on the "head-end" LSR.

First in the mplsTunnelTable:

```
{
  mplsTunnelIndex           = 1,
  mplsTunnelInstance        = 1,
  mplsTunnelIngressLSRId    = 192.0.2.1,
  mplsTunnelEgressLSRId     = 192.0.2.2,
  mplsTunnelName            = "My first tunnel",
  mplsTunnelDescr           = "Here to there and back again",
  mplsTunnelIsIf            = true(1),
  mplsTunnelXCPointer       = mplsXCIndex.3.0.0.12,
  mplsTunnelSignallingProto = none(1),
  mplsTunnelSetupPrio       = 0,
  mplsTunnelHoldingPrio     = 0,
  mplsTunnelSessionAttributes = recordRoute(4),
  mplsTunnelOwner           = snmp(2),
  mplsTunnelLocalProtectInUse = false(2),
  mplsTunnelResourcePointer = mplsTunnelResourceIndex.6,
  mplsTunnelInstancePriority = 1,
  mplsTunnelHopTableIndex   = 1,
  mplsTunnelPrimaryInstance = 0,
  mplsTunnelIncludeAnyAffinity = 0,
  mplsTunnelIncludeAllAffinity = 0,
  mplsTunnelExcludeAnyAffinity = 0,
  mplsTunnelPathInUse       = 1,
  mplsTunnelRole            = head(1),
  mplsTunnelRowStatus       = createAndWait(5),
}
```

```

In gmplsTunnelTable(1,1,192.0.2.1,192.0.2.2):
{
  gmplsTunnelUnnumIf          = true(1),
  gmplsTunnelAttributes       = labelRecordingRequired(1),
  gmplsTunnelLSPEncoding      = tunnelLspLambda,
  gmplsTunnelSwitchingType    = lsc,
  gmplsTunnelLinkProtection   = shared(2),
  gmplsTunnelGPid             = lambda,
  gmplsTunnelSecondary        = false(2),
  gmplsTunnelDirection        = bidirectional(1)
  gmplsTunnelPathComp         = explicit(2),
  gmplsTunnelSendPathNotifyRecipientType = ipv4(1),
  gmplsTunnelSendPathNotifyRecipient      = 'C0000201'H,
  gmplsTunnelAdminStatusFlags             = 0,
  gmplsTunnelExtraParamsPtr               = 0.0
}

```

Entries in the mplsTunnelResourceTable, mplsTunnelHopTable, and gmplsTunnelHopTable are created and activated at this time.

```

In mplsTunnelResourceTable:
{
  mplsTunnelResourceIndex      = 6,
  mplsTunnelResourceMaxRate    = 0,
  mplsTunnelResourceMeanRate   = 0,
  mplsTunnelResourceMaxBurstSize = 0,
  mplsTunnelResourceRowStatus  = createAndGo(4)
}

```

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

The following denotes the beginning of the network, or the first hop in our example. We have used the fictitious LSR identified by "192.0.2.1" as our head-end router.

```

In mplsTunnelHopTable:
{
  mplsTunnelHopListIndex      = 1,
  mplsTunnelPathOptionIndex   = 1,
  mplsTunnelHopIndex          = 1,
  mplsTunnelHopAddrType       = ipv4(1),
  mplsTunnelHopIpv4Addr       = 192.0.2.1,
  mplsTunnelHopIpv4PrefixLen  = 9,
  mplsTunnelHopType            = strict(1),
  mplsTunnelHopRowStatus      = createAndWait(5),
}

```

The following denotes the end of the network, or the last hop in our example. We have used the fictitious LSR identified by "192.0.2.2" as our tail-end router.

```
In mplstunnelHopTable:
{
    mplstunnelHopListIndex          = 1,
    mplstunnelPathOptionIndex       = 1,
    mplstunnelHopIndex              = 2,
    mplstunnelHopAddrType           = ipv4(1),
    mplstunnelHopIpv4Addr           = 192.0.2.2,
    mplstunnelHopIpv4PrefixLen      = 9,
    mplstunnelHopType               = loose(2),
    mplstunnelHopRowStatus          = createAndGo(4)
}
```

Now an associated entry in the gmplstunnelHopTable is created to provide additional GMPLS hop configuration indicating that the first hop is an unnumbered link using Explicit Forward and Reverse Labels.

An entry in the gmplsLabelTable is created first to include the Explicit Label.

```
In gmplsLabelTable:
{
    gmplsLabelInterface             = 2,
    gmplsLabelIndex                 = 1,
    gmplsLabelSubindex              = 0,
    gmplsLabelType                  = gmplsFreeformLabel(3),
    gmplsLabelFreeform              = 0xFEDCBA9876543210
    gmplsLabelRowStatus             = createAndGo(4)
}
```

```
In gmplstunnelHopTable(1,1,1):
{
    gmplstunnelHopLabelStatuses     = forwardPresent(0)
                                   +reversePresent(1),
    gmplstunnelHopExplicitForwardLabelPtr = gmplsLabelTable(2,1,0)
    gmplstunnelHopExplicitReverseLabelPtr = gmplsLabelTable(2,1,0)
}
```

The first hop is now activated:

```
In mplstunnelHopTable(1,1,1):
{
    mplstunnelHopRowStatus          = active(1)
}
```

No gmplsTunnelHopEntry is created for the second hop as it contains no special GMPLS features.

Finally, the mplsTunnelEntry is activated:

```
In mplsTunnelTable(1,1,192.0.2.1,192.0.2.2)
{
    mplsTunnelRowStatus          = active(1)
}
```

8. GMPLS Traffic Engineering MIB Module

This MIB module makes reference to the following documents:

[RFC2205], [RFC2578], [RFC2579], [RFC2580], [RFC3209], [RFC3411], [RFC3471], [RFC3473], [RFC3477], [RFC3812], [RFC4001], and [RFC4202].

GMPLS-TE-STD-MIB DEFINITIONS ::= BEGIN

IMPORTS

```
MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
Unsigned32, Counter32, Counter64, zeroDotZero, Gauge32
    FROM SNMPv2-SMI -- RFC 2578
MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
    FROM SNMPv2-CONF -- RFC 2580
TruthValue, TimeStamp, RowPointer
    FROM SNMPv2-TC -- RFC 2579
InetAddress, InetAddressType
    FROM INET-ADDRESS-MIB -- RFC 4001
SnmplibAdminString
    FROM SNMP-FRAMEWORK-MIB -- RFC 3411
mplsTunnelIndex, mplsTunnelInstance, mplsTunnelIngressLSRId,
mplsTunnelEgressLSRId, mplsTunnelHopListIndex,
mplsTunnelHopPathOptionIndex, mplsTunnelHopIndex,
mplsTunnelARHopListIndex, mplsTunnelARHopIndex,
mplsTunnelCHopListIndex, mplsTunnelCHopIndex,
mplsTunnelEntry,
mplsTunnelAdminStatus, mplsTunnelOperStatus,
mplsTunnelGroup, mplsTunnelScalarGroup
    FROM MPLS-TE-STD-MIB -- RFC3812
IANA GmplsLSPEncodingTypeTC, IANA GmplsSwitchingTypeTC,
IANA GmplsGeneralizedPidTC, IANA GmplsAdminStatusInformationTC
    FROM IANA-GMPLS-TC-MIB
mplsStdMIB
    FROM MPLS-TC-STD-MIB -- RFC 3811
```

;

gmplsTeStdMIB MODULE-IDENTITY

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ORGANIZATION

"IETF Common Control and Measurement Plane (CCAMP) Working Group"

CONTACT-INFO

" Thomas D. Nadeau
 Cisco Systems, Inc.
 Email: tnadeau@cisco.com
 Adrian Farrel
 Old Dog Consulting
 Email: adrian@olddog.co.uk

Comments about this document should be emailed directly
 to the CCAMP working group mailing list at
 ccamp@ops.ietf.org."

DESCRIPTION

"Copyright (C) The IETF Trust (2007). This version of
 this MIB module is part of RFC 4802; see the RFC itself for
 full legal notices.

This MIB module contains managed object definitions
 for GMPLS Traffic Engineering (TE) as defined in:

1. Generalized Multi-Protocol Label Switching (GMPLS)
 Signaling Functional Description, Berger, L. (Editor),
 RFC 3471, January 2003.
2. Generalized MPLS Signaling - RSVP-TE Extensions, Berger,
 L. (Editor), RFC 3473, January 2003.

"

REVISION

"200702270000Z" -- 27 February 2007 00:00:00 GMT

DESCRIPTION

"Initial version issued as part of RFC 4802."

::= { mplsStdMIB 13 }

gmplsTeNotifications OBJECT IDENTIFIER ::= { gmplsTeStdMIB 0 }

gmplsTeScalars OBJECT IDENTIFIER ::= { gmplsTeStdMIB 1 }

gmplsTeObjects OBJECT IDENTIFIER ::= { gmplsTeStdMIB 2 }

gmplsTeConformance OBJECT IDENTIFIER ::= { gmplsTeStdMIB 3 }

gmplsTunnelsConfigured OBJECT-TYPE

SYNTAX Gauge32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of GMPLS tunnels configured on this device. A GMPLS

tunnel is considered configured if an entry for the tunnel exists in the gmplsTunnelTable and the associated mplsTunnelRowStatus is active(1)."

::= { gmplsTeScalars 1 }

gmplsTunnelsActive OBJECT-TYPE

SYNTAX Gauge32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of GMPLS tunnels active on this device. A GMPLS tunnel is considered active if there is an entry in the gmplsTunnelTable and the associated mplsTunnelOperStatus for the tunnel is up(1)."

