Definitions of Managed Objects for the LDP Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths
draft-ietf-mpls-mldp-mib-05

Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols. In particular it defines objects for managing multicast LDP point-to-multipoint (P2MP) and multipoint-to-multipoint (MP2MP) Label Switched Paths. The MIB module defined in this document is extension of LDP MIB defined in RFC3815 which supports only for LDP point-to-point LSPs.

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols. In particular it defines objects for managing multicast LDP point-to-multipoint (P2MP) and multipoint-to-multipoint (MP2MP) Label Switched Paths. The MIB module defined in this document is extension of LDP MIB defined in RFC3815 which supports only for LDP point-to-point LSPs.

The RFC3815 describes only unicast Managed objects for the Label distribution protocol. The RFC6388 describes LDP protocol extensions for the point to multipoint and multipoint to multipoint LSPs. The RFC6826 describes multicast LDP inband signalling for P2MP and MP2MP LSPs.

This document defines a MIB module for managing and controlling mLDP P2MP and MP2MP LSPs. It builds on the objects and tables defined in [RFC3815] for mLDP MIB.

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.

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 [RFC2578], STD 58, RFC2579 [RFC2579] and STD 58, RFC2580 [RFC2580].

3. Conventions

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

This document focuses on the management of following multicast LDP (mLDP) features, which were defined after unicast LDP [RFC5036].

- **RFC6826**: Multipoint LDP In-Band Signaling for Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths.
- **RFC7060**: Using LDP Multipoint Extensions on Targeted LDP Sessions.
- **RFC7431**: Multicast only Fast Re-Route.
- **RFC7715**: mLDP Node Protection.

For all the above features, the mLDP MIB needs to include the following information:

- Session Capability (P2MP, MP2MP) information: configured capability, negotiated capability.
- mLDP FECs: include opaque information (Generic LSP Identifier, source and group address) and MoFRR enable.
- Primary and backup upstream session when mLDP MoFRR enabled.
- Active and inactive upstream session for make before break.
- mLDP Traffic stats per mLDP Fec: The traffic stats for mLDP fec.
- mLDP Traffic stats per Interface: The mLDP traffic stats per Interface.
- Notifications when mLDP Fec LSP up, down.

5. Future Considerations

Any new opaque TLVs added for any other mLDP features, the opaque value object in the mplsMldpFecTable need to be enhanced accordingly.

6. Structure of the MIB Module

This section describes the structure of the mLDP MIB. In this MIB MPLS-MLDP-STD-MIB, scalar objects, table objects and notifications are defined. Following section describes in details about each object.
6.1. Summary of mLDP Scalar Objects

New scalar objects mplsMldpP2mpCapable and mplsMldpMp2mpCapable are defined to provide the mLDP capabilities of P2MP, MP2MP support.

New scalar objects mplsMldpMbbCapable and mplsMldpMbbTime are defined to provide MBB capability information.

New scalar object mplsMldpNumFecs which will give the total number of mLDP FECs setup on the LSR.

Another New scalar object mplsMldpNumFecsActive, which will give the total number of active mLDP FECs.

New scalar objects mplsMldpPlrCapable, mplsMldpMptCapable, mplsMldpProtLsrCapable and mplsMldpNodeProtCapable are defined to provide mLDP node protection capabilities.

6.2. Summary of mLDP Table Objects

mplsLdpPeerCapabilityTable to include peer capability information.

mplsMldpSessionStatsTable : This table contains the number of mLDP FECs received and advertised to a particular LDP session.

mplsMldpFecTable: This table is similar to point to point mplsLdpFecTable and will have mLDP specific Fec information.

mplsMldpFecBranchStatsTable : This table contains the traffic statistics for the given mLDP FECs on particular interface.

mplsMldpFecUpstreamSessTable : Includes the upstream session info for the particular mLDP Fec and also includes the primary or backup upstream session, that may be used for mLDP MoFRR.

mplsMldpInterfaceStatsTable : This table contains the traffic statistics for all mLDP related FECs.

7. mLDP Scalar Objects

The following scalars are defined in this MIB Module.

