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Multiprotocol Label Switching Transport Profile (MPLS-TP) MIB-based Management Overview

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Abstract

A range of Management Information Base (MIB) modules has been developed to help model and manage the various aspects of Multiprotocol Label Switching (MPLS) networks. These MIB modules are defined in separate documents that focus on the specific areas of responsibility of the modules that they describe.

The MPLS Transport Profile (MPLS-TP) is a profile of MPLS functionality specific to the construction of packet-switched transport networks.

This document describes the MIB-based management architecture for MPLS-TP, indicates the interrelationships between different existing MIB modules that can be leveraged for MPLS-TP network management and identifies areas where additional MIB modules would be required.

This document is a product of a joint Internet Engineering Task Force (IETF) / International Telecommunication Union Telecommunication Standardization Sector (ITU-T) effort to include an MPLS Transport Profile within the IETF MPLS and PWE3 architectures to support the capabilities and functionalities of a packet transport network as defined by the ITU-T.

This Informational Internet-Draft is aimed at achieving IETF Consensus before publication as an RFC and will be subject to an IETF Last Call.

[RFC Editor, please remove this note before publication as an RFC and insert the correct Streams Boilerplate to indicate that the published RFC has IETF Consensus.]

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1. Introduction

The MPLS Transport Profile (MPLS-TP) is a packet transport technology based on a profile of the MPLS functionality specific to the construction of packet-switched transport networks. MPLS is described in [RFC3031] and requirements for MPLS-TP are specified in [RFC5654].

A range of Management Information Base (MIB) modules has been developed to help model and manage the various aspects of Multiprotocol Label Switching (MPLS) networks. These MIB modules are defined in separate documents that focus on the specific areas of responsibility of the modules that they describe.

An MPLS-TP network can be operated via static provisioning of transport paths, or the elective use of a Generalized MPLS (GMPLS) control plane to support dynamic provisioning of transport paths.

This document describes the MIB-based management architecture for MPLS-TP and indicates the interrelationships between different existing MIB modules that should be leveraged for MPLS-TP network management, if SNMP is used for the management interface, and identifies areas where additional MIB modules would be required. Note that [RFC5951] does not specify a preferred management interface protocol to be used as the standard protocol for managing MPLS-TP networks.

Comment [KL1]: Should clarify that the scope of this document is only when SNMP is used for the management interface. Proposed clarification is provided in the marked-up modification.

This document is a product of a joint Internet Engineering Task Force (IETF) / International Telecommunication Union Telecommunication Standardization Sector (ITU-T) effort to include an MPLS Transport Profile within the IETF MPLS and PWE3 architectures to support the capabilities and functionalities of a packet transport network.

2. Terminology

This document also uses terminology from the MPLS architecture document [RFC3031] and the following MPLS related MIB modules: MPLS TC MIB [RFC3811], MPLS LSR MIB [RFC3813], MPLS TE MIB [RFC3812], MPLS LDP MIB [RFC3815], MPLS FTN MIB [RFC3814] and TE LINK MIB [RFC4220].

3. The SNMP Management Framework

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).

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

This document discusses MIB modules that are compliant to the SMIv2, which is described in [RFC2578], [RFC2579] and [RFC2580].

4. Summary of MPLS-TP Management Function

The management of the MPLS-TP networks is separable from that of its client networks so that the same means of management can be used regardless of the client. The management functions of MPLS-TP includes fault management, configuration management, performance monitoring, and security management.

Comment [KL2]: The current summary is too brief. A pointer reference to RFC5951 and RFC5950 is suggested.

5. Overview of Existing Work

This section describes the existing tools and techniques for managing and modeling MPLS networks, devices, and protocols. It does not focus on MPLS-TP, but is intended to provide a description of the tool kit that is already available.

The following section (Section 6. Applicability of MPLS MIB modules to MPLS-TP) of this document outlines the existing MPLS MIB modules and optional use of GMPLS MIB modules to MPLS-TP and examines the additional MIB modules and objects that would be required for managing an MPLS-TP network.

5.1. MPLS Management Overview and Requirements

[RFC4378] outlines how data plane protocols can assist in providing the Operations and Management (OAM) requirements outlined in [RFC4377] and how it is applied to the management functions of fault, configuration, accounting, performance, and security (commonly known as FCAPS) for MPLS networks.

[RFC4221] describes the management architecture for MPLS. In particular, it describes how the managed objects defined in various MPLS-related MIB modules model different aspects of MPLS, as well as the interactions and dependencies between each of these MIB modules.

[RFC4377] describes the requirements for user and data plane OAM and applications for MPLS.

[RFC5654] describes the requirements for the optional use of a control plane to support dynamic provisioning of MPLS-TP transport paths. The MPLS-TP LSP control plane is based on GMPLS and is described in [RFC3945].