::= { gmplsTeScalars 2 }

gmplsTunnelTable OBJECT-TYPE

SYNTAX SEQUENCE OF GmplsTunnelEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The gmplsTunnelTable sparsely extends the mplsTunnelTable of MPLS-TE-STD-MIB. It allows GMPLS tunnels to be created between an LSR and a remote endpoint, and existing tunnels to be reconfigured or removed.

Note that only point-to-point tunnel segments are supported, although multipoint-to-point and point-to-multipoint connections are supported by an LSR acting as a cross-connect. Each tunnel can thus have one out-segment originating at this LSR and/or one in-segment terminating at this LSR.

The row status of an entry in this table is controlled by the mplsTunnelRowStatus in the corresponding entry in the mplsTunnelTable. When the corresponding mplsTunnelRowStatus has value active(1), a row in this table may not be created or modified.

The exception to this rule is the gmplsTunnelAdminStatusInformation object, which can be modified while the tunnel is active."

REFERENCE

"1. Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB), RFC 3812."

::= { gmplsTeObjects 1 }

gmplsTunnelEntry OBJECT-TYPE

SYNTAX GmplsTunnelEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table in association with the corresponding entry in the mplsTunnelTable represents a GMPLS tunnel.

An entry can be created by a network administrator via SNMP SET commands, or in response to signaling protocol events."

INDEX {

mplsTunnelIndex,
mplsTunnelInstance,
mplsTunnelIngressLSRId,
mplsTunnelEgressLSRId

}

::= { gmplsTunnelTable 1 }

GmplsTunnelEntry ::= SEQUENCE {

gmplsTunnelUnnumIf

TruthValue,

gmplsTunnelAttributes

BITS,

gmplsTunnelLSPEncoding

IANAGmplsLSPEncodingTypeTC,

gmplsTunnelSwitchingType

IANAGmplsSwitchingTypeTC,

gmplsTunnelLinkProtection

BITS,

gmplsTunnelGPid

IANAGmplsGeneralizedPidTC,

gmplsTunnelSecondary

TruthValue,

gmplsTunnelDirection

INTEGER,

gmplsTunnelPathComp

INTEGER,

gmplsTunnelUpstreamNotifyRecipientType

InetAddressType,

gmplsTunnelUpstreamNotifyRecipient

InetAddress,

gmplsTunnelSendResvNotifyRecipientType

InetAddressType,

gmplsTunnelSendResvNotifyRecipient

InetAddress,

gmplsTunnelDownstreamNotifyRecipientType

InetAddressType,

gmplsTunnelDownstreamNotifyRecipient

InetAddress,

gmplsTunnelSendPathNotifyRecipientType

InetAddressType,

gmplsTunnelSendPathNotifyRecipient

InetAddress,

gmplsTunnelAdminStatusFlags

IANAGmplsAdminStatusInformationTC,

gmplsTunnelExtraParamsPtr

RowPointer

}

gmplsTunnelUnnumIf OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Denotes whether or not this tunnel corresponds to an unnumbered interface represented by an entry in the interfaces group table (the ifTable) with ifType set to mpls(166).

This object is only used if mplSTunnelIsIf is set to 'true'.

If both this object and the mplSTunnelIsIf object are set to 'true', the originating LSR adds an LSP_TUNNEL_INTERFACE_ID object to the outgoing Path message.

This object contains information that is only used by the terminating LSR."

REFERENCE

"1. Signalling Unnumbered Links in RSVP-TE, RFC 3477."

DEFVAL { false }

::= { gmplsTunnelEntry 1 }

gmplsTunnelAttributes OBJECT-TYPE

SYNTAX BITS {

labelRecordingDesired(0)

}

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This bitmask indicates optional parameters for this tunnel. These bits should be taken in addition to those defined in mplSTunnelSessionAttributes in order to determine the full set of options to be signaled (for example SESSION_ATTRIBUTES flags in RSVP-TE). The following describes these bitfields:

labelRecordingDesired

This flag is set to indicate that label information should be included when doing a route record. This bit is not valid unless the recordRoute bit is set."

REFERENCE

"1. RSVP-TE: Extensions to RSVP for LSP Tunnels, RFC 3209, sections 4.4.3, 4.7.1, and 4.7.2."

DEFVAL { { } }

::= { gmplsTunnelEntry 2 }

gmplsTunnelLSPEncoding OBJECT-TYPE

SYNTAX IANAGmplsLSPEncodingTypeTC

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object indicates the encoding of the LSP being requested.

A value of 'tunnelLspNotGmpls' indicates that GMPLS signaling is not in use. Some objects in this MIB module may be of use for MPLS signaling extensions that do not use GMPLS signaling. By setting this object to 'tunnelLspNotGmpls', an application may

indicate that only those objects meaningful in MPLS should be examined.

The values to use are defined in the TEXTUAL-CONVENTION IANAGmplsLSPEncodingTypeTC found in the IANA-GMPLS-TC-MIB module."

```
DEFVAL { tunnelLspNotGmpls }  
::= { gmplsTunnelEntry 3 }
```

gmplsTunnelSwitchingType OBJECT-TYPE

SYNTAX IANAGmplsSwitchingTypeTC

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Indicates the type of switching that should be performed on a particular link. This field is needed for links that advertise more than one type of switching capability.

The values to use are defined in the TEXTUAL-CONVENTION IANAGmplsSwitchingTypeTC found in the IANA-GMPLS-TC-MIB module.

This object is only meaningful if gmplsTunnelLSPEncodingType is not set to 'tunnelLspNotGmpls'."

```
DEFVAL { unknown }  
::= { gmplsTunnelEntry 4 }
```

gmplsTunnelLinkProtection OBJECT-TYPE

```
SYNTAX BITS {  
    extraTraffic(0),  
    unprotected(1),  
    shared(2),  
    dedicatedOneToOne(3),  
    dedicatedOnePlusOne(4),  
    enhanced(5)  
}
```

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This bitmask indicates the level of link protection required. A value of zero (no bits set) indicates that any protection may be used. The following describes these bitfields:

extraTraffic

This flag is set to indicate that the LSP should use links that are protecting other (primary) traffic. Such LSPs may be preempted when the links carrying the (primary) traffic being protected fail.

unprotected

This flag is set to indicate that the LSP should not use any link layer protection.

shared

This flag is set to indicate that a shared link layer protection scheme, such as 1:N protection, should be used to support the LSP.

dedicatedOneToOne

This flag is set to indicate that a dedicated link layer protection scheme, i.e., 1:1 protection, should be used to support the LSP.

dedicatedOnePlusOne

This flag is set to indicate that a dedicated link layer protection scheme, i.e., 1+1 protection, should be used to support the LSP.

enhanced

This flag is set to indicate that a protection scheme that is more reliable than Dedicated 1+1 should be used, e.g., 4 fiber BLSR/MS-SPRING.

This object is only meaningful if gmplsTunnelLSPEncoding is not set to 'tunnelLspNotGmpls'."

REFERENCE

"1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description, RFC 3471, section 7.1."

DEFVAL { { } }

::= { gmplsTunnelEntry 5 }

gmplsTunnelGPid OBJECT-TYPE

SYNTAX IANAGmplsGeneralizedPidTC

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object indicates the payload carried by the LSP. It is only required when GMPLS will be used for this LSP.

The values to use are defined in the TEXTUAL-CONVENTION IANAGmplsGeneralizedPidTC found in the IANA-GMPLS-TC-MIB module.

This object is only meaningful if gmplsTunnelLSPEncoding is not set to 'tunnelLspNotGmpls'."

DEFVAL { unknown }

::= { gmplsTunnelEntry 6 }

gmplsTunnelSecondary OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Indicates that the requested LSP is a secondary LSP.

This object is only meaningful if gmplsTunnelLSPEncoding is not set to 'tunnelLspNotGmpls'."

REFERENCE

"1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description, RFC 3471, section 7.1."

DEFVAL { false }

::= { gmplsTunnelEntry 7 }

gmplsTunnelDirection OBJECT-TYPE

SYNTAX INTEGER {

forward(0),

bidirectional(1)

}

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Whether this tunnel carries forward data only (is unidirectional) or is bidirectional.

Values of this object other than 'forward' are meaningful only if gmplsTunnelLSPEncoding is not set to 'tunnelLspNotGmpls'."

DEFVAL { forward }

::= { gmplsTunnelEntry 8 }

gmplsTunnelPathComp OBJECT-TYPE

SYNTAX INTEGER {

dynamicFull(1), -- CSPF fully computed

explicit(2), -- fully specified path

dynamicPartial(3) -- CSPF partially computed

}

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This value instructs the source node on how to perform path computation on the explicit route specified by the associated entries in the gmplsTunnelHopTable.

dynamicFull

The user specifies at least the source and destination of the path and expects that the Constrained

Shortest Path First (CSPF) will calculate the remainder of the path.

explicit

The user specifies the entire path for the tunnel to take. This path may contain strict or loose hops. Evaluation of the explicit route will be performed hop by hop through the network.

dynamicPartial

The user specifies at least the source and destination of the path and expects that the CSPF will calculate the remainder of the path. The path computed by CSPF is allowed to be only partially computed allowing the remainder of the path to be filled in across the network.

When an entry is present in the gmplsTunnelTable for a tunnel, gmplsTunnelPathComp MUST be used and any corresponding mplsTunnelHopEntryPathComp object in the mplsTunnelHopTable MUST be ignored and SHOULD not be set.

mplsTunnelHopTable and mplsTunnelHopEntryPathComp are part of MPLS-TE-STD-MIB.