7.1. mplsMldpP2mpCapable

The mplsMldpP2mpCapable scalar object denotes whether the LSR is capable of supporting multicast LDP with Point-to-Multipoint capability.
7.2. mplsMldpMp2mpCapable

The mplsMldpMp2mpCapable scalar object denotes whether the LSR is capable of supporting multicast LDP with Multipoint-to-Multipoint LSPs.

7.3. mplsMldpMbbCapable

The mplsMldpMbbCapable scalar object denotes whether the LSR is capable of supporting multicast LDP with MBB (make before break) feature mentioned in the section 8 of RFC 6388.

7.4. mplsMldpMbbTime

The mplsMldpMbbTime scalar object denotes MBB time for which LSR is waiting for MBB Ack from upstream node. This timer helps LSR to prevent waiting indefinitely for the MBB Notification from upstream node.

7.5. mplsMldpNumFecs

The mplsMldpNumFecs provides a read-only counter of the number of mLDP FECs setup on this LSR.

7.6. mplsMldpNumFecsActive

The mplsMldpNumFecsActive provides a read-only counter of the number of mLDP FECs Active on this LSR.

7.7. mplsMldpPlrCapable

The mplsMldpPlrCapable scalar object denotes whether the LSR is capable of supporting PLR capability as specified in the section 5.1 of RFC7715.

7.8. mplsMldpMptCapable

The mplsMldpMptCapable scalar object denotes whether the LSR is capable of supporting MPT capability as specified in the section 5.2 of RFC7715.

7.9. mplsMldpProtLsrCapable

The mplsMldpProtLsrCapable scalar object denotes whether the LSR is capable of supporting the "Protected LSR" capability as specified in the section 5.3 of RFC7715.
7.10. mplsMldpNodeProtCapable

The mplsMldpNodeProtCapable scalar object denotes whether the LSR is capable of supporting the "Node Protection" capability as specified in the section 5.4 of RFC7715.

8. mLDP Table Objects

8.1. LDP Peer Capability Table mplsLdpPeerCapabilityTable

The new table mplsLdpPeerCapabilityTable is read-only table, which contains learned capability information from an LDP peer. This table augments the mplsLdpPeerTable, which is defined in RFC 3815. This is defined in this MIB as it is not defined in the standard LDP MIB (RFC3815).

8.2. mLDP Session Stats Table: mplsMldpSessionStatsTable

The mplsMldpSessionStatsTable is a read-only table which contains mLDP statistical information on sessions. This table augments the mplsLdpSessionStatsTable, which is defined in the RFC 3815.

8.3. mLDP Fec Table: mplsMldpFecTable

The mplsMldpFecTable is a table which contains FEC (Forwarding Equivalence Class) information relating to point to multi-point and multipoint to multipoint LDP LSP. Each entry/row represents a single FEC Element. This table is similar LDP LSP FEC Table, mplsLdpLspFecTable, which is defined in the RFC 3815, which associates FECs with the LSPs.

8.4. mLDP Fec Branch Traffic statistics Table: mplsMldpFecBranchStatsTable

This table mplsMldpFecBranchStatsTable gives information about the number of packets and number of bytes sent out on particular downstream session or on outgoing interface.

8.5. mLDP Fec Upstream Session Table: mplsMldpFecUpstreamSessTable

The mplsMldpFecUpstreamSessTable is a read-only table which contains mLDP upstream session information for mLDP Fec. This table is similar to mplsInSegmentLdpLspTable. This table will also have information about primary, backup upstream session, and also indicates whether the label is in MBB request or MBB Ack received state.
8.6. mLDP Interface Traffic statistics Table:
   mplsMldpInterfaceStatsTable

   This table mplsMldpInterfaceStatsTable gives information about the
   number of mLDP packets and number of mLDP bytes sent and received on
   a particular interface for all mLDP FECs.

9. The mLDP Notifications

   The RFC 3815 defined some of the notifications related to session and
   P2P Fec. In this MIB, the following notification added to support
   mLDP features.

   The mplsMldpFecUp and mplsMldpFecDown notifications are generated
   when mLDP FEC changes the state to UP and Down.

