Network Working Group
INTERNET-DRAFT
Intended Status: Standards Track
Expires: December 20, 2013

Sam Aldrin
Huawei Technologies
M.Venkatesan
Dell Inc.
Kannan KV Sampath
Redeem
Thomas D. Nadeau
Juniper Networks

June 18, 2013

MPLS-TP Operations, Administration, and Management (OAM) Identifiers Management Information Base (MIB) draft-ietf-mpls-tp-oam-id-mib-03

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 Operations, Administration, and Management (OAM) identifiers related managed objects for Multiprotocol Label Switching (MPLS) based Transport Profile (TP).

Status of this Memo

This Internet-Draft is submitted to IETF in full conformance with the provisions of BCP 78 and BCP 79.

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

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

The list of current Internet-Drafts can be accessed at http://www.ietf.org/ietf/1id-abstracts.txt.

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

This Internet-Draft will expire on December 20, 2013.

Table of Contents

1 Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects for modeling a Multiprotocol Label Switching (MPLS) [RFC3031] based transport profile.

This MIB module should be used for performing the OAM operations for MPLS LSPs, Pseudowires and Sections.

2. 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 RFC3410 [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, RFC2578, STD 58, RFC2579 and STD58, RFC2580.

3. Overview

3.1 Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC-2119 [RFC2119].

3.2 Terminology

This document uses terminology from the Multiprotocol Label Switching Architecture [RFC3031], Multiprotocol Label Switching (MPLS) Traffic Engineering (TE)Management Information Base (MIB)[RFC3812], Multiprotocol Label Switching (MPLS) Label Switching Router (LSR) Management Information Base (MIB)[RFC3813], Operations, Administration, and Maintenance Framework for MPLS-Based Transport Networks [RFC6371], MPLS Transport Profile (MPLS-TP) Identifiers [RFC6370], MPLS-TP Identifiers Following ITU-T Conventions [RFC6923], and OAM in MPLS Transport Networks [RFC5860].

3.3 Acronyms

ICC: ITU Carrier Code
IP: Internet Protocol

LSP: Label Switching Path
LSR: Label Switching Router
MIB: Management Information Base
ME: Maintenance Entity
MEG: Maintenance Entity Group
MEP: Maintenance Entity Group End Point
MIP: Maintenance Entity Group Intermediate Point
MPLS: Multi-Protocol Label Switching
MPLS-TP: MPLS Transport Profile
PW: Pseudowire
TE: Traffic Engineering
TP: Transport Profile

4. Feature List

The MPLS transport profile OAM identifiers MIB module is designed to satisfy the following requirements and constraints:

- The MIB module supports configuration of OAM identifiers for point-to-point, co-routed bidirectional, associated bidirectional MPLS tunnels and MPLS Pseudowires.

5. Brief description of MIB Objects

The objects described in this section support the functionality described in documents [RFC5654] and [RFC6370]. The tables support both IP compatible and ICC based OAM identifiers configurations for MPLS Tunnels and Pseudowires.

5.1. mplsOamIdMegTable

The mplsOamIdMegTable is used to manage one or more Maintenance Entities (MEs) that belongs to the same transport path.

When a new entry is created with mplsOamIdMegOperatorType set to ipCompatible (1), then as per [RFC6370] (MEG_ID for LSP is LSP_ID and MEG_ID for PW is PW_Path_ID), MEP_ID can be automatically formed.

For ICC based transport path, the user is expected to configure the ICC identifier explicitly in this table for MPLS tunnels and pseudowires.

5.2. mplsOamIdMeTable

The mplsOamIdMeTable defines a relationship between two points (source and sink) of a transport path to which maintenance and monitoring operations apply. The two points that define a maintenance entity are called Maintenance Entity Group End Points (MEPs).

In between MEPs, there are zero or more intermediate points, called Maintenance Entity Group Intermediate Points (MIPs). MEPs and MIPs are associated with the MEG and can be shared by more than one ME in a MEG.

6. MPLS OAM identifier configuration for MPLS tunnel example

In this section, we provide an example of the OAM identifier configuration for an MPLS co-routed bidirectional tunnel.

This example provides usage of a MEG and ME tables for management and monitoring operations of an MPLS tunnel.

This example considers the OAM identifiers configuration on a head-end LSR to manage and monitor a MPLS tunnel.
Only relevant objects which are applicable for IP based OAM identifiers of co-routed MPLS tunnel are illustrated here.

In mplsOamIdMegTable:

```
{
  -- MEG index (Index to the table)
  mplsOamIdMegIndex                = 1,
  mplsOamIdMegName                 = "MEG1",
  mplsOamIdMegOperatorType         = ipCompatible (1),
  mplsOamIdMegServicePointerType   = lsp (1),
  mplsOamIdMegMpLocation           = perNode(1),
-- Mandatory parameters needed to activate the row go here
  mplsOamIdMegRowStatus            = createAndGo (4),
  mplsOamIdMegPathFlow
                       = coRoutedBidirectionalPointToPoint (2)
}
```

This will create an entry in the mplsOamIdMegTable to manage and monitor the MPLS tunnel.