This object should be ignored if the value of gmplsTunnelLSPEncoding is 'tunnelLspNotGmpls'."

REFERENCE

- "1. Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB), RFC 3812."

DEFVAL { dynamicFull }

::= { gmplsTunnelEntry 9 }

gmplsTunnelUpstreamNotifyRecipientType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object is used to aid in interpretation of gmplsTunnelUpstreamNotifyRecipient."

DEFVAL { unknown }

::= { gmplsTunnelEntry 10 }

gmplsTunnelUpstreamNotifyRecipient OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Indicates the address of the upstream recipient for Notify messages relating to this tunnel and issued by this LSR. This information is typically received from an upstream LSR in a Path message.

This object is only valid when signaling a tunnel using RSVP.

It is also not valid at the head end of a tunnel since there are no upstream LSRs to which to send a Notify message.

This object is interpreted in the context of the value of gmplsTunnelUpstreamNotifyRecipientType. If this object is set to 0, the value of gmplsTunnelUpstreamNotifyRecipientType MUST be set to unknown(0)."

REFERENCE

"1. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473, section 4.2. "

DEFVAL { '00000000'H } -- 0.0.0.0
::= { gmplsTunnelEntry 11 }

gmplsTunnelSendResvNotifyRecipientType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object is used to aid in interpretation of gmplsTunnelSendResvNotifyRecipient."

DEFVAL { unknown }

::= { gmplsTunnelEntry 12 }

gmplsTunnelSendResvNotifyRecipient OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Indicates to an upstream LSR the address to which it should send downstream Notify messages relating to this tunnel.

This object is only valid when signaling a tunnel using RSVP.

It is also not valid at the head end of the tunnel since no Resv messages are sent from that LSR for this tunnel.

If set to 0, no Notify Request object will be included in the outgoing Resv messages.

This object is interpreted in the context of the value of gmplsTunnelSendResvNotifyRecipientType. If this object is set to

0, the value of gmplsTunnelSendResvNotifyRecipientType MUST be set to unknown(0)."

REFERENCE

"1. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473, section 4.2. "

DEFVAL { '00000000'H } -- 0.0.0.0

::= { gmplsTunnelEntry 13 }

gmplsTunnelDownstreamNotifyRecipientType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object is used to aid in interpretation of gmplsTunnelDownstreamNotifyRecipient."

DEFVAL { unknown }

::= { gmplsTunnelEntry 14 }

gmplsTunnelDownstreamNotifyRecipient OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Indicates the address of the downstream recipient for Notify messages relating to this tunnel and issued by this LSR. This information is typically received from an upstream LSR in a Resv message. This object is only valid when signaling a tunnel using RSVP.

It is also not valid at the tail end of a tunnel since there are no downstream LSRs to which to send a Notify message.

This object is interpreted in the context of the value of gmplsTunnelDownstreamNotifyRecipientType. If this object is set to 0, the value of gmplsTunnelDownstreamNotifyRecipientType MUST be set to unknown(0)."

REFERENCE

"1. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473, section 4.2. "

"

DEFVAL { '00000000'H } -- 0.0.0.0

::= { gmplsTunnelEntry 15 }

gmplsTunnelSendPathNotifyRecipientType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object is used to aid in interpretation of
gmplsTunnelSendPathNotifyRecipient."

DEFVAL { unknown }

::= { gmplsTunnelEntry 16 }

gmplsTunnelSendPathNotifyRecipient OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Indicates to a downstream LSR the address to which it should
send upstream Notify messages relating to this tunnel.

This object is only valid when signaling a tunnel using RSVP.

It is also not valid at the tail end of the tunnel since no Path
messages are sent from that LSR for this tunnel.

If set to 0, no Notify Request object will be included in the
outgoing Path messages.

This object is interpreted in the context of the value of
gmplsTunnelSendPathNotifyRecipientType. If this object is set to
0, the value of gmplsTunnelSendPathNotifyRecipientType MUST be
set to unknown(0)."

REFERENCE

"1. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473,
section 4.2. "

DEFVAL { '00000000'H } -- 0.0.0.0

::= { gmplsTunnelEntry 17 }

gmplsTunnelAdminStatusFlags OBJECT-TYPE

SYNTAX IANAGmplsAdminStatusInformationTC

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Determines the setting of the Admin Status flags in the
Admin Status object or TLV, as described in RFC 3471. Setting
this field to a non-zero value will result in the inclusion of
the Admin Status object on signaling messages.

The values to use are defined in the TEXTUAL-CONVENTION
IANAGmplsAdminStatusInformationTC found in the
IANA-GMPLS-TC-MIB module.

This value of this object can be modified when the
corresponding mplsTunnelRowStatus and mplsTunnelAdminStatus
is active(1). By doing so, a new signaling message will be

triggered including the requested Admin Status object or TLV."

REFERENCE

"1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description, RFC 3471, section 8."

DEFVAL { { } }

::= { gmplsTunnelEntry 18 }

gmplsTunnelExtraParamsPtr OBJECT-TYPE

SYNTAX RowPointer

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Some tunnels will run over transports that can usefully support technology-specific additional parameters (for example, Synchronous Optical Network (SONET) resource usage). Such parameters can be supplied in an external table and referenced from here.

A value of zeroDotzero in this attribute indicates that there is no such additional information."

DEFVAL { zeroDotZero }

::= { gmplsTunnelEntry 19 }

gmplsTunnelHopTable OBJECT-TYPE

SYNTAX SEQUENCE OF GmplsTunnelHopEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The gmplsTunnelHopTable sparsely extends the mplsTunnelHopTable of MPLS-TE-STD-MIB. It is used to indicate the Explicit Labels to be used in an explicit path for a GMPLS tunnel defined in the mplsTunnelTable and gmplsTunnelTable, when it is established using signaling. It does not insert new hops, but does define new values for hops defined in the mplsTunnelHopTable.

Each row in this table is indexed by the same indexes as in the mplsTunnelHopTable. It is acceptable for some rows in the mplsTunnelHopTable to have corresponding entries in this table and some to have no corresponding entry in this table.

The storage type for this entry is given by the value of mplsTunnelHopStorageType in the corresponding entry in the mplsTunnelHopTable.

The row status of an entry in this table is controlled by mplsTunnelHopRowStatus in the corresponding entry in the mplsTunnelHopTable. That is, it is not permitted to create a row

in this table, or to modify an existing row, when the corresponding mplSTunnelHopRowStatus has the value active(1)."

REFERENCE

- "1. Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB), RFC 3812.
2. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473.

"

::= { gmplsTeObjects 2 }

gmplsTunnelHopEntry OBJECT-TYPE

SYNTAX GmplsTunnelHopEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table represents additions to a tunnel hop defined in mplSTunnelHopEntry. At an ingress to a tunnel, an entry in this table is created by a network administrator for an ERLSP to be set up by a signaling protocol. At transit and egress nodes, an entry in this table may be used to represent the explicit path instructions received using the signaling protocol."

INDEX {

mplSTunnelHopListIndex,
mplSTunnelHopPathOptionIndex,
mplSTunnelHopIndex

}

::= { gmplsTunnelHopTable 1 }

GmplsTunnelHopEntry ::= SEQUENCE {

gmplsTunnelHopLabelStatuses BITS,
gmplsTunnelHopExplicitForwardLabel Unsigned32,
gmplsTunnelHopExplicitForwardLabelPtr RowPointer,
gmplsTunnelHopExplicitReverseLabel Unsigned32,
gmplsTunnelHopExplicitReverseLabelPtr RowPointer

}

gmplsTunnelHopLabelStatuses OBJECT-TYPE

SYNTAX BITS {

forwardPresent(0),
reversePresent(1)

}

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This bitmask indicates the presence of labels indicated by the gmplsTunnelHopExplicitForwardLabel or gmplsTunnelHopExplicitForwardLabelPtr, and gmplsTunnelHopExplicitReverseLabel or

gmplsTunnelHopExplicitReverseLabelPtr objects.

For the Present bits, a set bit indicates that a label is present for this hop in the route. This allows zero to be a valid label value."

DEFVAL { { } }

::= { gmplsTunnelHopEntry 1 }

gmplsTunnelHopExplicitForwardLabel OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"If gmplsTunnelHopLabelStatuses object indicates that a Forward Label is present and gmplsTunnelHopExplicitForwardLabelPtr contains the value zeroDotZero, then the label to use on this hop is represented by the value of this object."

::= { gmplsTunnelHopEntry 2 }

gmplsTunnelHopExplicitForwardLabelPtr OBJECT-TYPE

SYNTAX RowPointer

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"If the gmplsTunnelHopLabelStatuses object indicates that a Forward Label is present, this object contains a pointer to a row in another MIB table (such as the gmplsLabelTable of GMPLS-LABEL-STD-MIB) that contains the label to use on this hop in the forward direction.

If the gmplsTunnelHopLabelStatuses object indicates that a Forward Label is present and this object contains the value zeroDotZero, then the label to use on this hop is found in the gmplsTunnelHopExplicitForwardLabel object."

DEFVAL { zeroDotZero }

::= { gmplsTunnelHopEntry 3 }

gmplsTunnelHopExplicitReverseLabel OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"If the gmplsTunnelHopLabelStatuses object indicates that a Reverse Label is present and gmplsTunnelHopExplicitReverseLabelPtr contains the value zeroDotZero, then the label to use on this hop is found in this object encoded as a 32-bit integer."