   The mplsMldpMoFrrStatusChange notification is generated when mLDP
   MoFRR status switches from primary to backup path and vice versa.

10. Relationship to Other MIB Modules

   This section describes relationships between MIB tables defined in
   this document as part of MPLS-MLDP-STD-MIB, and the tables defined in

   The Figure 1 shows the diagrammatic representation of the
   relationship between MPLS-MLDP-STD-MIB, MPLS-LDP-STD-MIB and MPLS-
   LSR-STD-MIB. An arrow in the Figure shows that the MIB table pointed
   from contains a reference to the MIB table pointed to.

10.1. Diagrammatic Representation
10.2. Relationship to the LSR MIB

The LSR MIB [RFC3813] have below tables, which cross connects the incoming label to outgoing label. Below Tables will be used for mLDP also in the similar way as in the point to point LDP LSPs.

mplsXCTable
mplsInSegmentTable
mplsOutSegmentTable

10.3. Relationship to the LDP MIB

The MIB module defined in this document is extension of MPLS-LDP-STD-MIB to support multicast LDP features.

Below optional tables in MPLS-LDP-STD-MIB, will also be used in mLDP for associating the mLDP LSPs to LSR-MIB tables.
The LDP Peer Capability Table mplsLdpPeerCapabilityTable augments the mplsLdpPeerTable which is defined in MPLS-LDP-STD-MIB.

The mLDP Session Stats Table mplsMldpSessionStatsTable augments mplsLdpSessionStatsTable which is defined in MPLS-LDP-STD-MIB.

11. Multicast MPLS Label Distribution Protocol MIB Definitions

MPLS-MLDP-STD-MIB DEFINITIONS ::= BEGIN
IMPORTS
  MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
  Unsigned32, Counter32, Counter64
  FROM SNMPv2-SMI -- RFC 2578
  MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
  FROM SNMPv2-CONF -- RFC 2580
  TimeStamp
  FROM SNMPv2-TC -- RFC 2579

InterfaceIndex
  FROM IF-MIB -- [RFC2020]

mplsStdMIB, MplsLdpIdentifier
  FROM MPLS-TC-STD-MIB -- RFC 3811

MplsIndexType
  FROM MPLS-LSR-STD-MIB -- RFC 3813

IndexInteger
  FROM DIFFSERV-MIB -- RFC 3289

InetAddress, InetAddressType
  FROM INET-ADDRESS-MIB -- RFC 4001

mplsLdpEntityLdpId, mplsLdpEntityIndex,
  mplsLdpPeerLdpId, mplsLdpPeerEntry
  FROM MPLS-LDP-STD-MIB -- RFC 3815

;
This MIB module contains managed object definitions for mLDP LSPs defined in Label Distribution Protocol Extensions Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths, RFC 6388, November 2011.

REVISION "201907070000Z" -- July 7, 2019 00:00:00 EST
DESCRIPTION
"Initial version issued as part of RFC XXXX."
-- RFC Editor. Please replace XXXX with the RFC number for this document
::= { mplsStdMIB YYY }
-- RFC Editor. Please replace YYY with the codepoint issued by IANA
-- and remove this note.

-- Top level components of this MIB module.

-- notifications
mplsMldpNotifications OBJECT IDENTIFIER ::= { mplsMldpStdMIB 0 }
-- tables, scalars
mplsMldpScalars OBJECT IDENTIFIER ::= { mplsMldpStdMIB 1 }
mplsMldpObjects OBJECT IDENTIFIER ::= { mplsMldpStdMIB 2 }

-- MPLS mLDP LSP scalars.