The following ME table is used to associate the path information to a MEG.

```
In mplsOamIdMeTable:

{
-- ME index (Index to the table)
 mplsOamIdMeIndex                 = 1,

-- MP index (Index to the table)
 mplsOamIdMeMpIndex               = 1,
 mplsOamIdMeName                  = "ME1",
 mplsOamIdMeMpIfIndex             = 0,
 -- Source MEP id is derived from the IP compatible MPLS tunnel
 mplsOamIdMeSourceMepIndex        = 0,
 -- Source MEP id is derived from the IP compatible MPLS tunnel
 mplsOamIdMeSinkMepIndex          = 0,
 mplsOamIdMeMpType                = mep (1),
 mplsOamIdMeMepDirection          = down (2),
 mplsOamIdMeProactiveOamPhbTCValue = 0,
 mplsOamIdMeOnDemandOamPhbTCValue  = 0,
--  RowPointer MUST point to the first accessible column of an
--  MPLS tunnel
 mplsOamIdMeServicePointer        = mplsTunnelName.1.1.10.20,
-- Mandatory parameters needed to activate the row go here
 mplsOamIdMeRowStatus             = createAndGo (4)
}
```

7. MPLS OAM Identifiers MIB definitions

```
MPLS-OAM-ID-STD-MIB DEFINITIONS ::= BEGIN

    IMPORTS
       MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
       Unsigned32, zeroDotZero
          FROM SNMPv2-SMI                   -- [RFC2578]
       MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
          FROM SNMPv2-CONF                  -- [RFC2580]
       RowStatus, RowPointer, StorageType,
       TEXTUAL-CONVENTION
          FROM SNMPv2-TC                    -- [RFC2579]
       SnmpAdminString
          FROM SNMP-FRAMEWORK-MIB           -- [RFC3411]
       IndexIntegerNextFree
          FROM DIFFSERV-MIB                 -- [RFC3289]
       mplsStdMIB
          FROM MPLS-TC-STD-MIB              -- [RFC3811]
       InterfaceIndexOrZero, ifGeneralInformationGroup,
       ifCounterDiscontinuityGroup
          FROM IF-MIB;                      -- [RFC2863]
```

```
      mplsOamIdStdMIB MODULE-IDENTITY
         LAST-UPDATED
            "201306180000Z" -- June 18, 2013
         ORGANIZATION
            "Multiprotocol Label Switching (MPLS) Working Group"
         CONTACT-INFO
            "
                   Sam Aldrin
                   Huawei Technologies, co.
                   2330 Central Express Way,

                   Santa Clara, CA 95051, USA
            Email:  aldrin.ietf@gmail.com

                  Thomas D. Nadeau
                  Juniper Networks
                  10 Technology Park Drive,
                  Westford, MA 01886
            Email: tnadeau@juniper.net

                  Venkatesan Mahalingam
                  Dell Inc.
                  350 Holger way, San Jose, CA, USA
            Email: venkat.mahalingams@gmail.com

                  Kannan KV Sampath
                  Redeem,
                  India
            Email: kannankvs@gmail.com


                  Ping Pan
                  Infinera
            Email: ppan@infinera.com

                  Sami Boutros
                  Cisco Systems, Inc.
                  3750 Cisco Way
                  San Jose, California 95134
                  USA
            Email: sboutros@cisco.com

           "
         DESCRIPTION
             "Copyright (c) 2013 IETF Trust and the persons identified
              as the document authors.  All rights reserved.

              This MIB module contains generic object definitions for
```

```
            MPLS OAM maintenance identifiers."

         -- Revision history.

         REVISION
            "201306180000Z" -- June 18, 2013
         DESCRIPTION
              "MPLS OAM Identifiers MIB objects for LSPs and
               Pseudowires"

         ::= { mplsStdMIB xxx } -- xxx to be replaced with the correct
                                -- OID value assigned by
                                -- IANA (see section 9).

         -- TEXTUAL-CONVENTIONs

         MplsOamPhbTCValue ::= TEXTUAL-CONVENTION
            STATUS              current
            DESCRIPTION
                "This is the Per-hop Behavior (PHB) traffic class values
                 for the MPLS OAM operations."
            SYNTAX        INTEGER {
                            be (1),
                            af1 (2),
                            af2 (3),
                            af3 (4),
                            af4 (5),
                            ef (6),
                            cs6 (7),
                            cs7 (8)
                          }

      -- Top level components of this MIB module.

      -- notifications
      mplsOamIdNotifications
                  OBJECT IDENTIFIER ::= { mplsOamIdStdMIB 0 }
      -- tables, scalars
      mplsOamIdObjects  OBJECT IDENTIFIER ::= { mplsOamIdStdMIB 1 }
      -- conformance
      mplsOamIdConformance
                  OBJECT IDENTIFIER ::= { mplsOamIdStdMIB 2 }

       -- Start of MPLS Transport Profile MEG table

      mplsOamIdMegIndexNext OBJECT-TYPE
            SYNTAX        IndexIntegerNextFree (0..4294967295)
            MAX-ACCESS    read-only
```

```
            STATUS       current
            DESCRIPTION
                "This object contains an unused value for
                 mplsOamIdMegIndex, or a zero to indicate
                 that none exist. Negative values are not allowed,
                 as they do not correspond to valid values of
                 mplsOamIdMegIndex."
        ::= { mplsOamIdObjects 1 }
        mplsOamIdMegTable OBJECT-TYPE
         SYNTAX        SEQUENCE OF MplsOamIdMegEntry
         MAX-ACCESS    not-accessible
         STATUS        current
         DESCRIPTION
               "This table contains information about the Maintenance
                Entity Groups (MEG).

                MEG as mentioned in MPLS-TP OAM framework defines a set
                of one or more maintenance entities (ME).
                Maintenance Entities define a relationship between any
                two points of a transport path in an OAM domain to which
                maintenance and monitoring operations apply."