5.2. An Introduction to the MPLS and Pseudowire MIB Modules

5.2.1. Structure of the MPLS MIB OID Tree

The MPLS MIB OID tree has the following structure compatible for MPLS-TP.

```
 mib-2 -- RFC 2578 [RFC2578]
  |
  +-transmission
  |  |
  |  +- mplsStdMIB
  |  |     |
  |  |     +- mplsTCStdMIB -- MPLS-TC-STD-MIB [RFC3811]
  |  |     |
  |  |     +- mplsLsrStdMIB -- MPLS-LSR-STD-MIB [RFC3813]
  |  |     |
  |  |     +- mplsTeStdMIB -- MPLS-TE-STD-MIB [RFC3812]
  |  |     |
  |  |     +- mplsLdpStdMIB -- MPLS-LDP-STD-MIB [RFC3815]
  |  |     |
  |  |     +- mplsLdpGenericStdMIB -- MPLS-LDP-GENERIC-STD-MIB [RFC3815]
  |  |     |
  |  |     +- mplsFTNStdMIB -- MPLS-FTN-STD-MIB [RFC3814]
  |  |     |
  |  |     +- gmplsTCStdMIB -- GMPLS-TC-STD-MIB [RFC4801]
  |  |     |
  |  |     +- gmplsTeStdMIB -- GMPLS-TE-STD-MIB [RFC4802]
  |  |     |
  |  |     +- gmplsLsrStdMIB -- GMPLS-LSR-STD-MIB [RFC4803]
  |  |     |
  |  |     +- gmplsLabelStdMIB -- GMPLS-LABEL-STD-MIB [RFC4803]
  |  |
  |  +- teLinkStdMIB -- TE-LINK-STD-MIB [RFC4220]
  |  |
  |  +- pwStdMIB -- PW-STD-MIB [RFC5601]
  |
  +- ianaGmpls -- IANA-GMPLS-TC-MIB [RFC4802]
  |
  +- ianaPwe3MIB -- IANA-PWE3-MIB [RFC5601]
  |
  +- pwEnetStdMIB -- PW-ENET-STD-MIB [RFC5603]
  |
  +- pwMplsStdMIB -- PW-MPLS-STD-MIB [RFC5602]
  |
  +- pwTDMMIB -- PW-TDM-MIB [RFC5604]
  |
  +- pwTcStdMIB -- PW-TC-STD-MIB [RFC5542]
```

Note: The OIDs for MIB modules are assigned and managed by IANA. They can be found in the referenced MIB documents.

Comment [KL3]: Suggest add the RFC for clarity

5.2.2. Textual Convention Modules

MPLS-TC-STD-MIB [RFC3811] and GMPLS-TC-STD-MIB [RFC4801] contains the Textual Conventions for MPLS and GMPLS networks. These Textual Conventions should be imported by MIB modules which manage MPLS and GMPLS networks.

5.2.3. Mapping Data to LSPs

MPLS is a packet switching protocol that operates between the Network layer and the data link layer in the OSI model.

There is a clean separation between the control and forwarding planes in the MPLS protocol. This helps in easy portability and extensibility to the forwarding functions.

A router which performs MPLS forwarding is known as a "Label Switching Router. An LSR implements the control and forwarding plane of MPLS.

The LSR "control plane" provides information in terms of label bindings which are part of the information used to populate forwarding tables in an LSR. An LSR determines which label bindings to seek and retain based on configuration and other information.

The LSR forwarding plane then uses an index which is the incoming interface and label (usually of 20-bit length) to forward the packet.

Each entry in this forwarding table corresponds to a forwarding equivalence class (FEC). This can be loosely defined as the set of characteristics that are being shared by the packets which will be forwarded in a similar fashion and may share the same label.

MPLS packets are encapsulated by one more label entries referred to as the label stack. Each label stack entry consists of a label, the 3 TC-bits for classifying the Traffic Class, the bottom of stack bit, and TTL.

Comment [KL4]: Editorial: Should it be “one or more” instead?

The ingress and the egress devices of the MPLS network are called Label Edge Routers (LER). At the LER a label is pushed onto an incoming packet and popped to remove it.

At the ingress when an unlabeled packet enters, one or more label stack entries are (each label stack with one or more labels) is prefixed to this packet based on its FEC as discussed above. In

Comment [KL5]: Editorial: “is” is not needed.

addition, the "MPLS-specific" L2 encapsulation (including, for instance, the MPLS PID) is also added at the ingress. Then the packet is sent to the next-hop router for further processing. The next-hop router examines the topmost label in the label stack and then does a swap, 'push' or 'pop' operations based on the contents.

A label stack entry can be 'popped' or removed from the top of the label stack or a label stack entry is 'pushed' or inserted into the top of the stack based on the FEC information.

