Internet Engineering Task Force (IETF)
Request for Comments: 7697
Category: Standards Track
ISSN: 2070-1721

P. Pan
Infinera
S. Aldrin
Google, Inc.
M. Venkatesan
Dell, Inc.
K. Sampath
Redeem
T. Nadeau
Brocade
S. Boutros
VMware, Inc.
January 2016

MPLS Transport Profile (MPLS-TP) Operations, Administration, and Maintenance (OAM) Identifiers Management Information Base (MIB)

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 to configure the Operations, Administration, and Maintenance (OAM) identifiers for Multiprotocol Label Switching (MPLS) and the MPLS-based Transport Profile (TP).

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7697.

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 Transport Profile (TP) based on Multiprotocol Label Switching (MPLS) [RFC3031].

This MIB module should be used for performing the OAM (Operations, Administration, and Maintenance) operations for MPLS Tunnel LSPs (Label Switched Paths), Pseudowires, and Sections.

At the time of this writing, SNMP SET is no longer recommended as a way to configure MPLS networks as was described in [RFC3812]. However, since the MIB modules specified in this document are intended to work in parallel with the MIB modules for MPLS specified in [RFC3812], certain objects defined here are specified with a MAX-ACCESS of read-write or read-create so that specifications of the base tables in [RFC3812] and the new MIB modules in this document are consistent. Although the example described in Section 6 specifies means to configure OAM identifiers for MPLS-TP Tunnels, this should be seen as indicating how the MIB values would be returned in the specified circumstances having been configured by alternative means.

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, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [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], the MPLS Traffic Engineering (TE) MIB [RFC3812], the MPLS Label Switching Router (LSR) MIB [RFC3813], the OAM 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

BFD: Bidirectional Forwarding Detection

ICC: ITU Carrier Code

IP: Internet Protocol

LSP: Label Switched Path

LSR: Label Switching Router

ME: Maintenance Entity

MEG: Maintenance Entity Group

MEP: Maintenance Entity Group End Point

MIB: Management Information Base

MIP: Maintenance Entity Group Intermediate Point

MP: Maintenance Point

MPLS: Multiprotocol 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 MPLS point-to-point Tunnels, point-to-multipoint LSPs, co-routed bidirectional LSPs, associated bidirectional LSPs, and Pseudowires.

5. Brief Description of MIB Objects

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

5.1. mplsOamIdMegTable

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

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

For an ICC-based transport path, the user is expected to configure the ICC identifier explicitly in this table for MPLS Tunnels, LSPs, 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 an ME 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 LSP: Example

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

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

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

In the 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 the mplsOamIdMeTable:

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

-- MP index (Index to the table)
 mplsOamIdMeMpIndex                = 1,
 mplsOamIdMeName                   = "ME1",
 mplsOamIdMeMpIfIndex              = 0,
-- The source MEP ID is derived from the IP-compatible MPLS LSP
 mplsOamIdMeSourceMepIndex         = 0,
-- The sink MEP ID is derived from the IP-compatible MPLS LSP
 mplsOamIdMeSinkMepIndex           = 0,
 mplsOamIdMeMpType                 = mep (1),
 mplsOamIdMeMepDirection           = down (2),
--  RowPointer MUST point to the first accessible column of an
--  MPLS LSP
 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
             FROM SNMPv2-SMI                    -- RFC 2578
          MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
             FROM SNMPv2-CONF                   -- RFC 2580
          RowStatus, RowPointer, StorageType
             FROM SNMPv2-TC                     -- RFC 2579
          SnmpAdminString
             FROM SNMP-FRAMEWORK-MIB            -- RFC 3411
          IndexIntegerNextFree
             FROM DIFFSERV-MIB                  -- RFC 3289
          mplsStdMIB
             FROM MPLS-TC-STD-MIB               -- RFC 3811
          InterfaceIndexOrZero, ifGeneralInformationGroup,
          ifCounterDiscontinuityGroup
             FROM IF-MIB;                       -- RFC 2863

      mplsOamIdStdMIB MODULE-IDENTITY
         LAST-UPDATED
            "201601070000Z" -- January 07, 2016
         ORGANIZATION
            "Multiprotocol Label Switching (MPLS) Working Group"
         CONTACT-INFO
            "Sam Aldrin
             Google, Inc.
             1600 Amphitheatre Parkway
             Mountain View, CA  94043
             USA
             Email: aldrin.ietf@gmail.com