::= { gmplsTunnelHopEntry 4 }

`gmplsTunnelHopExplicitReverseLabelPtr OBJECT-TYPE``SYNTAX RowPointer``MAX-ACCESS read-create``STATUS current``DESCRIPTION`

"If the `gmplsTunnelHopLabelStatuses` object indicates that a Reverse Label is present, this object contains a pointer to a row in another MIB table (such as the `gmplsLabelTable` of GMPLS-LABEL-STD-MIB) that contains the label to use on this hop in the reverse direction.

If the `gmplsTunnelHopLabelStatuses` object indicates that a Reverse Label is present and this object contains the value `zeroDotZero`, then the label to use on this hop is found in the `gmplsTunnelHopExplicitReverseLabel` object."

`DEFVAL { zeroDotZero }``::= { gmplsTunnelHopEntry 5 }``gmplsTunnelARHopTable OBJECT-TYPE``SYNTAX SEQUENCE OF GmplsTunnelARHopEntry``MAX-ACCESS not-accessible``STATUS current``DESCRIPTION`

"The `gmplsTunnelARHopTable` sparsely extends the `mplsTunnelARHopTable` of MPLS-TE-STD-MIB. It is used to indicate the labels currently in use for a GMPLS tunnel defined in the `mplsTunnelTable` and `gmplsTunnelTable`, as reported by the signaling protocol. It does not insert new hops, but does define new values for hops defined in the `mplsTunnelARHopTable`.

Each row in this table is indexed by the same indexes as in the `mplsTunnelARHopTable`. It is acceptable for some rows in the `mplsTunnelARHopTable` to have corresponding entries in this table and some to have no corresponding entry in this table.

Note that since the information necessary to build entries within this table is not provided by some signaling protocols and might not be returned in all cases of other signaling protocols, implementation of this table and the `mplsTunnelARHopTable` is optional. Furthermore, since the information in this table is actually provided by the signaling protocol after the path has been set up, the entries in this table are provided only for observation, and hence, all variables in this table are accessible exclusively as read-only."

`REFERENCE`

"1. Extensions to RSVP for LSP Tunnels, RFC 3209.

2. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473.
3. Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB), RFC 3812."

```
::= { gmplsTeObjects 3 }
```

```
gmplsTunnelARHopEntry OBJECT-TYPE
```

```
SYNTAX GmplsTunnelARHopEntry
```

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

```
STATUS current
```

```
DESCRIPTION
```

"An entry in this table represents additions to a tunnel hop visible in mplstunnelARHopEntry. An entry is created by the signaling protocol for a signaled ERLSP set up by the signaling protocol.

At any node on the LSP (ingress, transit, or egress), this table and the mplstunnelARHopTable (if the tables are supported and if the signaling protocol is recording actual route information) contain the actual route of the whole tunnel. If the signaling protocol is not recording the actual route, this table MAY report the information from the gmplsTunnelHopTable or the gmplsTunnelCHopTable.

Note that the recording of actual labels is distinct from the recording of the actual route in some signaling protocols. This feature is enabled using the gmplsTunnelAttributes object."

```
INDEX {
    mplstunnelARHopListIndex,
    mplstunnelARHopIndex
}
```

```
::= { gmplsTunnelARHopTable 1 }
```

```
GmplsTunnelARHopEntry ::= SEQUENCE {
    gmplsTunnelARHopLabelStatuses          BITS,
    gmplsTunnelARHopExplicitForwardLabel   Unsigned32,
    gmplsTunnelARHopExplicitForwardLabelPtr RowPointer,
    gmplsTunnelARHopExplicitReverseLabel   Unsigned32,
    gmplsTunnelARHopExplicitReverseLabelPtr RowPointer,
    gmplsTunnelARHopProtection             BITS
}
```

```
gmplsTunnelARHopLabelStatuses OBJECT-TYPE
```

```
SYNTAX BITS {
    forwardPresent(0),
    reversePresent(1),
    forwardGlobal(2),
    reverseGlobal(3)
}
```

MAX-ACCESS read-only
STATUS current
DESCRIPTION

"This bitmask indicates the presence and status of labels indicated by the gmplsTunnelARHopExplicitForwardLabel or gmplsTunnelARHopExplicitForwardLabelPtr, and gmplsTunnelARHopExplicitReverseLabel or gmplsTunnelARHopExplicitReverseLabelPtr objects.

For the Present bits, a set bit indicates that a label is present for this hop in the route.

For the Global bits, a set bit indicates that the label comes from the Global Label Space; a clear bit indicates that this is a Per-Interface label. A Global bit only has meaning if the corresponding Present bit is set."

::= { gmplsTunnelARHopEntry 1 }

gmplsTunnelARHopExplicitForwardLabel OBJECT-TYPE

SYNTAX Unsigned32
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"If the gmplsTunnelARHopLabelStatuses object indicates that a Forward Label is present and gmplsTunnelARHopExplicitForwardLabelPtr contains the value zeroDotZero, then the label in use on this hop is found in this object encoded as a 32-bit integer."

::= { gmplsTunnelARHopEntry 2 }

gmplsTunnelARHopExplicitForwardLabelPtr OBJECT-TYPE

SYNTAX RowPointer
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"If the gmplsTunnelARHopLabelStatuses object indicates that a Forward Label is present, this object contains a pointer to a row in another MIB table (such as the gmplsLabelTable of GMPLS-LABEL-STD-MIB) that contains the label in use on this hop in the forward direction.

If the gmplsTunnelARHopLabelStatuses object indicates that a Forward Label is present and this object contains the value zeroDotZero, then the label in use on this hop is found in the gmplsTunnelARHopExplicitForwardLabel object."

::= { gmplsTunnelARHopEntry 3 }

gmplsTunnelARHopExplicitReverseLabel OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"If the gmplsTunnelARHopLabelStatuses object indicates that a Reverse Label is present and gmplsTunnelARHopExplicitReverseLabelPtr contains the value zeroDotZero, then the label in use on this hop is found in this object encoded as a 32-bit integer."

::= { gmplsTunnelARHopEntry 4 }

gmplsTunnelARHopExplicitReverseLabelPtr OBJECT-TYPE

SYNTAX RowPointer

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"If the gmplsTunnelARHopLabelStatuses object indicates that a Reverse Label is present, this object contains a pointer to a row in another MIB table (such as the gmplsLabelTable of GMPLS-LABEL-STD-MIB) that contains the label in use on this hop in the reverse direction.

If the gmplsTunnelARHopLabelStatuses object indicates that a Reverse Label is present and this object contains the value zeroDotZero, then the label in use on this hop is found in the gmplsTunnelARHopExplicitReverseLabel object."

::= { gmplsTunnelARHopEntry 5 }

gmplsTunnelARHopProtection OBJECT-TYPE

SYNTAX BITS {

localAvailable(0),

localInUse(1)

}

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Availability and usage of protection on the reported link.

localAvailable

This flag is set to indicate that the link downstream of this node is protected via a local repair mechanism.

localInUse

This flag is set to indicate that a local repair mechanism is in use to maintain this tunnel (usually in the face of an outage of the link it was previously routed over)."

REFERENCE

"1. RSVP-TE: Extensions to RSVP for LSP Tunnels, RFC 3209,
section 4.4.1."

::= { gmplsTunnelARHopEntry 6 }

gmplsTunnelCHopTable OBJECT-TYPE

SYNTAX SEQUENCE OF GmplsTunnelCHopEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The gmplsTunnelCHopTable sparsely extends the
mplsTunnelCHopTable of MPLS-TE-STD-MIB. It is used to indicate
additional information about the hops of a GMPLS tunnel defined
in the mplsTunnelTable and gmplsTunnelTable, as computed by a
constraint-based routing protocol, based on the
mplsTunnelHopTable and the gmplsTunnelHopTable.

Each row in this table is indexed by the same indexes as in the
mplsTunnelCHopTable. It is acceptable for some rows in the
mplsTunnelCHopTable to have corresponding entries in this table
and some to have no corresponding entry in this table.

Please note that since the information necessary to build
entries within this table may not be supported by some LSRs,
implementation of this table is optional.

Furthermore, since the information in this table is actually
provided by a path computation component after the path has been
computed, the entries in this table are provided only for
observation, and hence, all objects in this table are accessible
exclusively as read-only."

REFERENCE

"1. Multiprotocol Label Switching (MPLS) Traffic Engineering (TE)
Management Information Base (MIB), RFC 3812.

2. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473."

::= { gmplsTeObjects 4 }

gmplsTunnelCHopEntry OBJECT-TYPE

SYNTAX GmplsTunnelCHopEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table represents additions to a computed tunnel
hop visible in mplsTunnelCHopEntry. An entry is created by a
path computation component based on the hops specified in the
corresponding mplsTunnelHopTable and gmplsTunnelHopTable.