When a 'swap' operation is executed, the topmost label stack entry is replaced with a different one and the depth of the label stack remains the same. After the swap the packet is forwarded based on the new entry.

MPLS-FTN-STD-MIB [RFC3814] describes the managed objects for mapping FEC's to label bindings.

5.2.4. Label Switching Router Modules

MPLS-LSR-STD-MIB [RFC3813] describes the managed objects for modeling a Multiprotocol Label Switching (MPLS) [RFC3031] LSR.

MPLS-TP is specific to the use of MPLS in transport networks. According to [RFC5654] multipoint-to-point LSPs do not form part of MPLS-TP, so multipoint-to-point cross-connects are out of scope for this document.

Comment [KL6]: For clarity suggest modify as "… multipoint-to-point cross-connects as modeled in [RFC3813] are out of scope …"

5.2.5. Label Switched Path Modules

The path taken through the MPLS domain by a packet is referred to as a label switched path (LSP). It is possible that this path may not be understood or completely stored in one LSR within the MPLS domain.

MPLS-LSR-STD-MIB [RFC3813] defines the required objects for setting up an LSP. It defines the conceptual object MPLS cross-connect that is used to map incoming labels to outgoing labels on a MPLS enabled interfaces. This is referenced by other MIB modules in order to refer to an underlying MPLS LSP.

This label switched path can be programmed using a variety of mechanisms. These include manual programming and using a signalling protocol.

RSVP-TE (Resource reservation protocol for Traffic Engineering) is normally used for signalling LSPs used for Traffic Engineering.

5.2.6. Pseudowire Modules

The PW (Pseudowire) MIB modules architecture provides a layered modular model into which any supported emulated service can be connected to any supported packet switched network (PSN) type. Emulated Service Layer, Generic PW Layer and PSN VC Layer constitute the different layers of the model. A combination of the MIB modules belonging to each layer provides the glue for mapping the emulated service onto the native PSN service. At least three MIB modules each belonging to a different layer is required to define a PW emulated service.

Comment [KL7]: Editorial: replace "is" with "are".

Starting from the emulated Service Layer, the first is a service-specific module that is dependent on the emulated signal type.

The second is the PW-STD-MIB module, which configures general parameters of the PW that are common to all types of emulated services and PSN types.

The third is a PSN-specific module. There is a different module for each type of PSN. These modules associate the PW with one or more "tunnels" that carry the service over the PSN. These modules are defined in other documents.

PW-TC-STD-MIB [RFC5542] contains the textual conventions required for PW MIB modules.

PW-STD-MIB [RFC5601] defines a MIB module that can be used to manage pseudowire (PW) services for transmission over a Packet Switched Network (PSN) [RFC3931] [RFC4447]. This MIB module provides generic management of PWs that is common to all types of PSN and PW services defined by the IETF PWE3 Working Group.

PW-MPLS-STD-MIB [RFC5602] describes a model for managing pseudowire services for transmission over different flavors of MPLS tunnels. The general PW MIB module [RFC5601] defines the parameters global to the PW regardless of the underlying Packet Switched Network (PSN) and emulated service. This document is applicable for PWs that use MPLS PSN type in the PW-STD-MIB. Additionally this document describes the MIB objects that define pseudowire association to the MPLS PSN, that is not specific to the carried service.

Together, [RFC3811], [RFC3812] and [RFC3813] describe the modeling of an MPLS tunnel, and a tunnel's underlying cross-connects. This MIB module supports MPLS-TE PSN, non-TE MPLS PSN (an outer tunnel created by the Label Distribution Protocol (LDP) or manually), and MPLS PW label only (no outer tunnel).

PW-ENET-STD-MIB [RFC5603] describes a model for managing Ethernet pseudowire services for transmission over a PSN. This MIB module is generic and common to all types of PSNs supported in the Pseudowire Emulation Edge-to-Edge (PWE3) architecture [RFC3985], which describes the transport and encapsulation of L1 and L2 services over supported PSN types.

In particular, the MIB module associates a port or specific VLANs on top of a physical Ethernet port or a virtual Ethernet interface (for Virtual Private LAN Service (VPLS)) to a point-to-point PW. It is complementary to the PW-STD-MIB [RFC5601], which manages the generic PW parameters common to all services, including all supported PSN types.

PW-TDM-MIB [RFC5604] describes a model for managing TDM pseudowires, i.e., TDM data encapsulated for transmission over a Packet Switched Network (PSN). The term TDM in this document is limited to the scope of Plesiochronous Digital Hierarchy (PDH). It is currently specified to carry any TDM Signals in either Structure Agnostic Transport mode (E1, T1, E3, and T3) or in Structure Aware Transport mode (E1, T1, and NxDS0) as defined in the Pseudowire Emulation Edge-to-Edge (PWE3) TDM Requirements document [RFC4197].