             Thomas D. Nadeau
             Email: tnadeau@lucidvision.com

             Venkatesan Mahalingam
             Dell, Inc.
             5450 Great America Parkway
             Santa Clara, CA  95054
             USA
             Email: venkat.mahalingams@gmail.com
```

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

            Ping Pan
            Infinera

            Sami Boutros
            VMware, Inc.
            3401 Hillview Ave.
            Palo Alto, CA  94304
            USA
            Email: sboutros@vmware.com"

         DESCRIPTION
            "Copyright (c) 2016 IETF Trust and the persons identified
            as authors of the code.  All rights reserved.

            Redistribution and use in source and binary forms, with or
            without modification, is permitted pursuant to, and subject
            to the license terms contained in, the Simplified BSD
            License set forth in Section 4.c of the IETF Trust's
            Legal Provisions Relating to IETF Documents
            (http://trustee.ietf.org/license-info).

            This MIB module contains generic object definitions for
            MPLS OAM identifiers."

         -- Revision history

         REVISION
            "201601070000Z" -- January 07, 2016
         DESCRIPTION
            "MPLS OAM Identifiers MIB objects for Tunnels, LSPs,
            Pseudowires, and Sections."

         ::= { mplsStdMIB 21 }

      -- 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 (MEGs).

            A MEG, as mentioned in the MPLS-TP OAM framework, defines
            a set of one or more Maintenance Entities (MEs).
            MEs 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 an 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 RFC 6370 (MEG_ID for an LSP is LSP_ID, and
             MEG_ID for a PW is PW_Path_ID), MEP_ID can be
             automatically formed.
```

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

            For an 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 an LSP, MEP_ID is formed using
            Global_ID::Node_ID::Tunnel_Num::LSP_Num.

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

            For a 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.
            The ICC MEG_ID for an LSP and a PW is formed using the
            objects mplsOamIdMegIdIcc and mplsOamIdMegIdUmc.

            MEP_ID can be formed using MEG_ID::MEP_Index."
        REFERENCE
          "1. RFC 5860: Requirements for Operations, Administration,
              and Maintenance (OAM) in MPLS Transport Networks,
              May 2010.
           2. RFC 6371: Operations, Administration, and Maintenance
              Framework for MPLS-Based Transport Networks,
              September 2011, Section 3.
           3. RFC 6370: MPLS Transport Profile (MPLS-TP) Identifiers,
              September 2011.
           4. RFC 6923: MPLS Transport Profile (MPLS-TP) Identifiers
              Following ITU-T Conventions, May 2013."
        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 MEG has a 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 the MEG.  Conceptual rows
            having 'iccBased' as the operator type MUST have valid
            values for the objects mplsOamIdMegIdIcc and
            mplsOamIdMegIdUmc when the row status is active."
         REFERENCE
           "1. RFC 6370: MPLS Transport Profile (MPLS-TP) Identifiers,
               September 2011.
            2. RFC 6923: MPLS Transport Profile (MPLS-TP) Identifiers
               Following ITU-T Conventions, May 2013, 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 uppercase letters (i.e., A-Z).

            This object MUST contain a non-null value if
            the MplsOamIdMegOperatorType value is iccBased (2);
            otherwise, a null value with octet size 0
            should be assigned."
         REFERENCE
           "RFC 6923: MPLS Transport Profile (MPLS-TP) Identifiers
            Following ITU-T Conventions, May 2013, Section 3."
         DEFVAL {""}
         ::= { mplsOamIdMegEntry 4 }
```

```
   mplsOamIdMegIdIcc OBJECT-TYPE
      SYNTAX        SnmpAdminString (SIZE(0..6))
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
        "Unique code assigned to a network operator or service
         provider; maintained by the ITU-T.  This is the
         ITU Carrier Code used to form the MEGID.