         ::= { mplsOamIdObjects 2 }

        mplsOamIdMegEntry OBJECT-TYPE
         SYNTAX        MplsOamIdMegEntry
         MAX-ACCESS    not-accessible
         STATUS        current
         DESCRIPTION
               "An entry in this table represents MPLS-TP MEG.
                An entry can be created by a network administrator
                or by an SNMP agent as instructed by an MPLS-TP OAM
                Framework.

                When a new entry is created with
                mplsOamIdMegOperatorType set to ipCompatible (1),
                then as per [RFC6370] (MEG_ID for LSP is LSP_ID and
                MEG_ID for PW is PW_Path_ID), MEP_ID can be
                automatically formed.

                For co-routed bidirectional LSP, MEG_ID is
                A1-{Global_ID::Node_ID::Tunnel_Num}::Z9-{Global_ID::
                Node_ID::Tunnel_Num}::LSP_Num.

                For associated bidirectional LSP, MEG_ID is A1-
                {Global_ID::Node_ID::Tunnel_Num::LSP_Num}:: Z9-
                {Global_ID::Node_ID::Tunnel_Num::LSP_Num}

                For LSP, MEP_ID is formed using,
```

```
            Global_ID::Node_ID::Tunnel_Num::LSP_Num

            For PW, MEG_ID is formed using AGI::A1-
            {Global_ID::Node_ID::AC_ID}:: Z9-
            {Global_ID::Node_ID::AC_ID}.

            For PW, MEP_ID is formed using
            AGI::Global_ID::Node_ID::AC_ID

            MEP_ID is retrieved from the mplsOamIdMegServicePointer
            object based on the mplsOamIdMegServicePointerType value.
            ICC MEG_ID for LSP and PW is formed using the objects
            mplsOamIdMegIdIcc and mplsOamIdMegIdUmc.

            MEP_ID can be formed using MEG_ID::MEP_Index."
        REFERENCE
            "1. RFC5860, Requirements for OAM in MPLS Transport
                Networks, May 2010.
             2. RFC6371, Operations, Administration, and Maintenance
                Framework for MPLS-Based Transport Networks,
                September 2011 Section 3.
             3. RFC6370, MPLS Transport Profile (MPLS-TP) Identifiers.
             4. RFC6923, MPLS Transport Profile (MPLS-TP) Identifiers
                Following ITU-T Conventions."
        INDEX { mplsOamIdMegIndex }
        ::= { mplsOamIdMegTable 1 }

        MplsOamIdMegEntry ::= SEQUENCE {
             mplsOamIdMegIndex            Unsigned32,
             mplsOamIdMegName             SnmpAdminString,
             mplsOamIdMegOperatorType     INTEGER,
             mplsOamIdMegIdCc             SnmpAdminString,
             mplsOamIdMegIdIcc            SnmpAdminString,
             mplsOamIdMegIdUmc            SnmpAdminString,
             mplsOamIdMegServicePointerType      INTEGER,
             mplsOamIdMegMpLocation       INTEGER,
             mplsOamIdMegPathFlow         INTEGER,
             mplsOamIdMegOperStatus       INTEGER,
             mplsOamIdMegSubOperStatus    BITS,
             mplsOamIdMegRowStatus        RowStatus,
             mplsOamIdMegStorageType      StorageType
        }

        mplsOamIdMegIndex  OBJECT-TYPE
           SYNTAX        Unsigned32 (1..4294967295)
           MAX-ACCESS    not-accessible
           STATUS        current
           DESCRIPTION
```

```
            "Index for the conceptual row identifying a MEG within
             this MEG table. Managers should obtain new values for row
             creation in this table by reading
             mplsOamIdMegIndexNext."
        ::= { mplsOamIdMegEntry 1 }

        mplsOamIdMegName  OBJECT-TYPE
           SYNTAX        SnmpAdminString (SIZE(0..48))
           MAX-ACCESS    read-create
           STATUS        current
           DESCRIPTION
               "Each Maintenance Entity Group has unique name amongst
                all those used or available to a service provider or
                operator. It facilitates easy identification of
                administrative responsibility for each MEG."
           ::= { mplsOamIdMegEntry 2 }

        mplsOamIdMegOperatorType OBJECT-TYPE
           SYNTAX        INTEGER {
                             ipCompatible (1),

                             iccBased (2)
                         }
           MAX-ACCESS    read-create
           STATUS        current
           DESCRIPTION
               "Indicates the operator type for MEG. Conceptual rows
                having 'iccBased' as operator type, MUST have valid
                values for the objects mplsOamIdMegIdIcc and
                mplsOamIdMegIdUmc when the row status is active."
           REFERENCE
               "1. RFC6370, MPLS Transport Profile (MPLS-TP)
                   Identifiers.
                2. RFC6923, MPLS Transport Profile (MPLS-TP) Identifiers
                   Following ITU-T Conventions. Section 3.1"
           DEFVAL { ipCompatible }
           ::= { mplsOamIdMegEntry 3 }

        mplsOamIdMegIdCc OBJECT-TYPE
           SYNTAX      SnmpAdminString (SIZE(0..2))
           MAX-ACCESS  read-create
           STATUS      current
           DESCRIPTION
             "Global uniqueness is assured by concatenating the ICC
              with a Country Code (CC).  The Country Code (alpha-2)
              is a string of two alphabetic characters represented
              with upper case letters (i.e., A-Z).
```

```
            This object MUST contain a non-null ICC value if
            the MplsOamIdMegOperatorType value is iccBased(2),
            otherwise a null ICC value with octet size 0
            should be assigned."
        REFERENCE
           "RFC6923, MPLS Transport Profile (MPLS-TP) Identifiers
            Following ITU-T Conventions. Section 3."
        DEFVAL {""}
        ::= { mplsOamIdMegEntry 4 }


        mplsOamIdMegIdIcc OBJECT-TYPE
           SYNTAX      SnmpAdminString (SIZE(0..6))
           MAX-ACCESS  read-create
           STATUS      current
           DESCRIPTION