mplsMldpP2mpCapable OBJECT-TYPE
SYNTAX INTEGER {
    enable(1),
    disable(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object provides the P2MP capability of the LSR."
REFERENCE
"Section 2.1 of [RFC6388]."
::= { mplsMldpScalars 1 }

mplsMldpMp2mpCapable OBJECT-TYPE
SYNTAX INTEGER {
    enable(1),
    disable(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object provides MP2MP capability of the LSR."
REFERENCE
"Section 3.1 of [RFC6388]."
::= { mplsMldpScalars 2 }

mplsMldpMbbCapable OBJECT-TYPE
SYNTAX INTEGER {
   enable(1),
   disable(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object provides MBB (make before break) capability of the LSR."
REFERENCE
"Section 8.3 of [RFC6388]."
::= { mplsMldpScalars 3 }

mplsMldpMbbTime OBJECT-TYPE
SYNTAX Unsigned32 (1..300)
UNITS "seconds"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The 32-bit unsigned integer value provides the time for waiting MBB Ack from upstream node."
DEFVAL { 30 }
::= { mplsMldpScalars 4 }

mplsMldpNumFecs OBJECT-TYPE
SYNTAX Unsigned32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of active and passive mLdp Fecs on this device."
::= { mplsMldpScalars 5 }

mplsMldpNumFecsActive OBJECT-TYPE
SYNTAX Unsigned32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of mLdp FECs Active on this device. The mLDP FEC is
considered active if the mplsMldpFecOperStatus is up(1)."

::= { mplsMldpScalars 6 }

mplsMldpPlrCapable OBJECT-TYPE
SYNTAX INTEGER {
   enable(1),
   disable(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object provides Point of Local Repair (PLR)
capability of the LSR."

REFERENCE
"Section 5.1 of RFC7715]."

::= { mplsMldpScalars 7 }

mplsMldpMptCapable OBJECT-TYPE
SYNTAX INTEGER {
   enable(1),
   disable(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object provides Merge Point (MPT) capability of the LSR."

REFERENCE
"Section 5.2 of RFC7715]."

::= { mplsMldpScalars 8 }

mplsMldpLsrCapable OBJECT-TYPE
SYNTAX INTEGER {
   enable(1),
   disable(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "This object provides Protected LSR capability."

REFERENCE
 "Section 5.3 of RFC7715]."

::= { mplsMldpScalars 9 }

mplsMldProtNodeProtCapable OBJECT-TYPE
SYNTAX      INTEGER {
    enable(1),
    disable(2)
}
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
 "This object provides Node Protection capability of the LSR."

REFERENCE
 "Section 5.3 of RFC7715]."

::= { mplsMldpScalars 10 }

-- End of MPLS mLDP scalars.

-- MPLS mLDP tables.

-- The MPLS LDP Peer Capability Table

mplsLdpPeerCapabilityTable OBJECT-TYPE
SYNTAX      SEQUENCE OF MplsLdpPeerCapabilityEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
 "This table will have learned information relating to Mldp. This table AUGMENTS the mplsLdpPeerTable."

::= { mplsMldpObjects 1 }

mplsLdpPeerCapabilityEntry OBJECT-TYPE
SYNTAX      MplsLdpPeerCapabilityEntry
MAX-ACCESS  not-accessible
STATUS current
DESCRIPTION
"Information about a single Peer which is related to a Session. This table augments the mplsLdpPeerTable."

AUGMENTS { mplsLdpPeerEntry }
::= { mplsLdpPeerCapabilityTable 1 }

MplsLdpPeerCapabilityEntry ::= SEQUENCE {
  mplsLdpPeerCapability BITS
}

mplsLdpPeerCapability OBJECT-TYPE
SYNTAX BITS {
  default (0),
  p2mp (1),
  mp2mp (2),
  mbb (3),
  upstreamLabelAssignment (4),
  dynamic (5),
  plr (6),
  mpt (7),
  protLsr (8),
  nodeProt (9)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This will indicate the LDP capability information about peer. The default indicates P2P Capability. The p2mp indicates peer supports P2MP Capability. The mp2mp indicates peer supports MP2MP Capability. The mbb indicates peer supports MBB Capability. The upstream-label-assignment indicates peer supports Upstream label assignment Capability. The dynamic indicates peer supports dynamic Capability. The plr indicates Point of Local Repair Capability. The mpt indicates Point of Merge Point Capability. The prot-lsr indicates Protected LSR Capability. The node-prot indicates Node Protection LSR Capability."