         This object MUST contain a non-null value if
         the MplsOamIdMegOperatorType value is iccBased (2);
         otherwise, a null value with octet size 0
         should be assigned."
      REFERENCE
        "RFC 6923: MPLS Transport Profile (MPLS-TP) Identifiers
         Following ITU-T Conventions, May 2013, 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 a network operator or service
         provider.  This code is appended to mplsOamIdMegIdIcc to
         form the MEGID.
         This object MUST contain a non-null value if
         the MplsOamIdMegOperatorType value is iccBased (2);
         otherwise, a null value with octet size 0
         should be assigned."
      REFERENCE
        "RFC 6923: MPLS Transport Profile (MPLS-TP) Identifiers
         Following ITU-T Conventions, May 2013, Section 7.1."
      DEFVAL {""}
      ::= { mplsOamIdMegEntry 6 }
```

```
      mplsOamIdMegServicePointerType OBJECT-TYPE
         SYNTAX        INTEGER {
                           tunnel (1),
                           lsp (2),
                           pseudowire (3),
                           section (4)
                       }
         MAX-ACCESS    read-create
         STATUS        current
         DESCRIPTION
           "Indicates the service type for the MEG.
            If the service type indicates tunnel (1), the service
            pointer in the mplsOamIdMeTable points to an entry in
            the point-to-point mplsTunnelTable (RFC 3812).

            If the service type indicates lsp (2), the service pointer
            in the mplsOamIdMeTable points to an entry in
            the co-routed or associated bidirectional mplsTunnelTable.

            If the value is the pseudowire (3) service type, the
            service pointer in the mplsOamIdMeTable points to an entry
            in the pwTable (RFC 5601).

            If the value is the section (4) service type, the service
            pointer in the mplsOamIdMeTable points to an entry in
            the mplsTunnelTable (RFC 3812)."
         REFERENCE
           "1. RFC 3812: Multiprotocol Label Switching (MPLS)
               Traffic Engineering (TE) Management Information
               Base (MIB), June 2004.
            2. RFC 5601: Pseudowire (PW) Management Information
               Base (MIB), 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 MEPs/MIPs, 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 the case of a unidirectional point-to-point transport
            path, a single unidirectional ME is defined to monitor it.
            In the case of associated bidirectional point-to-point
            transport paths, two independent unidirectional MEs are
            defined to independently monitor each direction.
            In the case of co-routed bidirectional point-to-point
            transport paths, a single bidirectional ME is defined to
            monitor both directions congruently.
            In the case of unidirectional point-to-multipoint transport
            paths, a single unidirectional ME 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 indicated 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 that the MEG is down.
             The bit 1 (meDown) indicates that the ME table is down.
             The bit 2 (oamAppDown) indicates that the OAM application
             (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 the
             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 ME information.

         The 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 MEP and MIP
         information within a MEG."
      ::= { mplsOamIdObjects 5 }