At a transit LSR, this table (if the table is supported) MAY
contain the path computed by a path computation engine on (or on

```

    behalf of) the transit LSR."
INDEX {
    mplSTunnelCHopListIndex,
    mplSTunnelCHopIndex
}
 ::= { gmplsTunnelCHopTable 1 }

GmplsTunnelCHopEntry ::= SEQUENCE {
    gmplsTunnelCHopLabelStatuses          BITS,
    gmplsTunnelCHopExplicitForwardLabel   Unsigned32,
    gmplsTunnelCHopExplicitForwardLabelPtr RowPointer,
    gmplsTunnelCHopExplicitReverseLabel   Unsigned32,
    gmplsTunnelCHopExplicitReverseLabelPtr RowPointer
}

gmplsTunnelCHopLabelStatuses OBJECT-TYPE
SYNTAX BITS {
    forwardPresent(0),
    reversePresent(1)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "This bitmask indicates the presence of labels indicated by the
    gmplsTunnelCHopExplicitForwardLabel or
    gmplsTunnelCHopExplicitForwardLabelPtr and
    gmplsTunnelCHopExplicitReverseLabel or
    gmplsTunnelCHopExplicitReverseLabelPtr objects.

    A set bit indicates that a label is present for this hop in the
    route, thus allowing zero to be a valid label value."
 ::= { gmplsTunnelCHopEntry 1 }

gmplsTunnelCHopExplicitForwardLabel OBJECT-TYPE
SYNTAX Unsigned32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "If the gmplsTunnelCHopLabelStatuses object indicates that a
    Forward Label is present and
    gmplsTunnelCHopExplicitForwardLabelPtr contains the value
    zeroDotZero, then the label to use on this hop is found in this
    object encoded as a 32-bit integer."
 ::= { gmplsTunnelCHopEntry 2 }

gmplsTunnelCHopExplicitForwardLabelPtr OBJECT-TYPE
SYNTAX RowPointer
MAX-ACCESS read-only

```

STATUS current
DESCRIPTION

"If the gmplsTunnelCHopLabelStatuses object indicates that a Forward Label is present, this object contains a pointer to a row in another MIB table (such as the gmplsLabelTable of GMPLS-LABEL-STD-MIB) that contains the label to use on this hop in the forward direction.

If the gmplsTunnelCHopLabelStatuses object indicates that a Forward Label is present and this object contains the value zeroDotZero, then the label to use on this hop is found in the gmplsTunnelCHopExplicitForwardLabel object."

::= { gmplsTunnelCHopEntry 3 }

gmplsTunnelCHopExplicitReverseLabel OBJECT-TYPE

SYNTAX Unsigned32
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"If the gmplsTunnelCHopLabelStatuses object indicates that a Reverse Label is present and gmplsTunnelCHopExplicitReverseLabelPtr contains the value zeroDotZero, then the label to use on this hop is found in this object encoded as a 32-bit integer."

::= { gmplsTunnelCHopEntry 4 }

gmplsTunnelCHopExplicitReverseLabelPtr OBJECT-TYPE

SYNTAX RowPointer
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"If the gmplsTunnelCHopLabelStatuses object indicates that a Reverse Label is present, this object contains a pointer to a row in another MIB table (such as the gmplsLabelTable of GMPLS-LABEL-STD-MIB) that contains the label to use on this hop in the reverse direction.

If the gmplsTunnelCHopLabelStatuses object indicates that a Reverse Label is present and this object contains the value zeroDotZero, then the label to use on this hop is found in the gmplsTunnelCHopExplicitReverseLabel object."

::= { gmplsTunnelCHopEntry 5 }

gmplsTunnelReversePerfTable OBJECT-TYPE

SYNTAX SEQUENCE OF GmplsTunnelReversePerfEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"This table augments the gmplsTunnelTable to provide per-tunnel packet performance information for the reverse direction of a bidirectional tunnel. It can be seen as supplementing the mplsTunnelPerfTable, which augments the mplsTunnelTable.

For links that do not transport packets, these packet counters cannot be maintained. For such links, attempts to read the objects in this table will return noSuchInstance.

A tunnel can be known to be bidirectional by inspecting the gmplsTunnelDirection object."

REFERENCE

"1. Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB), RFC 3812."

```
::= { gmplsTeObjects 5 }
```

gmplsTunnelReversePerfEntry OBJECT-TYPE

SYNTAX GmplsTunnelReversePerfEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table is created by the LSR for every bidirectional GMPLS tunnel where packets are visible to the LSR."

AUGMENTS { gmplsTunnelEntry }

```
::= { gmplsTunnelReversePerfTable 1 }
```

```
GmplsTunnelReversePerfEntry ::= SEQUENCE {
    gmplsTunnelReversePerfPackets      Counter32,
    gmplsTunnelReversePerfHCPackets    Counter64,
    gmplsTunnelReversePerfErrors        Counter32,
    gmplsTunnelReversePerfBytes         Counter32,
    gmplsTunnelReversePerfHCBytes       Counter64
}
```

gmplsTunnelReversePerfPackets OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Number of packets forwarded on the tunnel in the reverse direction if it is bidirectional.

This object represents the 32-bit value of the least significant part of the 64-bit value if both gmplsTunnelReversePerfHCPackets and this object are returned.

For links that do not transport packets, this packet counter cannot be maintained. For such links, this value will return noSuchInstance."

::= { gmplsTunnelReversePerfEntry 1 }

gmplsTunnelReversePerfHCPackets OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"High-capacity counter for number of packets forwarded on the tunnel in the reverse direction if it is bidirectional.

For links that do not transport packets, this packet counter cannot be maintained. For such links, this value will return noSuchInstance."

::= { gmplsTunnelReversePerfEntry 2 }

gmplsTunnelReversePerfErrors OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Number of errored packets received on the tunnel in the reverse direction if it is bidirectional. For links that do not transport packets, this packet counter cannot be maintained. For such links, this value will return noSuchInstance."

::= { gmplsTunnelReversePerfEntry 3 }

gmplsTunnelReversePerfBytes OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Number of bytes forwarded on the tunnel in the reverse direction if it is bidirectional.

This object represents the 32-bit value of the least significant part of the 64-bit value if both gmplsTunnelReversePerfHCBytes and this object are returned.

For links that do not transport packets, this packet counter cannot be maintained. For such links, this value will return noSuchInstance."

::= { gmplsTunnelReversePerfEntry 4 }

gmplsTunnelReversePerfHCBytes OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only
STATUS current

DESCRIPTION

"High-capacity counter for number of bytes forwarded on the tunnel in the reverse direction if it is bidirectional.

For links that do not transport packets, this packet counter cannot be maintained. For such links, this value will return noSuchInstance."

::= { gmplsTunnelReversePerfEntry 5 }

gmplsTunnelErrorTable OBJECT-TYPE

SYNTAX SEQUENCE OF GmplsTunnelErrorEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table augments the mplsTunnelTable.

This table provides per-tunnel information about errors. Errors may be detected locally or reported through the signaling protocol. Error reporting is not exclusive to GMPLS, and this table may be applied in MPLS systems.

Entries in this table are not persistent over system resets or re-initializations of the management system."

REFERENCE

"1. Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB), RFC 3812."

::= { gmplsTeObjects 6 }

gmplsTunnelErrorEntry OBJECT-TYPE

SYNTAX GmplsTunnelErrorEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table is created by the LSR for every tunnel where error information is visible to the LSR.

Note that systems that read the objects in this table one at a time and do not perform atomic operations to read entire instantiated table rows at once, should, for each conceptual column with valid data, read gmplsTunnelErrorLastTime prior to the other objects in the row and again subsequent to reading the last object of the row. They should verify that the value of gmplsTunnelErrorLastTime did not change and thereby ensure that all data read belongs to the same error event."

```

AUGMENTS { mplstunnelEntry }
::= { gmplstunnelErrorTable 1 }

GmplstunnelErrorEntry ::= SEQUENCE {
    gmplstunnelErrorLastErrorType    INTEGER,
    gmplstunnelErrorLastTime         TimeStamp,
    gmplstunnelErrorReporterType     InetAddressType,
    gmplstunnelErrorReporter         InetAddress,
    gmplstunnelErrorCode             Unsigned32,
    gmplstunnelErrorSubcode          Unsigned32,
    gmplstunnelErrorTLVs             OCTET STRING,
    gmplstunnelErrorHelpString       SnmpAdminString
}

gmplstunnelErrorLastErrorType OBJECT-TYPE
    SYNTAX  INTEGER {
        noError(0),
        unknown(1),
        protocol(2),
        pathComputation(3),
        localConfiguration(4),
        localResources(5),
        localOther(6)
    }
    MAX-ACCESS read-only
    STATUS    current
    DESCRIPTION
        "The nature of the last error.  Provides interpretation context
        for gmplstunnelErrorProtocolCode and
        gmplstunnelErrorProtocolSubcode.

        A value of noError(0) shows that there is no error associated
        with this tunnel and means that the other objects in this table
        entry (conceptual row) have no meaning.

        A value of unknown(1) shows that there is an error but that no
        additional information about the cause is known.  The error may
        have been received in a signaled message or generated locally.

        A value of protocol(2) or pathComputation(3) indicates the
        cause of an error and identifies an error that has been received
        through signaling or will itself be signaled.

        A value of localConfiguration(4), localResources(5) or
        localOther(6) identifies an error that has been detected
        by the local node but that will not be reported through
        signaling."
    ::= { gmplstunnelErrorEntry 1 }

```

gmplsTunnelErrorLastTime OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The time at which the last error occurred. This is presented as the value of SysUpTime when the error occurred or was reported to this node.

If gmplsTunnelErrorLastErrorType has the value noError(0), then this object is not valid and should be ignored.

Note that entries in this table are not persistent over system resets or re-initializations of the management system."

::= { gmplsTunnelErrorEntry 2 }

gmplsTunnelErrorReporterType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The address type of the error reported.

This object is used to aid in interpretation of gmplsTunnelErrorReporter."

::= { gmplsTunnelErrorEntry 3 }

gmplsTunnelErrorReporter OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The address of the node reporting the last error, or the address of the resource (such as an interface) associated with the error.

If gmplsTunnelErrorLastErrorType has the value noError(0), then this object is not valid and should be ignored.