REFERENCE
"Section 2.1 of RFC6388 for P2MP Capability TLV.
and the section 3.1 of RFC6388 for MP2MP Capability TLV.
The RFC6388 for MBB Capability TLV.
Section 9 of RFC5561 for Dynamic Capability Announcement TLV."
Section 3 of RFC6389 for Upstream Label Assignment Capability TLV.
Section 5 of RFC7715 describes for Point of Local Repair (plr) capability, Merge Point (mpt) capability, The Protected LSR (port-1sr) and Node Protection (node-prot) Capability.

::= {mplsLdpPeerCapabilityEntry 1 }

-- The MPLS mLDP Session Statistics Table
--

mplsMldpSessionStatsTable OBJECT-TYPE
SYNTAX SEQUENCE OF MplsMldpSessionStatsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"A table of statistics related to mLDP on Sessions. This table AUGMENTS the mplsLdpSessionStatsTable, which AUGMENTS the mplsLdpPeerTable."
::= {mplsMldpObjects 2 }

mplsMldpSessionStatsEntry OBJECT-TYPE
SYNTAX MplsMldpSessionStatsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"An entry in this table represents mLDP statistical information on a single session between an LDP Entity and LDP Peer."
AUGMENTS {mplsLdpPeerEntry }
::= {mplsMldpSessionStatsTable 1 }

MplsMldpSessionStatsEntry ::= SEQUENCE {
  mplsMldpSessionStatsNumFecsSent Counter32,
  mplsMldpSessionStatsNumMbbReqSentState Counter32,
  mplsMldpSessionStatsNumFecsRcvd Counter32,
  mplsMldpSessionStatsNumMbbReqRcvdState Counter32,
  mplsMldpSessionStatsNumMbbResetAckByTimer Counter32
}

mplsMldpSessionStatsNumFecsSent OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"This object counts the number of mLDP FECs sent on this session. If the FEC is withdrawn, then this number is decremented.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of mplsLdpSessionDiscontinuityTime."

::= { mplsMldpSessionStatsEntry 1 }

mplsMldpSessionStatsNumMbbReqSentState OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current

DESCRIPTION

"This object counts the number of mLDP FECs sent on this session and waiting for MBB Ack. This counter will get incremented when MBB req sent for a label on this session and will get decremented when the MBB Ack received."

::= { mplsMldpSessionStatsEntry 2 }

mplsMldpSessionStatsNumFecsRcvd OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current

DESCRIPTION

"This object counts the number of mLDP FECs received on this session. If the FEC is withdrawn from the downstream session, then this is decremented.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of mplsLdpSessionDiscontinuityTime."

::= { mplsMldpSessionStatsEntry 3 }

mplsMldpSessionStatsNumMbbReqRcvdState OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"This object counts the number of mLDP FECs received on this
session and waiting for sending MBB Ack. This counter will get
incremented when MBB req is received for a label on this session
and will get decremented when the MBB Ack sent."

 ::= { mplsMldpSessionStatsEntry 4 }

mplsMldpSessionStatsNumMbbResetAckByTimer OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"This object counts the number mLDP FECs for which the MBB Ack is
reset by MBB timer, in which the LSR is waiting for MBB ack."

 ::= { mplsMldpSessionStatsEntry 5 }

--
-- Mpls mLDP FEC Table
--

mplsMldpFecTable OBJECT-TYPE
SYNTAX SEQUENCE OF MplsMldpFecEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"This table represents the FEC
(Forwarding Equivalence Class)
Information associated with a mLDP LSP."