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

         An ME is a point-to-point 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 a point-to-point LSP, one MEG has one ME, and this ME
         is associated with two MEPs (source and sink MEPs) within
         a MEG.  Each mplsOamIdMeIndex value denotes the ME within
         a MEG.
```

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

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

            In the case of co-routed bidirectional point-to-point
            transport paths, a single bidirectional ME is defined to
            monitor both directions congruently, and the
            mplsOamIdMeServicePointer MIB object points to a co-routed
            bidirectional point-to-point transport path.

            In the case of unidirectional point-to-multipoint transport
            paths, a single unidirectional ME 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
            the 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,
            mplsOamIdMeServicePointer       RowPointer,
            mplsOamIdMeRowStatus            RowStatus,
            mplsOamIdMeStorageType          StorageType
      }
```

```
      mplsOamIdMeIndex  OBJECT-TYPE
         SYNTAX        Unsigned32 (1..4294967295)
         MAX-ACCESS    not-accessible
         STATUS        current
         DESCRIPTION
           "Uniquely identifies an ME 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 (MP) index that is used to
            create multiple MEPs in a node of a single ME.  The value
            of this object can be the MEP index or the 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 ME has a unique
            name within a MEG."
         ::= { mplsOamIdMeEntry 3 }

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

            If the mplsOamIdMegMpLocation object value is
            perInterface (2), the MP interface index should point to
            the incoming interface or outgoing interface."
```

```
      REFERENCE
        "1. RFC 6371: Operations, Administration, and Maintenance
            Framework for MPLS-Based Transport Networks,
            September 2011.
         2. RFC 2863: The Interfaces Group MIB, 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 the mplsOamIdMegOperatorType object
         in the mplsOamIdMegEntry is configured as iccBased (2).
         If the MEG is configured for an IP-based operator,
         the value of this object should be set to 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 the mplsOamIdMegOperatorType object
         in the mplsOamIdMegEntry is configured as iccBased (2).
         If the MEG is configured for an IP-based operator,
         the value of this object should be set to 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 MP 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 egress 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); otherwise, notApplicable (3) is set."
         DEFVAL { down }
         ::= { mplsOamIdMeEntry 8 }

      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 tunnel (1), lsp (2), or section (4),
            or at an entry in the pwEntry if
            mplsOamIdMegServicePointerType is configured
            as pseudowire (3).
```

```
            Note: This service pointer object is placed in the ME table
            instead of the MEG table, since it will be useful in the
            point-to-multipoint case, where each ME will point to
            different branches of a point-to-multipoint tree."
         ::= { mplsOamIdMeEntry 9 }

      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 the
            active(1) state, no objects in that row can be modified
            by the agent except mplsOamIdMeRowStatus."
         ::= { mplsOamIdMeEntry 10 }

      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 11 }

      -- 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 the 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 the 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 that can efficiently implement
                   the notifications contained in this group."

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

      ::= { mplsOamIdCompliances 1 }

        -- Compliance requirement for read-only implementations

         mplsOamIdModuleReadOnlyCompliance MODULE-COMPLIANCE
            STATUS current
            DESCRIPTION
                "Compliance statement for agents that only provide
                 read-only support for the MPLS-TP-OAM-STD-MIB module."

            MODULE -- this module

         MANDATORY-GROUPS    {
            mplsOamIdMegGroup,
            mplsOamIdMeGroup
         }


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

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

```
        -- mplsOamIdMegTable

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

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

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

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

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

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

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

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

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

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

        -- mplsOamIdMeTable

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

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

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

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

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

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

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

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

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

      ::= { mplsOamIdCompliances 2 }

   -- 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,
         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 Considerations

This MIB relates to a system that will provide network connectivity and packet forwarding services. As such, improper manipulation of the objects represented by this MIB may result in denial of service to a large number of end-users.

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection opens devices to attack.

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:

- The mplsOamIdMegTable and the mplsOamIdMeTable collectively show the MPLS OAM characteristics. If an administrator does not want to reveal this information, then these tables should be considered sensitive/vulnerable.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec), 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.

Implementations SHOULD provide the security features described by the SNMPv3 framework (see [RFC3410]), and implementations claiming compliance to the SNMPv3 standard MUST include full support for authentication and privacy via the User-based Security Model (USM) [RFC3414] with the AES cipher algorithm [RFC3826]. Implementations MAY also provide support for the Transport Security Model (TSM) [RFC5591] in combination with a secure transport such as SSH [RFC5592] or TLS/DTLS [RFC6353].

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.