If gmplsTunnelErrorLastErrorType has the value unknown(1), localConfiguration(4), localResources(5), or localOther(6), this object MAY contain a zero value.

This object should be interpreted in the context of the value of the object gmplsTunnelErrorReporterType."

REFERENCE

"1. Textual Conventions for Internet Network Addresses, RFC 4001, section 4, Usage Hints."

```
::= { gmplsTunnelErrorEntry 4 }
```

gmplsTunnelErrorCode OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The primary error code associated with the last error.

The interpretation of this error code depends on the value of gmplsTunnelErrorLastErrorType. If the value of gmplsTunnelErrorLastErrorType is noError(0), the value of this object should be 0 and should be ignored. If the value of gmplsTunnelErrorLastErrorType is protocol(2), the error should be interpreted in the context of the signaling protocol identified by the mplsTunnelSignallingProto object."

REFERENCE

1. Resource ReserVation Protocol -- Version 1 Functional Specification, RFC 2205, section B.
2. RSVP-TE: Extensions to RSVP for LSP Tunnels, RFC 3209, section 7.3.
3. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473, section 13.1."

```
::= { gmplsTunnelErrorEntry 5 }
```

gmplsTunnelErrorSubcode OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The secondary error code associated with the last error and the protocol used to signal this tunnel. This value is interpreted in the context of the value of gmplsTunnelErrorCode.

If the value of gmplsTunnelErrorLastErrorType is noError(0), the value of this object should be 0 and should be ignored."

REFERENCE

1. Resource ReserVation Protocol -- Version 1 Functional Specification, RFC 2205, section B.
2. RSVP-TE: Extensions to RSVP for LSP Tunnels, RFC 3209, section 7.3.
3. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473, section 13.1. "

```
::= { gmplsTunnelErrorEntry 6 }
```

gmplsTunnelErrorTLVs OBJECT-TYPE

SYNTAX OCTET STRING (SIZE(0..65535))

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The sequence of interface identifier TLVs reported with the error by the protocol code. The interpretation of the TLVs and the encoding within the protocol are described in the references. A value of zero in the first octet indicates that no TLVs are present."

REFERENCE

"1. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473, section 8.2."

```
::= { gmplsTunnelErrorEntry 7 }
```

```
gmplsTunnelErrorHelpString OBJECT-TYPE
```

```
SYNTAX  SnmpAdminString
```

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

```
STATUS  current
```

DESCRIPTION

"A textual string containing information about the last error, recovery actions, and support advice. If there is no help string, this object contains a zero length string.

If the value of gmplsTunnelErrorLastErrorType is noError(0), this object should contain a zero length string, but may contain a help string indicating that there is no error."

```
::= { gmplsTunnelErrorEntry 8 }
```

```
--
```

```
-- Notifications
```

```
--
```

```
gmplsTunnelDown NOTIFICATION-TYPE
```

```
OBJECTS {
```

```
    mplsTunnelAdminStatus,
```

```
    mplsTunnelOperStatus,
```

```
    gmplsTunnelErrorLastErrorType,
```

```
    gmplsTunnelErrorReporterType,
```

```
    gmplsTunnelErrorReporter,
```

```
    gmplsTunnelErrorCode,
```

```
    gmplsTunnelErrorSubcode
```

```
}
```

```
STATUS  current
```

DESCRIPTION

"This notification is generated when an mplsTunnelOperStatus object for a tunnel in the gmplsTunnelTable is about to enter the down state from some other state (but not from the notPresent state). This other state is indicated by the included value of mplsTunnelOperStatus.

The objects in this notification provide additional error information that indicates the reason why the tunnel has

transitioned to down(2).

Note that an implementation MUST only issue one of mplsTunnelDown and gmplsTunnelDown for any single event on a single tunnel. If the tunnel has an entry in the gmplsTunnelTable, an implementation SHOULD use gmplsTunnelDown for all tunnel-down events and SHOULD NOT use mplsTunnelDown.

This notification is subject to the control of mplsTunnelNotificationEnable. When that object is set to false(2), then the notification must not be issued.

Further, this notification is also subject to mplsTunnelNotificationMaxRate. That object indicates the maximum number of notifications issued per second. If events occur more rapidly, the implementation may simply fail to emit some notifications during that period, or may queue them until an appropriate time. The notification rate applies to the sum of all notifications in the MPLS-TE-STD-MIB and GMPLS-TE-STD-MIB modules applied across the whole of the reporting device.

mplsTunnelOperStatus, mplsTunnelAdminStatus, mplsTunnelDown, mplsTunnelNotificationEnable, and mplsTunnelNotificationMaxRate objects are found in MPLS-TE-STD-MIB."

REFERENCE

"1. Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB), RFC 3812."

```
::= { gmplsTeNotifications 1 }
```

gmplsTeGroups

```
OBJECT IDENTIFIER ::= { gmplsTeConformance 1 }
```

gmplsTeCompliances

```
OBJECT IDENTIFIER ::= { gmplsTeConformance 2 }
```

-- Compliance requirement for fully compliant implementations.

gmplsTeModuleFullCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"Compliance statement for agents that provide full support for GMPLS-TE-STD-MIB. Such devices can then be monitored and also be configured using this MIB module.

The mandatory group has to be implemented by all LSRs that originate, terminate, or act as transit for TE-LSPs/tunnels. In addition, depending on the type of tunnels supported, other

groups become mandatory as explained below."

MODULE MPLS-TE-STD-MIB -- The MPLS-TE-STD-MIB, RFC 3812

```
MANDATORY-GROUPS {
    mplsTunnelGroup,
    mplsTunnelScalarGroup
}
```

MODULE -- this module

```
MANDATORY-GROUPS {
    gmplsTunnelGroup,
    gmplsTunnelScalarGroup
}
```

GROUP gmplsTunnelSignaledGroup

DESCRIPTION

"This group is mandatory for devices that support signaled tunnel set up, in addition to gmplsTunnelGroup. The following constraints apply:

mplsTunnelSignallingProto should be at least read-only returning a value of ldp(2) or rsvp(3)."

GROUP gmplsTunnelOptionalGroup

DESCRIPTION

"Objects in this group are optional."

GROUP gmplsTeNotificationGroup

DESCRIPTION

"This group is mandatory for those implementations that can implement the notifications contained in this group."

::= { gmplsTeCompliances 1 }

-- Compliance requirement for read-only compliant implementations.

gmplsTeModuleReadOnlyCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

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

MODULE -- this module

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

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

```
MANDATORY-GROUPS {  
    gmplsTunnelGroup,  
    gmplsTunnelScalarGroup  
}
```

GROUP gmplsTunnelSignaledGroup

DESCRIPTION

"This group is mandatory for devices that support signaled
tunnel set up, in addition to gmplsTunnelGroup. The following
constraints apply:

mplsTunnelSignallingProto should be at least read-only
returning a value of ldp(2) or rsvp(3)."

GROUP gmplsTunnelOptionalGroup

DESCRIPTION

"Objects in this group are optional."

GROUP gmplsTeNotificationGroup

DESCRIPTION

"This group is mandatory for those implementations that can
implement the notifications contained in this group."

OBJECT gmplsTunnelUnnumIf

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelAttributes

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelLSPEncoding

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelSwitchingType

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelLinkProtection

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelGPid
MIN-ACCESS read-only
DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelSecondary
MIN-ACCESS read-only
DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelDirection
MIN-ACCESS read-only
DESCRIPTION

"Only forward(0) is required."

OBJECT gmplsTunnelPathComp
MIN-ACCESS read-only
DESCRIPTION

"Only explicit(2) is required."

OBJECT gmplsTunnelUpstreamNotifyRecipientType
SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2) }
MIN-ACCESS read-only
DESCRIPTION "Only unknown(0), ipv4(1), and ipv6(2) support
is required."

OBJECT gmplsTunnelUpstreamNotifyRecipient
SYNTAX InetAddress (SIZE(0|4|16))
MIN-ACCESS read-only
DESCRIPTION "An implementation is only required to support
unknown(0), ipv4(1), and ipv6(2) sizes."

OBJECT gmplsTunnelSendResvNotifyRecipientType
SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2) }
MIN-ACCESS read-only
DESCRIPTION "Only unknown(0), ipv4(1), and ipv6(2) support
is required."

OBJECT gmplsTunnelSendResvNotifyRecipient
SYNTAX InetAddress (SIZE(0|4|16))
MIN-ACCESS read-only
DESCRIPTION "An implementation is only required to support
unknown(0), ipv4(1), and ipv6(2) sizes."

OBJECT gmplsTunnelDownstreamNotifyRecipientType
SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2) }

MIN-ACCESS read-only

DESCRIPTION "Only unknown(0), ipv4(1), and ipv6(2) support
is required."

OBJECT gmplsTunnelDownstreamNotifyRecipient

SYNTAX InetAddress (SIZE(0|4|16))

MIN-ACCESS read-only

DESCRIPTION "An implementation is only required to support
unknown(0), ipv4(1), and ipv6(2) sizes."

OBJECT gmplsTunnelSendPathNotifyRecipientType

SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2) }

MIN-ACCESS read-only

DESCRIPTION "Only unknown(0), ipv4(1), and ipv6(2) support
is required."

OBJECT gmplsTunnelSendPathNotifyRecipient

SYNTAX InetAddress (SIZE(0|4|16))

MIN-ACCESS read-only

DESCRIPTION "An implementation is only required to support
unknown(0), ipv4(1), and ipv6(2) sizes."