             "Unique code assigned to Network Operator or Service
              Provider maintained by ITU-T. The ITU Carrier Code
              used to form MEGID.

              This object MUST contain a non-null ICC value if
              the MplsOamIdMegOperatorType value is iccBased(2),
              otherwise a null ICC value with octet size 0
              should be assigned."
        REFERENCE
           "RFC6923, MPLS Transport Profile (MPLS-TP) Identifiers
            Following ITU-T Conventions. Section 3.1."
        DEFVAL {""}
        ::= { mplsOamIdMegEntry 5 }

        mplsOamIdMegIdUmc OBJECT-TYPE
           SYNTAX      SnmpAdminString (SIZE(0..7))
           MAX-ACCESS  read-create
           STATUS      current
           DESCRIPTION
             "Unique code assigned by Network Operator or Service
              Provider and is appended to mplsOamIdMegIdIcc to form
              the MEGID.
              This object MUST contain a non-null ICC value if
              the MplsOamIdMegOperatorType value is iccBased(2),
              otherwise a null ICC value with octet size 0
              should be assigned."
           REFERENCE
              "RFC6923, MPLS Transport Profile (MPLS-TP) Identifiers
               Following ITU-T Conventions. Section 7.1."
           DEFVAL {""}
           ::= { mplsOamIdMegEntry 6 }
```

```
      mplsOamIdMegServicePointerType OBJECT-TYPE

         SYNTAX        INTEGER {
                           lsp (1),
                           pseudowire (2),
                           section (3)
                       }
         MAX-ACCESS    read-create
         STATUS        current
         DESCRIPTION
           "Indicates the service type for the MEG.
            If the service type indicates lsp, the service pointer
            in mplsOamIdMeTable points to an entry in
            the mplsTunnelTable [RFC3812].

            If the value is pseudowire service type, the service
            pointer in mplsOamIdMeTable points to an entry in
            the pwTable [RFC5601].

            If the value is section service type, the service
            pointer in mplsOamIdMeTable points to an entry in
            the mplsTunnelTable [RFC3812]."
            REFERENCE
                "1. Multiprotocol Label Switching (MPLS) Traffic
                    Engineering (TE) Management Information
                    Base (MIB), Srinivasan, et al, RFC 3812, June 2004
                 2. Pseudowire (PW) Management Information Base (MIB),
                    Nadeau & Zelig, RFC 5601, July 2009."
            DEFVAL { lsp }
            ::= { mplsOamIdMegEntry 7 }

      mplsOamIdMegMpLocation OBJECT-TYPE
         SYNTAX        INTEGER {

                           perNode (1),
                           perInterface (2)
                       }
         MAX-ACCESS    read-create
         STATUS        current
         DESCRIPTION
           "Indicates the MP location type for this MEG.

            If the value is perNode, then the MEG in the LSR supports
            only perNode MEP/MIP, i.e., only one MEP/MIP in an LSR.

            If the value is perInterface, then the MEG in the LSR
            supports perInterface MEPs/MIPs, i.e., two MEPs/MIPs in
            an LSR."
```

```
          REFERENCE
            "RFC 6371, Operations, Administration, and Maintenance
             Framework for MPLS-Based Transport Networks,
             September 2011."
          DEFVAL { perNode }
          ::= { mplsOamIdMegEntry 8 }

       mplsOamIdMegPathFlow OBJECT-TYPE
          SYNTAX        INTEGER {
                          unidirectionalPointToPoint (1),
                          coRoutedBidirectionalPointToPoint (2),
                          associatedBidirectionalPointToPoint (3),
                          unidirectionalPointToMultiPoint (4)
                        }
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
         "Indicates the transport path flow for this MEG.
          In case of a unidirectional point-to-point transport path,
          a single unidirectional Maintenance Entity is defined to
          monitor it.
          In case of associated bidirectional point-to-point transport
          paths, two independent unidirectional Maintenance Entities are
          defined to independently monitor each direction.
          In case of co-routed bidirectional point-to-point transport
          paths, a single bidirectional Maintenance Entity is defined to
          monitor both directions congruently.
          In case of unidirectional point-to-multipoint transport paths,
          a single unidirectional Maintenance Entity for each leaf is
          defined to monitor the transport path from the root to
          that leaf."
       REFERENCE
         "RFC 6371, Operations, Administration, and Maintenance
          Framework for MPLS-Based Transport Networks,
          September 2011."
       DEFVAL { coRoutedBidirectionalPointToPoint }
       ::= { mplsOamIdMegEntry 9 }

       mplsOamIdMegOperStatus OBJECT-TYPE
          SYNTAX       INTEGER {
                         up (1),
                         down (2)
                       }
          MAX-ACCESS   read-only
          STATUS       current
          DESCRIPTION
              "This object specifies the operational status of the
               Maintenance Entity Group (MEG). This object is used to
```

```
            send the notification to the SNMP manager about the MEG.

            The value up (1) indicates that the MEG and its monitored
            path are operationally up. The value down (2) indicates
            that the MEG is operationally down.

            When the value of mplsOamIdMegOperStatus is up(1), all
            the bits of mplsOamIdMegSubOperStatus must be cleared.
            When the value of mplsOamIdMegOperStatus is down(2),
            at least one bit of mplsOamIdMegSubOperStatus must be
            set."
        ::= { mplsOamIdMegEntry 10 }