5.2.7. Routing and Traffic Engineering

In MPLS traffic engineering, its possible to specify explicit routes or choose routes based on QOS metrics in setting up a path such that some specific data can be routed around network hot spots.

Comment [KL8]: Editorial: replace “its” with “it’s”.

MPLS-TE-STD-MIB [RFC3812] describes managed objects for modeling a Multiprotocol Label Switching (MPLS) [RFC3031] based traffic engineering. This MIB module should be used in conjunction with the companion document [RFC3813] for MPLS based traffic engineering configuration and management.

5.2.8. Resiliency

MPLS Fast Reroute is a restoration network resiliency mechanism used in MPLS TE to redirect the traffic onto the backup LSP's in 10s of milliseconds in case of link or node failure across the LSP. Two different modes of local protection are described in the [RFC4090] to protect LSP.

o One-to-One Backup
o Facility Backup

Facility backup uses label stacking to reroute multiple protected TE LSPs using a single backup TE LSP. One-to-one backup does not use label stacking, and every protected TE LSP requires a dedicated backup TE LSP.

MPLS-FRR-GENERAL-STD-MIB [draft-ietf-mpls-fastreroute-mib-14] contains objects that apply to any MPLS LSR implementing MPLS TE fast reroute functionality.

MPLS-FRR-ONE2ONE-STD-MIB [draft-ietf-mpls-fastreroute-mib-14] contains objects that apply to one-to-one backup method.

MPLS-FRR-FACILITY-STD-MIB [draft-ietf-mpls-fastreroute-mib-14] contains objects that apply to facility backup method.

5.2.9. Fault Management and Performance Management

MPLS manages the LSP and pseudowire faults through the use of LSP ping [RFC4379], VCCV [RFC5085], BFD for LSPs [RFC5884] and BFD for VCCV [RFC5885] tools.

Current MPLS focuses on the in and/or out packet counters, errored packets, discontinuity time.

Some of the MPLS and Pseudowire performance tables used for performance management are given below.

mplsTunnelPerfTable provides several counters (packets forwarded, packets dropped because of errors) to measure the performance of the MPLS tunnels.

mplsInterfacePerfTable provides performance information (incoming and outgoing labels in use and lookup failures) on a per-interface basis.

mplsInSegmentPerfTable contains statistical information (total packets received by the insegment, total errored packets received, total packets discarded, discontinuity time) for incoming MPLS segments to an LSR.

mplsOutSegmentPerfTable contains statistical information (total packets received, total errored packets received, total packets discarded, discontinuity time) for outgoing MPLS segments from an LSR.

mplsFTNPerfTable contains performance information for the specified interface and an FTN entry mapped to this interface.

mplsLdpEntityStatsTable and mplsLdpSessionStatsTable contain statistical information (session attempts, errored packets, notifications) about an LDP entity.

pwPerfCurrentTable, pwPerfIntervalTable, pwPerf1DayIntervalTable provides pseudowire performance information (in and/or out packets) based on time (current interval, each interval, 1day interval).

Comment [KL9]: Clarification is needed.

pwEnetStatsTable contains statistical counters specific for Ethernet PW.

pwTDMPerfCurrentTable, pwTDMPerfIntervalTable and pwTDMPerf1DayIntervalTable contain statistical informations accumulated per 15-minute, 24 hour, 1 day respectively.

gmplsTunnelErrorTable and gmplsTunnelReversePerfTable provides information about performance errored packets and in/out packet counters.

5.2.10. MIB Module Interdependencies

This section provides an overview of the relationship between the MPLS MIB modules for managing MPLS networks. More details of these relationships are given below.

[RFC4221] mainly focuses on the MPLS MIB module interdependencies, this section also highlights the GMPLS and PW MIB modules interdependencies.