 ::= { mplsMldpObjects 3 }

mplsMldpFecEntry OBJECT-TYPE
SYNTAX MplsMldpFecEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"Each row represents a single mLDP FEC Element."
INDEX
{ mplsLdpEntityLdpId,
  mplsLdpEntityIndex,
  mplsMldpFecIndex
}
::= { mplsMldpFecTable 1 }

MplsMldpFecEntry ::= SEQUENCE {
    mplsMldpFecIndex               IndexInteger,
    mplsMldpFecType                INTEGER,
    mplsMldpFecRootAddrType        InetAddressType,
    mplsMldpFecRootAddr            InetAddress,
    mplsMldpFecOpaqueType          INTEGER,
    mplsMldpFecOpaqueGenLspId      Unsigned32,
    mplsMldpFecOpaqueTransitSourceOrBidirAddrType   InetAddressType,
    mplsMldpFecOpaqueTransitSourceOrBidirAddr       InetAddress,
    mplsMldpFecOpaqueTransitGroupAddrType            InetAddressType,
    mplsMldpFecOpaqueTransitGroupAddr               InetAddress,
    mplsMldpFecAdminStatus         INTEGER,
    mplsMldpFecOperStatus          INTEGER,
    mplsMldpFecMoFrr               INTEGER,
    mplsMldpFecLsrState            INTEGER,
    mplsMldpFecUpTime              TimeStamp
}

mplsMldpFecIndex OBJECT-TYPE
    SYNTAX     IndexInteger
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
        "The index which uniquely identifies this entry."
    ::= { mplsMldpFecEntry 1 }

mplsMldpFecType OBJECT-TYPE
    SYNTAX     INTEGER {
        p2mp(6),
        mp2mpUpstream(7),
        mp2mpDownstream(8)
    }
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "The type of the FEC. If the value of this object
        is 6, then it is P2MP Fec Type, and 7, 8 are correspond to
        MP2MP upstream and downstream type."
    REFERENCE
        "RFC6388, Section 2.2. The P2MP FEC Element and the section 3.3"
Internet-Draft                  mLDP MIB                       July 2019

for the MP2MP Fec elements.

 ::= { mplsMldpFecEntry 2 }

mplsMldpFecRootAddrType  OBJECT-TYPE
SYNTAX      InetAddressType
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"The value of this object is the type of the
Internet address. The value of this object,
decides how the value of the mplsMldpFecRootAddr object
is interpreted."
REFERENCE
"RFC6388, Section 2.2. The P2MP FEC Element and the section 3.3
for the MP2MP Fec elements."

 ::= { mplsMldpFecEntry 3 }

mplsMldpFecRootAddr     OBJECT-TYPE
SYNTAX      InetAddress
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"The value of this object is interpreted based
on the value of the mplsMldpFecRootAddrType object.
This is ingress node address for the mLDP LSP."
REFERENCE
"RFC6388, Section 2.2. The P2MP FEC Element and the section 3.3
for the MP2MP Fec elements."

 ::= { mplsMldpFecEntry 4 }

mplsMldpFecOpaqueType  OBJECT-TYPE
SYNTAX      INTEGER {
    genericLspId(1),
    transitIpv4Source(3),
    transitIpv6Source(4),
    transitIpv4Bidir(5),
    transitIpv6Bidir(6)
} 
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"This is opaque type of the mLDP FEC. The value of this object is shown below.

1 - The Generic LSP Identifier
3 - Transit IPv4 Source TLV
4 - Transit IPv6 Source TLV
5 - Transit IPv4 Bidir TLV
6 - Transit IPv6 Bidir TLV.

::= { mplsMldpFecEntry 5 }

mplsMldpFecOpaqueGenLspId OBJECT-TYPE
SYNTAX      Unsigned32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"The 32-bit unsigned integer value which is to represent Generic LSP ID. This value is only valid if the mplsMldpFecOpaqueType is genericLspId(1), otherwise 0 must be returned."

REFERENCE
"RFC6388, Section 2.3.1."

::= { mplsMldpFecEntry 6 }

mplsMldpFecOpaqueTransitSourceOrBidirAddrType OBJECT-TYPE
SYNTAX      InetAddressType
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"The value of this object is the type of the Internet address. The value of this object, decides how the value of the mplsMldpFecOpaqueTransitSourceOrBidirAddr object is interpreted."

REFERENCE
"RFC6826, Section 3.1."

::= { mplsMldpFecEntry 7 }

mplsMldpFecOpaqueTransitSourceOrBidirAddr OBJECT-TYPE
SYNTAX      InetAddress
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"The value of this object is interpreted based on the value of the mplsMldpFecOpaqueTransitSourceOrBidirAddrType object. This is source node address for the mLDP inband LSP."