      mplsOamIdMegSubOperStatus OBJECT-TYPE
         SYNTAX       BITS {
                       megDown (0),
                       meDown (1),
                       oamAppDown (2),
                       pathDown (3)
                      }
         MAX-ACCESS   read-only
         STATUS       current
         DESCRIPTION
             "This object specifies the reason why the MEG operational
              status as mentioned by the object mplsOamIdMegOperStatus
              is down. This object is used to send the notification to
              the SNMP manager about the MEG.

              The bit 0 (megDown) indicates the MEG is down.
              The bit 1 (meDown) indicates the ME table is
              down.
              The bit 2 (oamAppDown) indicates that the
              OAM application has notified that the entity (LSP or PW)
              monitored by this MEG is down. Currently, BFD is the
              only supported OAM application.
              The bit 3 (pathDown) indicates that the underlying
              LSP or PW is down."
         ::= { mplsOamIdMegEntry 11 }

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

            "This variable is used to create, modify, and/or delete
             a row in this table. When a row in this table is in
             active(1) state, no objects in that row can be modified
```

```
            by the agent except mplsOamIdMegRowStatus."
        ::= { mplsOamIdMegEntry 12 }

    mplsOamIdMegStorageType OBJECT-TYPE
        SYNTAX        StorageType
        MAX-ACCESS    read-create
        STATUS        current
        DESCRIPTION
          "This variable indicates the storage type for this
           object.
           Conceptual rows having the value 'permanent'
           need not allow write-access to any columnar
           objects in the row."
         DEFVAL { volatile }
         ::= { mplsOamIdMegEntry 13 }

    -- End of MPLS Transport Profile MEG table


    -- Start of MPLS Transport Profile ME table

    mplsOamIdMeIndexNext OBJECT-TYPE
          SYNTAX        IndexIntegerNextFree (0..4294967295)
          MAX-ACCESS    read-only
          STATUS        current
          DESCRIPTION
              "This object contains an unused value for
               mplsOamIdMeIndex, or a zero to indicate
               that none exist. Negative values are not allowed,
               as they do not correspond to valid values of
               mplsOamIdMeIndex."
    ::= { mplsOamIdObjects 3 }

    mplsOamIdMeMpIndexNext OBJECT-TYPE
          SYNTAX        IndexIntegerNextFree (0..4294967295)
          MAX-ACCESS    read-only
          STATUS        current
          DESCRIPTION
              "This object contains an unused value for
               mplsOamIdMeMpIndex, or a zero to indicate
               that none exist. Negative values are not allowed,
               as they do not correspond to valid values of
               mplsOamIdMeMpIndex."
    ::= { mplsOamIdObjects 4 }

    mplsOamIdMeTable OBJECT-TYPE
     SYNTAX        SEQUENCE OF MplsOamIdMeEntry
     MAX-ACCESS    not-accessible
```

```
        STATUS       current
        DESCRIPTION
              "This table contains MPLS-TP maintenance entity
               information.

               ME is some portion of a transport path that requires
               management bounded by two points (called MEPs), and the
               relationship between those points to which maintenance
               and monitoring operations apply.

               This table is generic enough to handle MEPs and MIPs
               information within a MEG."
        ::= { mplsOamIdObjects 5 }

      mplsOamIdMeEntry OBJECT-TYPE
        SYNTAX       MplsOamIdMeEntry
        MAX-ACCESS   not-accessible STATUS       current
        DESCRIPTION
             "An entry in this table represents MPLS-TP maintenance
              entity. This entry represents the ME if the source and
              sink MEPs are defined.

              A ME is a p2p entity. One ME has two such MEPs.
              A MEG is a group of one or more MEs. One MEG can have
              two or more MEPs.

              For P2P LSP, one MEG has one ME and this ME is associated
              two MEPs (source and sink MEPs) within a MEG.
              Each mplsOamIdMeIndex value denotes the ME within a MEG.

              In case of unidirectional point-to-point transport paths,
              a single unidirectional Maintenance Entity is defined to
              monitor it and mplsOamIdMeServicePointer points to
              unidirectional point-to-point path.

              In case of associated bidirectional point-to-point
              transport paths, two independent unidirectional
              Maintenance Entities are defined to independently monitor
              each direction and each mplsOamIdMeServicePointer MIB
              object points to unique unidirectional transport path.
              This has implications for transactions that terminate at
              or query a MIP, as a return path from MIP to source MEP
              does not necessarily exist within the MEG.

              In case of co-routed bidirectional point-to-point
              transport paths, a single bidirectional Maintenance Entity
              is defined to monitor both directions congruently and
              mplsOamIdMeServicePointer MIB object points to co-routed
```

```
            bidirectional point-to-point transport path.

            In case of unidirectional point-to-multipoint transport
            paths, a single unidirectional Maintenance entity for each
            leaf is defined to monitor the transport path from the
            root to that leaf and each leaf has different transport
            path information in mplsOamIdMeServicePointer MIB object.
            Note that the MplsOamIdMeEntry should be created manually