The relationship "A --> B" means A depends on B and that MIB module A uses an object, object identifier, or textual convention defined in MIB module B, or that MIB module A contains a pointer (index or RowPointer) to an object in MIB module B.

```
   +-------> MPLS-TC-STD-MIB <-----------------------------------------+
   |            ^                                                      |
   |            |                                                      |
   |         MPLS-LSR-STD-MIB <--------------------------------+       |
   |                                                           |       |
   +<----------------------- MPLS-LDP-STD-MIB ---------------->+       |
   |                                    ^                      |       |
   |                                    |                      |       |
   +<-- MPLS-LDP-GENERIC-STD-MIB ------>+                      |       |
   |                                                           |       |
   +<------ MPLS-FTN-STD-MIB ---------+----------------------->+       |
   |                |                |                                |
   |                V                |                                |
   +<------------- MPLS-TE-STD-MIB  ->+                                |
                                      |  GMPLS-TC-STD-MIB ------------>+
                                      |    ^                           |
                                      |    |                           |
                                  +---+    +<-- GMPLS-LABEL-STD-MIB -->+
                                  |   ^    ^      ^                    |
                                  |   |    |      |                    |
   +----> PW-TC-STD-MIB           |  GMPLS-LSR-STD-MIB --------------->+
   |                              |      ^       ^                     |
   |                              |      |       |                     |
   |   IANA-PWE3-MIB              |      |       | IANA-GMPLS-TC-MIB   |
   |        ^                     |      |       |    ^                |
   |        |                     |      |       |    |                |
   |        |                     +<--- GMPLS-TE-STD-MIB ------------->+
   |        |                     ^                                    |
   +<--- PW-STD-MIB <------+      |                                    |
   |                       |      |                                    |
   +<--- PW-ENET-STD-MIB ->+      |                                    |
   |                       ^      |                                    |
   |                       |      |                                    |
   +<---------------- PW-MPLS-STD-MIB -------------------------------->+
```

Thus:

- All the MPLS MIB modules depend on MPLS-TC-STD-MIB.

- All the GMPLS MIB modules depend on GMPLS-TC-STD-MIB.

- All the PW MIB modules depend on PW-TC-STD-MIB.

- MPLS-LDP-STD-MIB, MPLS-TE-STD-MIB, MPLS-FTN-STD-MIB, GMPLS-LSR-STD-MIB, and PW-MPLS-STD-MIB contain references to objects in MPLS-LSR-STD-MIB.

- MPLS-LDP-GENERIC-STD-MIB contains references to objects in MPLS-LDP-STD-MIB.

- MPLS-FTN-STD-MIB, PW-MPLS-STD-MIB, and GMPLS-TE-STD-MIB contain references to objects in MPLS-TE-STD-MIB.

- PW-MPLS-STD-MIB, and PW-ENET-STD-MIB contains references to objects in PW-STD-MIB.

- PW-STD-MIB contains references to objects in IANA-PWE3-MIB.

- GMPLS-TE-STD-MIB contains references to objects in IANA-GMPLS-TC-MIB.

- GMPLS-LSR-STD-MIB contains references to objects in GMPLS-LABEL-STD-MIB.

Note that there is a textual convention (MplsIndexType) defined in MPLS-LSR-STD-MIB that is imported by MPLS-LDP-STD-MIB.

5.2.11. Dependencies on External MIB Modules

MPLS MIB modules have dependencies with the TE-LINK-STD-MIB for maintaining the traffic engineering information.

MPLS MIB modules depend on the CSPF module to get the paths for MPLS tunnel to traverse to reach the end point of the tunnel and BFD module to verify the data-plane failures of LSPs and PWs.

Finally, all of the MIB modules import standard textual conventions such as integers, strings, timestamps, etc., from the MIB modules in which they are defined.

This is business as usual for a MIB module and is not discussed further in this document.

6. Applicability of MPLS MIB modules to MPLS-TP

In addition to the MPLS management overview [RFC4221] section 4.12 (Dependencies on External MIB Modules), some of the existing MPLS MIBs, PW MIBs and GMPLS MIBs are re-used with extensions for achieving the MPLS-TP functionality.

[RFC5951] specifies the requirements for the management of equipment used in networks supporting an MPLS-TP. It also details the essential network management capabilities for operating networks consisting of MPLS-TP equipment.

[RFC5950] provides the network management framework for MPLS-TP. The document explains how network elements and networks that support MPLS-TP can be managed using solutions that satisfy the requirements defined in [RFC5951]. The relationship between MPLS-TP management and OAM is described in the MPLS-TP framework [RFC5950] document.

Fault management and performance management form key parts of Operations, Administration, and Maintenance (OAM) function. MPLS-TP OAM is described in [MPLS-TP-OAM-FWK].

[Editors note - A seperate draft will provide an MPLS-TP abstract model and use a formal language to define the terminology, the information that must be retrieved and method for storing. The draft will also list the new MPLS-TP MIB modules identified in this document]

6.1 Gap Analysis

6.1.1 MPLS-TP Tunnel

- o An MPLS tunnel may not be compatible for non-IP environments. i.e., the tunnel ingress and egress identifiers are not always identified via an IP address, rather identification is achieved using local numbers to operate in a non-IP environment.
- o Next-hop IP address in MPLS XC table is not compatible for non-IP environment.
- o Bidirectional LSPs are not introduced until the GMPLS MIB modules, tunnel table should be enhanced to provide static and signalling corouted/associated bidirectional connectivity.

6.1.2 MPLS-TP Pseudowire

- o MPLS pseudowire may not be compatible for non-IP environments. i.e., pseudowire source and destination identifiers are not always identified via an IP address, rather identification is achieved using local numbers to operate in a non-IP environment.
- o Pseudowire mib modules should be enhanced to operate over corouted/associated bi-directional tunnel.
- o Pseudowire 129 FEC type-2 should be used in non-IP and IP environments with the required changes.