REFERENCE
"RFC6826, Section 3.1."

 ::= { mplsMldpFecEntry 8 }

mplsMldpFecOpaqueTransitGroupAddrType OBJECT-TYPE
SYNTAX      InetAddressType
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"The value of this object is the type of the Internet address. The value of this object, decides how the value of the mplsMldpFecOpaqueTransitGroupAddr object is interpreted."

REFERENCE
"RFC6826, Section 3.2."

 ::= { mplsMldpFecEntry 9 }

mplsMldpFecOpaqueTransitGroupAddr OBJECT-TYPE
SYNTAX      InetAddress
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"The value of this object is interpreted based on the value of the mplsMldpFecOpaqueTransitGroupAddrType object. This is group node address for the mLDP inband LSP."

REFERENCE
"RFC6826, Section 3.2."

 ::= { mplsMldpFecEntry 2 }

mplsMldpFecAdminStatus OBJECT-TYPE
SYNTAX       INTEGER {
       up(1),        -- ready to pass data
       down(2)       -- out of service
    }
MAX-ACCESS    read-only
STATUS            current
DESCRIPTION       "Indicates the admin status of this mLDP FEC."
DEFVAL { up }
::= { mplsMldpFecEntry 11 }

mplsMldpFecOperStatus OBJECT-TYPE
SYNTAX             INTEGER {
   up(1),             -- ready to pass data
   down(2)            -- out of service
}
MAX-ACCESS         read-only
STATUS             current
DESCRIPTION        "Indicates the actual operational status of this mLDP Fec."
::= { mplsMldpFecEntry 12 }

mplsMldpFecMoFrr OBJECT-TYPE
SYNTAX             INTEGER {
   enable(1),
   disable(2)
}
MAX-ACCESS         read-only
STATUS             current
DESCRIPTION        "This object provides whether MoFRR enabled for this mLDP FEC.
                   on this mLDP FEC. As mentioned in the section 3.2 of [ RFC7431 ],
                   When this is enabled, then mLDP may select two upstream sessions,
                   one is primary and other one is backup. The backup traffic is
discarded when the primary upstream session is UP. When the

                   primary upstream session goes down, the traffic from the backup
                   upstream session will be forwarded to downstream."
::= { mplsMldpFecEntry 13 }

mplsMldpFecLsrState OBJECT-TYPE
SYNTAX             INTEGER {
   egress(1),
   bud(2),
   transit(3),
   ingress(4)
MAX-ACCESS read-only
STATUS current
DESCRIPTION "Indicates the role of FEC either egress, bud, transit or ingress"

::= { mplsMldpFecEntry 14 }

mplsMldpFecUpTime OBJECT-TYPE
SYNTAX TimeStamp
MAX-ACCESS read-only
STATUS current
DESCRIPTION "This values shows Fec UP time. This is time since mplsMldpFecOperStatus is UP."

::= { mplsMldpFecEntry 15 }

-- MPLS mLDP LSP Branch Traffic Stats Table.

mplsMldpFecBranchStatsTable OBJECT-TYPE
SYNTAX SEQUENCE OF MplsMldpFecBranchStatsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION "This table provides mLDP Fec branch MPLS Traffic Stats information."

::= { mplsMldpObjects 4 }

mplsMldpFecBranchStatsEntry OBJECT-TYPE
SYNTAX MplsMldpFecBranchStatsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION "An entry in this table is created by the LSR for each downstream branch (out-segment) from this LSR for this mLDP LSP. Each downstream session may represent a single out-segment. Each entry in the table is indexed by the four identifiers of the mLDP LSP, and the out-segment that identifies the outgoing branch."