            once the MEG is configured for OAM operations."
            INDEX { mplsOamIdMegIndex,
                    mplsOamIdMeIndex,
                    mplsOamIdMeMpIndex
                  }
            ::= { mplsOamIdMeTable 1 }

         MplsOamIdMeEntry ::= SEQUENCE {
              mplsOamIdMeIndex                 Unsigned32,
              mplsOamIdMeMpIndex               Unsigned32,
              mplsOamIdMeName                  SnmpAdminString,
              mplsOamIdMeMpIfIndex             InterfaceIndexOrZero,
              mplsOamIdMeSourceMepIndex        Unsigned32,
              mplsOamIdMeSinkMepIndex          Unsigned32,
              mplsOamIdMeMpType                INTEGER,
              mplsOamIdMeMepDirection          INTEGER,
              mplsOamIdMeProactiveOamPhbTCValue MplsOamPhbTCValue,
              mplsOamIdMeOnDemandOamPhbTCValue  MplsOamPhbTCValue,
              mplsOamIdMeServicePointer        RowPointer,
              mplsOamIdMeRowStatus             RowStatus,
              mplsOamIdMeStorageType           StorageType
         }

         mplsOamIdMeIndex  OBJECT-TYPE
            SYNTAX        Unsigned32 (1..4294967295)
            MAX-ACCESS    not-accessible
            STATUS        current
            DESCRIPTION
              "Uniquely identifies a maintenance entity index within
               a MEG. Managers should obtain new values for row
               creation in this table by reading
               mplsOamIdMeIndexNext."
            ::= { mplsOamIdMeEntry 1 }

         mplsOamIdMeMpIndex  OBJECT-TYPE

            SYNTAX        Unsigned32 (1..4294967295)
            MAX-ACCESS    not-accessible
            STATUS        current
            DESCRIPTION
```

```
            "Indicates the maintenance point index, used to create
             multiple MEPs in a node of single ME. The value of this
             object can be MEP index or MIP index. Managers should
             obtain new values for row creation in this table by reading
             mplsOamIdMeMpIndexNext."
          ::= { mplsOamIdMeEntry 2 }

       mplsOamIdMeName  OBJECT-TYPE
          SYNTAX        SnmpAdminString (SIZE(1..48))
          MAX-ACCESS    read-create
          STATUS        current
          DESCRIPTION
              "This object denotes the ME name, each
               Maintenance Entity has unique name within MEG."
          ::= { mplsOamIdMeEntry 3 }

       mplsOamIdMeMpIfIndex OBJECT-TYPE
          SYNTAX        InterfaceIndexOrZero
          MAX-ACCESS    read-create
          STATUS        current
          DESCRIPTION
            "Indicates the maintenance point interface.
             If the mplsOamIdMegMpLocation object value
             is perNode (1), the MP interface index should point
             to incoming interface or outgoing interface or
             zero (indicates the MP OAM packets are initiated
             from forwarding engine).

             If the mplsOamIdMegMpLocation object value is
             perInterface (2), the MP interface index should point to
             incoming interface or outgoing interface."
          REFERENCE
            "RFC 6371, Operations, Administration, and Maintenance
             Framework for MPLS-Based Transport Networks,
             September 2011.
             RFC 2863 - The Interfaces Group MIB, McCloghrie, K.,
             and F. Kastenholtz, June 2000."
          DEFVAL { 0 }
          ::= { mplsOamIdMeEntry 4 }

       mplsOamIdMeSourceMepIndex  OBJECT-TYPE
          SYNTAX        Unsigned32
          MAX-ACCESS    read-create
          STATUS        current
          DESCRIPTION
            "Indicates the source MEP Index of the ME. This object
             should be configured if mplsOamIdMegOperatorType object
             in the mplsOamIdMegEntry is configured as iccBased (2).
```

```
            If the MEG is configured for IP based operator,
            the value of this object should be set zero and the MEP
            ID will be automatically derived from the service
            Identifiers(MPLS-TP LSP/PW Identifier)."
         DEFVAL { 0 }
         ::= { mplsOamIdMeEntry 5 }


      mplsOamIdMeSinkMepIndex  OBJECT-TYPE
         SYNTAX        Unsigned32
         MAX-ACCESS    read-create
         STATUS        current
         DESCRIPTION
           "Indicates the sink MEP Index of the ME. This object
            should be configured if mplsOamIdMegOperatorType object
            in the mplsOamIdMegEntry is configured as iccBased (2).
            If the MEG is configured for IP based operator,
            the value of this object should be set zero and the MEP
            ID will be automatically derived from the service
            Identifiers(MPLS-TP LSP/PW Identifier)."
         DEFVAL { 0 }
         ::= { mplsOamIdMeEntry 6 }

      mplsOamIdMeMpType OBJECT-TYPE
         SYNTAX        INTEGER {
                           mep (1),
                           mip (2)
                       }
         MAX-ACCESS    read-create
         STATUS        current
         DESCRIPTION
             "Indicates the maintenance point type within the MEG.

              The object should have the value mep (1),  only in the
              Ingress or Egress nodes of the transport path.

              The object can have the value mip (2),
              in the intermediate nodes and possibly in the end nodes
              of the transport path."
         DEFVAL { mep }
         ::= { mplsOamIdMeEntry 7 }

      mplsOamIdMeMepDirection OBJECT-TYPE
         SYNTAX        INTEGER {
                           up (1),
                           down (2),
                           notApplicable (3)
                       }
```

```
          MAX-ACCESS    read-create
          STATUS        current
          DESCRIPTION
            "Indicates the direction of the MEP. This object
             should be configured if mplsOamIdMeMpType is