6.1.3 MPLS-TP Sections

There is no gap in the existing MPLS MIB modules as this MPLS-TP section will be defined as the new term for MPLS-TP.

6.1.4 MPLS-TP OAM

MPLS manages the LSP and pseudowire faults through LSP ping [RFC4379], VCCV [RFC5085], BFD for LSPs [RFC5884] and BFD for VCCV [RFC5885] tools.

There is no MIB management model currently available for the above fault management tools.

There is no performance management tool currently available for MPLS except the statistics information.

6.1.5 MPLS-TP Protection Switching

An important aspect that MPLS-TP technology provides is protection switching. In general, the mechanism of protection switching can be described as the substitution of a protection or standby facility for a working or primary facility. An MPLS-TP protection switching can be managed with the following parameters:

- o Topology (linear, ring, mesh)
- o Protection architecture (1+1, 1:1, or others as defined in different topologies)
- o Switching type (unidirectional, bidirectional)
- o Operation mode (revertive, non-revertive)
- o Automatic protection channel
- o Protection state
- o Position of the switch
- o Timer values (hold-off, Wait-to-Restore)
- o Failure of protocol

Among the parameters described above for protection switching, it is the topology itself which has the most significant influence. Therefore, three MIB modules are to be defined to model and manage protection switching for each of three different topologies (linear, ring and mesh) availible.

7. Interfaces

MPLS-TP can be carried over the existing and evolving physical transport technologies such as SONET/SDH, OTN/WDM, and Ethernet.

The Interfaces Group of IF-MIB [RFC2863] defines generic managed objects for managing interfaces. The MPLS-TP MIB modules make references to interfaces so that it can be clearly determined where the procedures managed by the MIB modules should be performed. Additionally, the MPLS-TP MIB modules (notably MPLS-TE-STD-MIB and TE-LINK-STD-MIB, PW-STD-MIB) utilize interface stacking within the Interface Group.

Please refer to section 4. (Node and Interface Identifiers) in [MPLS-TP-IDENTIFIERS] for more information on MPLS-TP specific interfaces.

7.1. MPLS Tunnels as Interfaces

An extension to mplsTunnelTable should address the tunnel requirements specific to MPLS-TP.

MPLS Tunnel logical interfaces can be stacked over PDH/SDH/OTH/Ethernet physical interfaces. For more information on Tunnel interfaces, refer section 11.1 (MPLS Tunnels as Interfaces) of RFC-4221.

7.2. Application of the Interfaces Group to TE Links

TE links can be formed over PDH/SDH/OTH/Ethernet physical interfaces. For more information on TE links, Refer section 11.2. Application of the Interfaces Group to TE Links of RFC-4221.

7.3. References to Interface Objects from MPLS MIB Modules

MPLSTP-STD-MIB includes the extensions of Tunnel table, PW table for MPLS-TP.

More information on Tunnel interfaces can be found in the RFC-3812, section 8. (Application of the Interface Group to MPLS Tunnels)

The PW in general is not an ifIndex on its own, for agent scalability reasons. The PW is typically associated via the PWE3 MIB modules to an ifIndex (physical entity) the PW is emulating. Some implementations may manage the PW as an ifIndex in the ifTable. A special ifType to represent a PW virtual interface (246) will be used in the ifTable in this case. More information on PW interfaces can be found in the RFC-5601, section 8 (PW relations to the IF-MIB).

8. New MIB Modules Required for MPLS-TP

This section highlights the new MIB modules that have been identified in Section 6.1 (Gap Analysis) and are required for MPLS-TP. This section also provides an overview of the following:

- the MPLS Object Identifier (OID) tree structure and the position of different MPLS related MIB modules on this tree;

- the purpose of each of the MIB modules within the MIB documents, what it can be used for, and how it relates to the other MIB modules.

Note that each new MIB document should contain one or more compliance statements for the modules and objects that it defines. Therefore, the support for the different MIB modules and objects is beyond the scope of this document, although some recommendations are included in the sections that follow.

8.1 MPLS Extension MIB Modules

8.1.1 The MPLS Extension MIB OID Tree

The MPLS Extension MIB OID tree has the following structure.

```
transmission -- RFC 2578 [RFC2578]
  |
  +- mplsStdMIB
       |
       +- mplsTCExtStdMIB -- MPLS-TC-EXT-STD-MIB
       |
       +- mplsLsrExrStdMIB -- MPLS-LSR-EXT-STD-MIB
       |
       +- mplsTeExtStdMIB -- MPLS-TE-EXT-STD-MIB
```

Note: The OIDs for MIB modules are yet to be assigned and managed by IANA.