9. IANA Considerations

As described in [RFC4221] and [RFC6639], and as requested in the MPLS-TC-STD-MIB [RFC3811], MPLS-related Standards Track MIB modules should be rooted under the mplsStdMIB subtree. The following subsection lists a new assignment that has been made by IANA under the mplsStdMIB subtree for the MPLS-OAM-ID-STD-MIB module defined in this document. New assignments can only be made via a Standards Action as specified in [RFC5226].

9.1. IANA Considerations for MPLS-OAM-ID-STD-MIB

IANA has to assign the OID { mplsStdMIB 21 } to the MPLS-OAM-ID-STD-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, DOI 10.17487/RFC2119, March 1997, <http://www.rfc-editor.org/info/rfc2119>.

[RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, DOI 10.17487/RFC2578, April 1999, <http://www.rfc-editor.org/info/rfc2578>.

[RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Textual Conventions for SMIv2", STD 58, RFC 2579, DOI 10.17487/RFC2579, April 1999, <http://www.rfc-editor.org/info/rfc2579>.

[RFC2580] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Conformance Statements for SMIv2", STD 58, RFC 2580, DOI 10.17487/RFC2580, April 1999, <http://www.rfc-editor.org/info/rfc2580>.

[RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", RFC 2863, DOI 10.17487/RFC2863, June 2000, <http://www.rfc-editor.org/info/rfc2863>.

[RFC3031] Rosen, E., Viswanathan, A., and R. Callon, "Multiprotocol Label Switching Architecture", RFC 3031, DOI 10.17487/RFC3031, January 2001, <http://www.rfc-editor.org/info/rfc3031>.

[RFC3289] Baker, F., Chan, K., and A. Smith, "Management Information Base for the Differentiated Services Architecture", RFC 3289, DOI 10.17487/RFC3289, May 2002, <http://www.rfc-editor.org/info/rfc3289>.

[RFC3411] Harrington, D., Presuhn, R., and B. Wijnen, "An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks", STD 62, RFC 3411, DOI 10.17487/RFC3411, December 2002, <http://www.rfc-editor.org/info/rfc3411>.

[RFC3414] Blumenthal, U. and B. Wijnen, "User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)", STD 62, RFC 3414, DOI 10.17487/RFC3414, December 2002, <http://www.rfc-editor.org/info/rfc3414>.

[RFC3826] Blumenthal, U., Maino, F., and K. McCloghrie, "The Advanced Encryption Standard (AES) Cipher Algorithm in the SNMP User-based Security Model", RFC 3826, DOI 10.17487/RFC3826, June 2004, <http://www.rfc-editor.org/info/rfc3826>.

[RFC5591] Harrington, D. and W. Hardaker, "Transport Security Model for the Simple Network Management Protocol (SNMP)", STD 78, RFC 5591, DOI 10.17487/RFC5591, June 2009, <http://www.rfc-editor.org/info/rfc5591>.

[RFC5592] Harrington, D., Salowey, J., and W. Hardaker, "Secure Shell Transport Model for the Simple Network Management Protocol (SNMP)", RFC 5592, DOI 10.17487/RFC5592, June 2009, <http://www.rfc-editor.org/info/rfc5592>.

[RFC5601] Nadeau, T., Ed., and D. Zelig, Ed., "Pseudowire (PW) Management Information Base (MIB)", RFC 5601, DOI 10.17487/RFC5601, July 2009, <http://www.rfc-editor.org/info/rfc5601>.

[RFC6353] Hardaker, W., "Transport Layer Security (TLS) Transport Model for the Simple Network Management Protocol (SNMP)", STD 78, RFC 6353, DOI 10.17487/RFC6353, July 2011, <http://www.rfc-editor.org/info/rfc6353>.

10.2. Informative References

[RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, DOI 10.17487/RFC3410, December 2002, <http://www.rfc-editor.org/info/rfc3410>.

[RFC3811] Nadeau, T., Ed., and J. Cucchiara, Ed., "Definitions of Textual Conventions (TCs) for Multiprotocol Label Switching (MPLS) Management", RFC 3811, DOI 10.17487/RFC3811, June 2004, <http://www.rfc-editor.org/info/rfc3811>.