             configured as mep (1) else notApplicable (3) is set."
          DEFVAL { down }
          ::= { mplsOamIdMeEntry 8 }

       mplsOamIdMeProactiveOamPhbTCValue  OBJECT-TYPE
          SYNTAX        MplsOamPhbTCValue
          MAX-ACCESS    read-create
          STATUS        current
          DESCRIPTION
            "Indicates the Per-hop Behavior (PHB) value for this source
             MEP generated proactive traffic."
          DEFVAL { ef }
          ::= { mplsOamIdMeEntry 9 }

      mplsOamIdMeOnDemandOamPhbTCValue  OBJECT-TYPE
          SYNTAX        MplsOamPhbTCValue
          MAX-ACCESS    read-create
          STATUS        current
          DESCRIPTION
            "Indicates the Per-hop Behavior (PHB) value for this
             source MEP generated on-demand traffic."
          DEFVAL { ef }

          ::= { mplsOamIdMeEntry 10 }

       mplsOamIdMeServicePointer OBJECT-TYPE

          SYNTAX        RowPointer
          MAX-ACCESS    read-create
          STATUS        current
          DESCRIPTION
            "This variable represents a pointer to the MPLS-TP
             transport path. This value MUST point at an entry in the
             mplsTunnelEntry if mplsOamIdMegServicePointerType
             is configured as lsp (1) or at an entry in the pwEntry if
             mplsOamIdMegServicePointerType is configured
             as pseudowire (2).

             Note: This service pointer object, is placed in ME table
             instead of MEG table, since it will be useful in case of
             point-to-multipoint, where each ME will point to different
             branches of a P2MP tree."
```

```
         ::= { mplsOamIdMeEntry 11 }

      mplsOamIdMeRowStatus OBJECT-TYPE
         SYNTAX        RowStatus
         MAX-ACCESS    read-create
         STATUS        current
         DESCRIPTION
            "This variable is used to create, modify, and/or
             delete a row in this table.  When a row in this
             table is in active(1) state, no objects in that row
             can be modified by the agent except
             mplsOamIdMeRowStatus."
         ::= { mplsOamIdMeEntry 12 }

      mplsOamIdMeStorageType OBJECT-TYPE
          SYNTAX        StorageType
          MAX-ACCESS    read-create
          STATUS        current
          DESCRIPTION
            "This variable indicates the storage type for this
             object.
             Conceptual rows having the value 'permanent'
             need not allow write-access to any columnar
             objects in the row."
           DEFVAL { volatile }
           ::= { mplsOamIdMeEntry 13 }

      -- End of MPLS Transport Profile ME table

      -- End of MPLS-TP OAM Tables

   -- Notification Definitions of MPLS-TP identifiers

      mplsOamIdDefectCondition NOTIFICATION-TYPE
       OBJECTS      {
                      mplsOamIdMegName,
                      mplsOamIdMeName,
                      mplsOamIdMegOperStatus,
                      mplsOamIdMegSubOperStatus
                    }
       STATUS       current
       DESCRIPTION
           "This notification is sent whenever the operational
            status of MEG is changed."
       ::= { mplsOamIdNotifications 1 }

   -- End of Notifications.
```

```
   -- Module Compliance.


   mplsOamIdCompliances
      OBJECT IDENTIFIER ::= { mplsOamIdConformance 1 }

   mplsOamIdGroups
      OBJECT IDENTIFIER ::= { mplsOamIdConformance 2 }

   -- Compliance requirement for fully compliant implementations.

   mplsOamIdModuleFullCompliance MODULE-COMPLIANCE
      STATUS       current
      DESCRIPTION "Compliance statement for agents that provide full
                   support for MPLS-TP-OAM-STD-MIB. Such devices can
                   then be monitored and also be configured using
                   this MIB module."

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

      MODULE -- This module.
      MANDATORY-GROUPS {
            mplsOamIdMegGroup,
            mplsOamIdMeGroup
      }

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

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

      ::= { mplsOamIdCompliances 1 }

   -- Units of conformance.

   mplsOamIdMegGroup OBJECT-GROUP
      OBJECTS {
         mplsOamIdMegIndexNext,
         mplsOamIdMegName,
```

```
        mplsOamIdMegOperatorType,
        mplsOamIdMegIdCc,
        mplsOamIdMegIdIcc,
        mplsOamIdMegIdUmc,
        mplsOamIdMegServicePointerType,
        mplsOamIdMegMpLocation,
        mplsOamIdMegOperStatus,
        mplsOamIdMegSubOperStatus,
        mplsOamIdMegPathFlow,
        mplsOamIdMegRowStatus,
        mplsOamIdMegStorageType
     }

     STATUS  current
     DESCRIPTION
            "Collection of objects needed for MPLS MEG information."
     ::= { mplsOamIdGroups 1 }

   mplsOamIdMeGroup  OBJECT-GROUP
     OBJECTS {
        mplsOamIdMeIndexNext,
        mplsOamIdMeMpIndexNext,
        mplsOamIdMeName,
        mplsOamIdMeMpIfIndex,
        mplsOamIdMeSourceMepIndex,
        mplsOamIdMeSinkMepIndex,
        mplsOamIdMeMpType,
        mplsOamIdMeMepDirection,
        mplsOamIdMeProactiveOamPhbTCValue,
        mplsOamIdMeOnDemandOamPhbTCValue,
        mplsOamIdMeServicePointer,
        mplsOamIdMeRowStatus,
        mplsOamIdMeStorageType
     }
     STATUS  current
     DESCRIPTION
            "Collection of objects needed for MPLS ME information."
     ::= { mplsOamIdGroups 2 }

   mplsOamIdNotificationObjectsGroup  OBJECT-GROUP
     OBJECTS {

        mplsOamIdMegOperStatus,

        mplsOamIdMegSubOperStatus
     }
     STATUS  current
     DESCRIPTION
```

```
            "Collection of objects needed to implement notifications."
      ::= { mplsOamIdGroups 3 }

   mplsOamIdNotificationGroup NOTIFICATION-GROUP
      NOTIFICATIONS {
          mplsOamIdDefectCondition
      }
      STATUS  current
      DESCRIPTION
            "Set of notifications implemented in this module."
      ::= { mplsOamIdGroups 4 }

   END
```