8.1.2 MPLS-TC-EXT-STD-MIB

MPLS-TC-STD-MIB defines textual conventions [RFC2579] that may be common to MPLS-related MIB modules. These conventions allow multiple MIB modules to use the same syntax and format for a concept that is shared between the MIB modules. This MIB is extended to support new textual definitions supporting MPLS-TP networks.

For example, MEP identifier is used to identify ~~maintainence~~maintenance entity group end point within MPLS-TP networks. The textual convention representing the MEP identifier is defined in MPLS-TC-EXT-STD-MIB, which is an extension to MPLS-TC-STD-MIB

All new extensions related to MPLS-TP are defined in this MIB module and will be referenced by other MIB modules to support MPLS-TP.

8.1.3 MPLS-LSR-EXT-STD-MIB

MPLS-LSR-STD-MIB describes managed objects for modeling an MPLS Label Switching Router (LSR). This puts it at the heart of the management architecture for MPLS.

MPLS-LSR-STD-MIB MIB module is used to model and manage the basic label switching behavior of an MPLS LSR. It represents the label forwarding information base (LFIB) of the LSR and provides a view of the LSPs that are being switched by the LSR in question.

Since basic MPLS label switching is common to all MPLS applications, this MIB module is referenced by many of the other MPLS MIB modules.

In general, MPLS-LSR-STD-MIB provides a model of incoming labels on MPLS-enabled interfaces being mapped to outgoing labels on MPLS-enabled interfaces via a conceptual object called an MPLS cross-connect. MPLS cross-connect entries and their properties are represented in MPLS-LSR-STD-MIB and are typically referenced by other MIB modules in order to refer to the underlying MPLS LSP.

In the case of MPLS-TP, the MPLS-LSR-STD-MIB is extended to support the MPLS-TP LSP's, which are bidirectional and co-routed or associated. This extended MIB, MPLS-LSR-EXT-STD-MIB all models of MPLS-TP tunnels.

Comment [KL10]: Editorial: the sentence needs correction.

8.1.4 MPLS-TE-EXT-STD-MIB

MPLS-TE-STD-MIB describes managed objects that are used to model and manage MPLS Traffic Engineered (TE) Tunnels.

This MIB module is based on a table that represents TE tunnels that either originate from, traverse via, or terminate on the LSR in question. The MIB module provides configuration and statistics objects needed for TE tunnels.

MPLS-TP tunnels are much similar to MPLS-TE tunnels, but are bidirectional and could be associated or co-routed. The MPLS-TE-EXT-STD-MIB contains the extensions to support the MPLS-TP specific ~~attributed~~ attributes for the tunnel.

8.2 PWE3 Extension MIB Modules

This section provides an overview of Pseudowire extension mib modules to meet the MPLS based transport network requirements.

8.2.1 Structure of the PWE3 Extension MIB OID Tree

```
mib-2 -- RFC 2578 [RFC2578]
 |
 +-transmission
 |  |
 |  +- pwExtStdMIB -- PW-EXT-STD-MIB
 |
 +- pwMplsExtStdMIB -- PW-MPLS-EXT-STD-MIB
 |
 +- pwTcExtStdMIB -- PW-TC-EXT-STD-MIB
```

Note: The OIDs for MIB modules are yet to be assigned and managed by IANA.

8.2.2 PW-TC-EXT-STD-MIB

PW-TC-STD-MIB MIB defines textual conventions used for pseudowire (PW) technology and for Pseudowire Edge-to-Edge Emulation (PWE3) MIB Modules. PW-TC-EXT-STD-MIB add extensions to PW-TC-STD-MIB to support textual definitions for MPLS-TP specific Pseudowire attributes.

8.2.3 PW-EXT-STD-MIB

PW-STD-MIB describes managed objects for modeling of Pseudowire Edge-to-Edge services carried over a general Packet Switched Network. This MIB module is extended as PW-EXT-STD-MIB to support MPLS-TP specific attributes related to Pseudowires.

8.2.4 PW-MPLS-EXT-STD-MIB

PW-MPLS-STD-MIB defines the managed objects for Pseudowire operations over MPLS LSR's. This MIB supports both, manual and dynamically signaled PW's, point-to-point connections, enables the use of any emulated service, MPLS-TE as outer tunnel and no outer tunnel as MPLS-TE.

The newly extended MIB, PW-MPLS-EXT-STD-MIB defines the managed objects, extending PW-MPLS-STD-MIB, by supporting with or without MPLS-TP as outer tunnel.

8.3 OAM MIB Modules

This section provides an overview of Operations, Administration, and Maintenance (OAM) mib modules for MPLS LSPs and Pseudowires.