OBJECT gmplsTunnelAdminStatusFlags

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelExtraParamsPtr

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

-- gmplsTunnelHopLabelStatuses has max access read-only

OBJECT gmplsTunnelHopExplicitForwardLabel

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelHopExplicitForwardLabelPtr

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelHopExplicitReverseLabel

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT gmplsTunnelHopExplicitReverseLabelPtr

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

-- gmplsTunnelARHopTable

-- all objects have max access read-only

-- gmplsTunnelCHopTable

-- all objects have max access read-only

-- gmplsTunnelReversePerfTable

-- all objects have max access read-only

-- gmplsTunnelErrorTable

-- all objects have max access read-only

OBJECT gmplsTunnelErrorReporterType

SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2) }

DESCRIPTION "Only unknown(0), ipv4(1), and ipv6(2) support
is required."

OBJECT gmplsTunnelErrorReporter

SYNTAX InetAddress (SIZE(0|4|16))

DESCRIPTION "An implementation is only required to support
unknown(0), ipv4(1), and ipv6(2)."

::= { gmplsTeCompliances 2 }

gmplsTunnelGroup OBJECT-GROUP

OBJECTS {

gmplsTunnelDirection,
gmplsTunnelReversePerfPackets,
gmplsTunnelReversePerfHCPackets,
gmplsTunnelReversePerfErrors,
gmplsTunnelReversePerfBytes,
gmplsTunnelReversePerfHCBytes,
gmplsTunnelErrorLastErrorType,
gmplsTunnelErrorLastTime,
gmplsTunnelErrorReporterType,
gmplsTunnelErrorReporter,
gmplsTunnelErrorCode,
gmplsTunnelErrorSubcode,
gmplsTunnelErrorTLVs,
gmplsTunnelErrorHelpString,
gmplsTunnelUnnumIf

}

STATUS current

DESCRIPTION

"Necessary, but not sufficient, set of objects to implement tunnels. In addition, depending on the type of the tunnels supported (for example, manually configured or signaled, persistent or non-persistent, etc.), the gmplsTunnelSignaledGroup group is mandatory."

```
::= { gmplsTeGroups 1 }
```

gmplsTunnelSignaledGroup OBJECT-GROUP

```
OBJECTS {
    gmplsTunnelAttributes,
    gmplsTunnelLSPEncoding,
    gmplsTunnelSwitchingType,
    gmplsTunnelLinkProtection,
    gmplsTunnelGPid,
    gmplsTunnelSecondary,
    gmplsTunnelPathComp,
    gmplsTunnelUpstreamNotifyRecipientType,
    gmplsTunnelUpstreamNotifyRecipient,
    gmplsTunnelSendResvNotifyRecipientType,
    gmplsTunnelSendResvNotifyRecipient,
    gmplsTunnelDownstreamNotifyRecipientType,
    gmplsTunnelDownstreamNotifyRecipient,
    gmplsTunnelSendPathNotifyRecipientType,
    gmplsTunnelSendPathNotifyRecipient,
    gmplsTunnelAdminStatusFlags,
    gmplsTunnelHopLabelStatuses,
    gmplsTunnelHopExplicitForwardLabel,
    gmplsTunnelHopExplicitForwardLabelPtr,
    gmplsTunnelHopExplicitReverseLabel,
    gmplsTunnelHopExplicitReverseLabelPtr
}
```

STATUS current

DESCRIPTION

"Objects needed to implement signaled tunnels."

```
::= { gmplsTeGroups 2 }
```

gmplsTunnelScalarGroup OBJECT-GROUP

```
OBJECTS {
    gmplsTunnelsConfigured,
    gmplsTunnelsActive
}
```

STATUS current

DESCRIPTION

"Scalar objects needed to implement MPLS tunnels."

```
::= { gmplsTeGroups 3 }
```

gmplsTunnelOptionalGroup OBJECT-GROUP

```
OBJECTS {
```

```

    gmplsTunnelExtraParamsPtr,
    gmplsTunnelARHopLabelStatuses,
    gmplsTunnelARHopExplicitForwardLabel,
    gmplsTunnelARHopExplicitForwardLabelPtr,
    gmplsTunnelARHopExplicitReverseLabel,
    gmplsTunnelARHopExplicitReverseLabelPtr,
    gmplsTunnelARHopProtection,
    gmplsTunnelCHopLabelStatuses,
    gmplsTunnelCHopExplicitForwardLabel,
    gmplsTunnelCHopExplicitForwardLabelPtr,
    gmplsTunnelCHopExplicitReverseLabel,
    gmplsTunnelCHopExplicitReverseLabelPtr
}
STATUS    current
DESCRIPTION
    "The objects in this group are optional."
 ::= { gmplsTeGroups 4 }

gmplsTeNotificationGroup NOTIFICATION-GROUP
NOTIFICATIONS {
    gmplsTunnelDown
}
STATUS    current
DESCRIPTION
    "Set of notifications implemented in this module.  None is
    mandatory."
 ::= { gmplsTeGroups 5 }

END

```

9. Security Considerations

It is clear that the MIB modules described in this document in association with MPLS-TE-STD-MIB [RFC3812] are potentially useful for monitoring of MPLS and GMPLS tunnels. These MIB modules 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 these MIB modules 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 gmplsTunnelTable and gmplsTunnelHopTable collectively contain objects to provision GMPLS tunnels interfaces at their ingress LSRs. Unauthorized write access to objects in these tables could result in disruption of traffic on the network. This is especially true if a tunnel has already been established.

Some of the readable objects in these MIB modules (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 gmplsTunnelTable, gmplsTunnelHopTable, gmplsTunnelARHopTable, gmplsTunnelCHopTable, gmplsTunnelReversePerfTable, and gmplsTunnelErrorTable collectively show the tunnel network topology and status. 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 these MIB modules.

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.

10. Acknowledgments

This document is a product of the CCAMP Working Group.

This document extends [RFC3812]. The authors would like to express their gratitude to all those who worked on that earlier MIB document. Thanks also to Tony Zinicola and Jeremy Crossen for their valuable contributions during an early implementation, and to Lars Eggert,

Baktha Muralidharan, Tom Petch, Dan Romascanu, Dave Thaler, and Bert Wijnen for their review comments.

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Joan Cucchiara provided a helpful and very thorough MIB Doctor review.

11. IANA Considerations

IANA has rooted MIB objects in the MIB modules contained in this document according to the sections below.

11.1. IANA Considerations for GMPLS-TE-STD-MIB

IANA has rooted MIB objects in the GMPLS-TE-STD-MIB module contained in this document under the mplsStdMIB subtree.

IANA has made the following assignments in the "NETWORK MANAGEMENT PARAMETERS" registry located at <http://www.iana.org/assignments/smi-numbers> in table:

...mib-2.transmission.mplsStdMIB (1.3.6.1.2.1.10.166)

Decimal	Name	References
-----	-----	-----
13	GMPLS-TE-STD-MIB	[RFC4802]

In the future, GMPLS-related standards-track MIB modules should be rooted under the mplsStdMIB (sic) subtree. IANA has been requested to manage that namespace in the SMI Numbers registry [RFC3811]. New assignments can only be made via a Standards Action as specified in [RFC2434].

11.2. Dependence on IANA MIB Modules

Three MIB objects in the GMPLS-TE-STD-MIB module defined in this document (gmplsTunnelLSPEncoding, gmplsTunnelSwitchingType, and gmplsTunnelGPid) use textual conventions imported from the IANA-GMPLS-TC-MIB module. The purpose of defining these textual conventions in a separate MIB module is to allow additional values to be defined without having to issue a new version of this document. The Internet Assigned Numbers Authority (IANA) is responsible for the assignment of all Internet numbers; it will administer the values associated with these textual conventions.

The rules for additions or changes to IANA-GMPLS-TC-MIB are outlined in the DESCRIPTION clause associated with its MODULE-IDENTITY statement.

The current version of IANA-GMPLS-TC-MIB can be accessed from the IANA home page at: <http://www.iana.org/>.

11.2.1. IANA-GMPLS-TC-MIB Definition

This section provides the base definition of the IANA GMPLS TC MIB module. This MIB module is under the direct control of IANA. Please see the most updated version of this MIB at <http://www.iana.org/assignments/ianagmplstc-mib>.

This MIB makes reference to the following documents: [RFC2578], [RFC2579], [RFC3471], [RFC3473], [RFC4202], [RFC4328], and [RFC4783].

IANA assigned an OID to the IANA-GMPLS-TC-MIB module specified in this document as { mib-2 152 }.