8. Security Consideration

There is a number of management objects defined in this MIB module that has a MAX-ACCESS clause of 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.

Some of the readable objects in this MIB module (i.e., objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP. These are the tables and objects and their sensitivity/vulnerability:

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec), even then, there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [RFC3410], section 8), including full supports 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 principles (users) that have legitimate

rights to indeed GET or SET (change/create/delete) them.

9. IANA Considerations

IANA is requested to assign an OID for the MIB module from the "MIB Transmission Group - MPLS STD" sub-registry of the "Internet-standard MIB - Transmission Group" registry for the MPLS-TP OAM ID MIB module specified in this document.

10. References

10.1 Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC2578] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.

[RFC2579] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Textual Conventions for SMIv2", STD 58, RFC 2579, April 1999.

[RFC2580] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Conformance Statements for SMIv2", STD 58, RFC 2580, April 1999.

[RFC2863] McCloghrie, K. and F. Kastenholtz, "The Interfaces Group MIB ", RFC 2863, June 2000

[RFC3031] Rosen, E., Viswanathan, A., and R. Callon, "Multiprotocol Label Switching Architecture", RFC 3031, January 2001.

[RFC3289] Baker, F., Chan, K., and A. Smith, "Management Information Base for the Differentiated Services Architecture", RFC 3289, May 2002.

[RFC3411] Harrington, D., Presuhn, R., and B. Wijnen, "An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks", STD 62, RFC 3411, December 2002.

[RFC5601] Zelig, D., Ed., and T. Nadeau, Ed., "Pseudowire (PW) Management Information Base (MIB)", RFC 5601, July 2009.

10.2 Informative References

[RFC3410] J. Case, R. Mundy, D. pertain, B.Stewart, "Introduction and Applicability Statement for Internet Standard Management Framework", RFC 3410, December 2002.

[RFC3811] Nadeau, T., Ed., and J. Cucchiara, Ed., "Definitions of Textual Conventions (TCs) for Multiprotocol Label Switching (MPLS) Management", RFC 3811, June 2004.

[RFC3812] Srinivasan, C., Viswanathan, A., and T. Nadeau, "Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB)", RFC 3812, June 2004.

[RFC3813] Srinivasan, C., Viswanathan, A., and T. Nadeau, "Multiprotocol Label Switching (MPLS) Label Switching (LSR) Router Management Information Base (MIB)", RFC 3813, June 2004.

[RFC5654] Niven-Jenkins, B., Ed., Brungard, D., Ed., Betts, M., Ed., Sprecher, N., and S. Ueno, "Requirements of an MPLS Transport Profile", RFC 5654, September 2009.

[RFC6370] Bocci, M., Swallow, G., and E. Gray, "MPLS-TP Identifiers", RFC 6370, September 2011.

[RFC6371] Busi, I., Niven-Jenkins, B., and D. Allan, "MPLS-TP OAM Framework and Overview", RFC 6371, September 2011.

[RFC6923] R. Winter, Ed, E. Gray, Ed., H. van Helvoort, and M. Betts, "MPLS-TP Identifiers Following ITU-T Conventions", RFC 6923, May 2013.

[RFC5860] M. Vigoureux, Ed, D. Ward, Ed, M. Betts, Ed, "OAM in MPLS Transport Networks", RFC 5860, May 2010.

11. Acknowledgments

We wish to thank Muly Ilan, Adrian Farrel, Joan Cucchiara and Weiying Cheng for their valuable comments on this document.

12. Authors' Addresses

Venkatesan Mahalingam
Dell Inc.
350 Holger way, San Jose, CA, USA
Email: venkat.mahalingams@gmail.com

Sam Aldrin

Huawei Technologies, co.
2330 Central Express Way,
Santa Clara, CA 95051, USA
Email: aldrin.ietf@gmail.com

Thomas D. Nadeau
Juniper Networks
10 Technology Park Drive, Westford, MA 01886
Email: tnadeau@juniper.net

Kannan KV Sampath
Redeem,
India
Email: kannankvs@gmail.com

Ping Pan
Infinera
Email: ppan@infinera.com

Sami Boutros
Cisco Systems, Inc.
3750 Cisco Way
San Jose, California 95134
USA
Email: sboutros@cisco.com