8.3.1 Structure of the OAM Extension MIB OID Tree

```
mib-2 -- RFC 2578 [RFC2578]
   |
   +-transmission
      |
      +- mplsLspPingStdMIB -- MPLS-LSPPING-STD-MIB
      |
      +- mplsBfdStdMIB -- MPLS-BFD-STD-MIB
      |
      +- mplsOamStdMIB -- MPLS-OAM-STD-MIB
```

Note: The OIDs for MIB modules are yet to be assigned and managed by IANA.

8.3.2 MPLS-LSPPING-STD-MIB

LSP ping is defined in RFC4379 to validate data plane consistency of MPLS LSP's. It defines how LSP ping and Trace could be performed across MPLS networks to identify and diagnose faults within MPLS networks. This OAM functionality is performed on demand basis for verification purposes.

MPLS-LSPPING-STD-MIB defines managed objects for modeling LSP ping protocol. It allows user to perform on demand operations based on RFC4379. The managed objects to support LSP ping for MPLS-TP is based on draft-ietf-mpls-tp-lsp-ping-bfd-procedures-01.

For example, a MPLS-TP tunnel LSP is to be pinged, a SNMP request issued using the MIB for the tunnel in test. The results for the operation could be queried using the managed objects defined in the MIB module.

8.3.3 MPLS-BFD-STD-MIB

BFD-STD-MIB defines managed objects for performing BFD operation in IP networks. This MIB is modeled to support BFD protocol RFC5880. MPLS-BFD-STD-MIB is an extension to BFD-STD-MIB managed objects to support BFD operations on MPLS LSP's. The new MPLS-TP managed objects for BFD are based on draft-ietf-mpls-tp-lsp-ping-bfd-procedures-01.

8.3.4 MPLS-OAM-STD-MIB

MPLS-OAM-STD-MIB defined managed objects for OAM maintenance identifiers i.e. Maintenance Entity Group Identifiers (MEG), Maintenance Entity Group End-point (MEP), Maintenance Entity Group Intermediate Point (MIP). Maintenance points are uniquely associated with a MEG. Within the context of a MEG, MEPs and MIPs must be uniquely identified.

8.4. Protection Switching MIB Modules

This section provides an overview of protection switching mib modules for MPLS LSPs and Pseudowires.

8.4.1 Structure of the MPLS Protection Switching MIB OID Tree

```
 mib-2 -- RFC 2578 [RFC2578]
  |
  +-transmission
     |
     +- mplsLpsStdMIB -- MPLS-LPS-STD-MIB
     |
     +- mplsRpsStdMIB -- MPLS-RPS-STD-MIB
     |
     +- mplsMpsStdMIB -- MPLS-MPS-STD-MIB
```

Note: The OIDs for MIB modules are yet to be assigned and managed by IANA.

8.4.2 MPLS-LPS-STD-MIB

MPLS-LPS-STD-MIB defined managed objects for linear protection switching of MPLS LSPs and Pseudowires.

8.4.3 MPLS-RPS-STD-MIB

MPLS-RPS-STD-MIB defined managed objects for ring protection switching of MPLS LSPs and Pseudowires.

8.4.4 MPLS-MPS-STD-MIB

MPLS-MPS-STD-MIB defined managed objects for Mesh protection switching of MPLS LSPs and Pseudowires.

9. Management Options

It is not the intention of this document to provide instructions or advice to implementers of management systems, management agents, or managed entities. It is, however, useful to make some observations about how the MIB modules described above might be used to manage MPLS systems, if SNMP is used in the management interface.

Comment [KL11]: Text added to clarify that the scope.

For MPLS specific management options, refer [RFC4221] Section 12 (Management Options).

[Editors Note: MPLS-TP specific management gaps and options will be documented in this document and will be referenced here.]

10. Security Considerations

This document describes the interrelationships amongst the different MIB modules relevant to MPLS-TP management and as such does not have any security implications in and of itself.

Each IETF MIB document that specifies MIB objects for MPLS-TP must provide a proper security considerations section that explains the security aspects of those objects.

The attention of readers is particularly drawn to the security implications of making MIB objects available for create or write access through an access protocol such as SNMP. SNMPv1 by itself is an insecure environment. Even if the network itself is made secure (for example, by using IPSec), there is no control over who on the secure network is allowed to access the objects in this MIB. It is recommended that the implementers consider the security features as provided by the SNMPv3 framework. Specifically, the use of the User-based Security Model STD 62, RFC3414 [RFC3414], and the View-based Access Control Model STD 62, RFC 3415 [RFC3415], is recommended.

It is then a customer/user responsibility to ensure that the SNMP entity giving access to an instance of each MIB module is properly configured to give access to only those objects, and to those principals (users) that have legitimate rights to access them.

11. IANA Considerations

This document makes no requests for IANA action.

12. Acknowledgements

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