IANA-GMPLS-TC-MIB DEFINITIONS ::= BEGIN

IMPORTS

MODULE-IDENTITY, mib-2	FROM SNMPv2-SMI	-- RFC 2578
TEXTUAL-CONVENTION	FROM SNMPv2-TC;	-- RFC 2579

ianaGmpls MODULE-IDENTITY

LAST-UPDATED

"200702270000Z" -- 27 February 2007 00:00:00 GMT

ORGANIZATION

"IANA"

CONTACT-INFO

"Internet Assigned Numbers Authority
Postal: 4676 Admiralty Way, Suite 330
Marina del Rey, CA 90292
Tel: +1 310 823 9358
E-Mail: iana@iana.org"

DESCRIPTION

"Copyright (C) The IETF Trust (2007). The initial version of this MIB module was published in RFC 4802. For full legal notices see the RFC itself. Supplementary information may be available on:
<http://www.ietf.org/copyrights/ianamib.html>"

REVISION

"200702270000Z" -- 27 February 2007 00:00:00 GMT

DESCRIPTION

"Initial version issued as part of RFC 4802."

```
::= { mib-2 152 }
```

```
IANAGmplsLSPEncodingTypeTC ::= TEXTUAL-CONVENTION
```

```
STATUS          current
```

```
DESCRIPTION
```

```
"This type is used to represent and control
the LSP encoding type of an LSP signaled by a GMPLS
signaling protocol.
```

```
This textual convention is strongly tied to the LSP
Encoding Types sub-registry of the GMPLS Signaling
Parameters registry managed by IANA. Values should be
assigned by IANA in step with the LSP Encoding Types
sub-registry and using the same registry management rules.
However, the actual values used in this textual convention
are solely within the purview of IANA and do not
necessarily match the values in the LSP Encoding Types
sub-registry.
```

```
The definition of this textual convention with the
addition of newly assigned values is published
periodically by the IANA, in either the Assigned
Numbers RFC, or some derivative of it specific to
Internet Network Management number assignments. (The
latest arrangements can be obtained by contacting the
IANA.)
```

```
Requests for new values should be made to IANA via
email (iana@iana.org)."
```

```
REFERENCE
```

- "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description, RFC 3471, section 3.1.1.
2. Generalized MPLS Signalling Extensions for G.709 Optical Transport Networks Control, RFC 4328, section 3.1.1."

```
SYNTAX  INTEGER {
```

```
    tunnelLspNotGmpls(0),          -- GMPLS is not in use
    tunnelLspPacket(1),            -- Packet
    tunnelLspEthernet(2),          -- Ethernet
    tunnelLspAnsiEtsiPdh(3),       -- PDH
    -- the value 4 is deprecated
    tunnelLspSdhSonet(5),          -- SDH or SONET
    -- the value 6 is deprecated
    tunnelLspDigitalWrapper(7),    -- Digital Wrapper
    tunnelLspLambda(8),            -- Lambda
    tunnelLspFiber(9),             -- Fiber
    -- the value 10 is deprecated
    tunnelLspFiberChannel(11),     -- Fiber Channel
```

```
tunnelDigitalPath(12),      -- Digital Path
tunnelOpticalChannel(13)    -- Optical Channel
}
```

IANAGmplsSwitchingTypeTC ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"This type is used to represent and control the LSP switching type of an LSP signaled by a GMPLS signaling protocol.

This textual convention is strongly tied to the Switching Types sub-registry of the GMPLS Signaling Parameters registry managed by IANA. Values should be assigned by IANA in step with the Switching Types sub-registry and using the same registry management rules. However, the actual values used in this textual convention are solely within the purview of IANA and do not necessarily match the values in the Switching Types sub-registry.

The definition of this textual convention with the addition of newly assigned values is published periodically by the IANA, in either the Assigned Numbers RFC, or some derivative of it specific to Internet Network Management number assignments. (The latest arrangements can be obtained by contacting the IANA.)

Requests for new values should be made to IANA via email (iana@iana.org)."

REFERENCE

- "1. Routing Extensions in Support of Generalized Multi-Protocol Label Switching, RFC 4202, section 2.4.
2. Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description, RFC 3471, section 3.1.1."

SYNTAX INTEGER {

```
    unknown(0),      -- none of the following, or not known
    psc1(1),          -- Packet-Switch-Capable 1
    psc2(2),          -- Packet-Switch-Capable 2
    psc3(3),          -- Packet-Switch-Capable 3
    psc4(4),          -- Packet-Switch-Capable 4
    l2sc(51),         -- Layer-2-Switch-Capable
    tdm(100),         -- Time-Division-Multiplex
    lsc(150),         -- Lambda-Switch-Capable
    fsc(200)          -- Fiber-Switch-Capable
}
```

IANA GmplsGeneralizedPidTC ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"This data type is used to represent and control the LSP Generalized Protocol Identifier (G-PID) of an LSP signaled by a GMPLS signaling protocol.

This textual convention is strongly tied to the Generalized PIDs (G-PID) sub-registry of the GMPLS Signaling Parameters registry managed by IANA. Values should be assigned by IANA in step with the Generalized PIDs (G-PID) sub-registry and using the same registry management rules. However, the actual values used in this textual convention are solely within the purview of IANA and do not necessarily match the values in the Generalized PIDs (G-PID) sub-registry.

The definition of this textual convention with the addition of newly assigned values is published periodically by the IANA, in either the Assigned Numbers RFC, or some derivative of it specific to Internet Network Management number assignments. (The latest arrangements can be obtained by contacting the IANA.)

Requests for new values should be made to IANA via email (iana@iana.org)."

REFERENCE

- "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description, RFC 3471, section 3.1.1.
2. Generalized MPLS Signalling Extensions for G.709 Optical Transport Networks Control, RFC 4328, section 3.1.3."

SYNTAX INTEGER {
 unknown(0), -- unknown or none of the following
 -- the values 1, 2, 3 and 4 are reserved in RFC 3471
 asynchE4(5),
 asynchDS3T3(6),
 asynchE3(7),
 bitsynchE3(8),
 bytesynchE3(9),
 asynchDS2T2(10),
 bitsynchDS2T2(11),
 reservedByRFC3471first(12),
 asynchE1(13),
 bytesynchE1(14),
 bytesynch31ByDS0(15),
 asynchDS1T1(16),
 bitsynchDS1T1(17),

```

bytesynchDS1T1(18),
vc1vc12(19),
reservedByRFC3471second(20),
reservedByRFC3471third(21),
ds1SFAsynch(22),
ds1ESFAsynch(23),
ds3M23Asynch(24),
ds3CBitParityAsynch(25),
vtLovc(26),
stsSpeHovc(27),
posNoScramble16BitCrc(28),
posNoScramble32BitCrc(29),
posScramble16BitCrc(30),
posScramble32BitCrc(31),
atm(32),
ethernet(33),
sdhSonet(34),
digitalwrapper(36),
lambda(37),
ansiEtsiPdh(38),
lapsSdh(40),
fddi(41),
dqdb(42),
fiberChannel3(43),
hdlc(44),
ethernetV2DixOnly(45),
ethernet802dot3Only(46),
g709ODUj(47),
g709OTUk(48),
g709CBRorCBRa(49),
g709CBRb(50),
g709BSOT(51),
g709BSNT(52),
gfpIPorPPP(53),
gfpEthernetMAC(54),
gfpEthernetPHY(55),
g709ESCON(56),
g709FICON(57),
g709FiberChannel(58)
}

```

IANA GmplsAdminStatusInformationTC ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"This data type determines the setting of the Admin Status flags in the Admin Status object or TLV, as described in RFC 3471. Setting this object to a non-zero value will result in the inclusion of the Admin Status

object or TLV on signaling messages.

This textual convention is strongly tied to the Administrative Status Information Flags sub-registry of the GMPLS Signaling Parameters registry managed by IANA. Values should be assigned by IANA in step with the Administrative Status Flags sub-registry and using the same registry management rules. However, the actual values used in this textual convention are solely within the purview of IANA and do not necessarily match the values in the Administrative Status Information Flags sub-registry.

The definition of this textual convention with the addition of newly assigned values is published periodically by the IANA, in either the Assigned Numbers RFC, or some derivative of it specific to Internet Network Management number assignments. (The latest arrangements can be obtained by contacting the IANA.)

Requests for new values should be made to IANA via email (iana@iana.org).

REFERENCE

- "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description, RFC 3471, section 8.
2. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473, section 7.
3. GMPLS - Communication of Alarm Information, RFC 4783, section 3.2.1."

SYNTAX BITS {

```
    reflect(0), -- Reflect bit (RFC 3471)
    reserved1(1), -- reserved
    reserved2(2), -- reserved
    reserved3(3), -- reserved
    reserved4(4), -- reserved
    reserved5(5), -- reserved
    reserved6(6), -- reserved
    reserved7(7), -- reserved
    reserved8(8), -- reserved
    reserved9(9), -- reserved
    reserved10(10), -- reserved
    reserved11(11), -- reserved
    reserved12(12), -- reserved
    reserved13(13), -- reserved
    reserved14(14), -- reserved
    reserved15(15), -- reserved
    reserved16(16), -- reserved
```

```
reserved17(17), -- reserved
reserved18(18), -- reserved
reserved19(19), -- reserved
reserved20(20), -- reserved
reserved21(21), -- reserved
reserved22(22), -- reserved
reserved23(23), -- reserved
reserved24(24), -- reserved
reserved25(25), -- reserved
reserved26(26), -- reserved
reserved27(27), -- Inhibit Alarm bit (RFC 4783)
reserved28(28), -- reserved
testing(29), -- Testing bit (RFC 3473)
administrativelyDown(30), -- Admin down (RFC 3473)
deleteInProgress(31) -- Delete bit (RFC 3473)
}
```

END

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Contact Information

Thomas D. Nadeau
Cisco Systems, Inc.
1414 Massachusetts Ave.
Boxborough, MA 01719

EMail: tnadeau@cisco.com

Cheenu Srinivasan
Bloomberg L.P.
731 Lexington Ave.
New York, NY 10022

Phone: +1-212-617-3682
EMail: cheenu@bloomberg.net

Adrian Farrel
Old Dog Consulting

Phone: +44-(0)-1978-860944
EMail: adrian@olddog.co.uk

Tim Hall
Data Connection Ltd.
100 Church Street
Enfield, Middlesex
EN2 6BQ, UK

Phone: +44 20 8366 1177
EMail: tim.hall@dataconnection.com

Ed Harrison
Data Connection Ltd.
100 Church Street
Enfield, Middlesex
EN2 6BQ, UK

Phone: +44 20 8366 1177
EMail: ed.harrison@dataconnection.com

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