[RFC3812] Srinivasan, C., Viswanathan, A., and T. Nadeau, "Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Management Information Base (MIB)", RFC 3812, DOI 10.17487/RFC3812, June 2004, <http://www.rfc-editor.org/info/rfc3812>.

[RFC3813] Srinivasan, C., Viswanathan, A., and T. Nadeau, "Multiprotocol Label Switching (MPLS) Label Switching Router (LSR) Management Information Base (MIB)", RFC 3813, DOI 10.17487/RFC3813, June 2004, <http://www.rfc-editor.org/info/rfc3813>.

[RFC4221] Nadeau, T., Srinivasan, C., and A. Farrel, "Multiprotocol Label Switching (MPLS) Management Overview", RFC 4221, DOI 10.17487/RFC4221, November 2005, <http://www.rfc-editor.org/info/rfc4221>.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, DOI 10.17487/RFC5226, May 2008, <http://www.rfc-editor.org/info/rfc5226>.

[RFC5654] Niven-Jenkins, B., Ed., Brungard, D., Ed., Betts, M., Ed., Sprecher, N., and S. Ueno, "Requirements of an MPLS Transport Profile", RFC 5654, DOI 10.17487/RFC5654, September 2009, <http://www.rfc-editor.org/info/rfc5654>.

[RFC5860] Vigoureux, M., Ed., Ward, D., Ed., and M. Betts, Ed., "Requirements for Operations, Administration, and Maintenance (OAM) in MPLS Transport Networks", RFC 5860, DOI 10.17487/RFC5860, May 2010, <http://www.rfc-editor.org/info/rfc5860>.

[RFC6370] Bocci, M., Swallow, G., and E. Gray, "MPLS Transport Profile (MPLS-TP) Identifiers", RFC 6370, DOI 10.17487/RFC6370, September 2011, <http://www.rfc-editor.org/info/rfc6370>.

[RFC6371] Busi, I., Ed., and D. Allan, Ed., "Operations, Administration, and Maintenance Framework for MPLS-Based Transport Networks", RFC 6371, DOI 10.17487/RFC6371, September 2011, <http://www.rfc-editor.org/info/rfc6371>.

[RFC6639] King, D., Ed., and M. Venkatesan, Ed., "Multiprotocol Label Switching Transport Profile (MPLS-TP) MIB-Based Management Overview", RFC 6639, DOI 10.17487/RFC6639, June 2012, <http://www.rfc-editor.org/info/rfc6639>.

[RFC6923] Winter, R., Gray, E., van Helvoort, H., and M. Betts, "MPLS Transport Profile (MPLS-TP) Identifiers Following ITU-T Conventions", RFC 6923, DOI 10.17487/RFC6923, May 2013, <http://www.rfc-editor.org/info/rfc6923>.

Acknowledgments

We wish to thank Muly Ilan, Adrian Farrel, Joan Cucchiara, Weiying Cheng, Mach Chen, Peter Yee, and Tina TSOU for their valuable comments on this document.

The coauthors of this document, the working group chairs, the document shepherd, the responsible AD, and the MPLS Working Group wish to dedicate this RFC to the memory of our friend and colleague Ping Pan, in recognition for his devotion and hard work at the IETF.

Authors' Addresses

Ping Pan
Infinera

Sam Aldrin
Google, Inc.
1600 Amphitheatre Parkway
Mountain View, CA 94043
United States

Email: aldrin.ietf@gmail.com

Venkatesan Mahalingam
Dell, Inc.
5450 Great America Parkway
Santa Clara, CA 95054
United States

Email: venkat.mahalingams@gmail.com

Kannan KV Sampath
Redeem
India

Email: kannankvs@gmail.com

Thomas D. Nadeau
Brocade

Email: tnadeau@lucidvision.com

Sami Boutros
VMware, Inc.
3401 Hillview Ave.
Palo Alto, CA 94304
United States

Email: sboutros@vmware.com