INDEX { mplsLdpEntityLdpId, mplsLdpEntityIndex, mplsMldpFecBranchFecIndex, }
mplsMldpFecBranchOutSegIndex

 ::= { mplsMldpFecBranchStatsTable 1 }

MplsMldpFecBranchStatsEntry ::= SEQUENCE {
    mplsMldpFecBranchFecIndex          MplsIndexType,
    mplsMldpFecBranchOutSegIndex       MplsIndexType,
    mplsMLdpFecBranchPeerLdpId         MplsLdpIdentifier,
    mplsMldpFecBranchStatsPackets      Counter64,
    mplsMldpFecBranchStatsBytes        Counter64,
    mplsMldpFecBranchStatsDiscontinuityTime TimeStamp
}

mplsMldpFecBranchFecIndex OBJECT-TYPE
SYNTAX        MplsIndexType
MAX-ACCESS    not-accessible
STATUS        current
DESCRIPTION
    "This index identifies the mLDP FEC entry in the
    mplsMldpFecTable. This is same as mplsMldpFecIndex."

 ::= { mplsMldpFecBranchStatsEntry 1 }

mplsMldpFecBranchOutSegIndex OBJECT-TYPE
SYNTAX        MplsIndexType
MAX-ACCESS    not-accessible
STATUS        current
DESCRIPTION
    "This object identifies an outgoing branch from this mLDP LSP
    Its value is unique within the context of the mLDP LSP.
    This contains the same value as the mplsOutSegmentIndex in the
    MPLS-LSR-STD-MIBs mplsOutSegmentTable."

 ::= { mplsMldpFecBranchStatsEntry 2 }

mplsMLdpFecBranchPeerLdpId OBJECT-TYPE
SYNTAX        MplsLdpIdentifier
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
    "This object identifies an outgoing branch peer LDP ID for this
mLDP LSP. Its value is unique within the context of the mLDP LSP. On Egress node, this value could be 0.0.0.0:00 as there will no downstream LDP session.

::= { mplsMldpFecBranchStatsEntry 3 }

mplsMldpFecBranchStatsPackets OBJECT-TYPE
SYNTAX Counter64
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object represent the 64-bit value, which gives the number of packets forwarded by the mLDP LSP onto this branch. This object should be read in conjunction with mplsMldpFecBranchStatsDiscontinuityTime."

::= { mplsMldpFecBranchStatsEntry 4 }

mplsMldpFecBranchStatsBytes OBJECT-TYPE
SYNTAX Counter64
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object represent the 64-bit value, which gives the number of bytes forwarded by the mLDP LSP onto this branch. This object should be read in conjunction with mplsMldpFecBranchStatsDiscontinuityTime."

::= { mplsMldpFecBranchStatsEntry 5 }

mplsMldpFecBranchStatsDiscontinuityTime OBJECT-TYPE
SYNTAX TimeStamp
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The value of sysUpTime on the most recent occasion at which any one or more of this rows Counter32 or Counter64 objects experienced a discontinuity. If no such discontinuity has occurred since the last re-initialization of the local management subsystem, then this object contains a zero value."

::= { mplsMldpFecBranchStatsEntry 6 }

-- End of mplsMldpFecBranchStatsTable
-- MPLS mLDP LSP Upstream Session Table.

mplsMldpFecUpstreamSessTable OBJECT-TYPE
SYNTAX        SEQUENCE OF MplsMldpFecUpstreamSessEntry
MAX-ACCESS    not-accessible
STATUS        current
DESCRIPTION
"This table provides mLDP Fec upstream Session information."
::= { mplsMldpObjects 5 }

mplsMldpFecUpstreamSessEntry OBJECT-TYPE
SYNTAX        MplsMldpFecUpstreamSessEntry
MAX-ACCESS    not-accessible
STATUS        current
DESCRIPTION
"An entry in this table is created by the LSR for each upstream session (in-segment) from this LSR for this mLDP LSP. Each upstream session may represent a single in-segment. Each entry in the table is indexed by the four identifiers of the mLDP LSP, and the in-segment that identifies the incoming traffic."
INDEX       { mplsLdpEntityLdpId,
                mplsLdpEntityIndex,
                mplsLdpPeerLdpId,
                mplsMldpFecUpstreamSessFecIndex,
                mplsMldpFecUpstreamSessInSegIndex
                }
::= { mplsMldpFecUpstreamSessTable 1 }

MplsMldpFecUpstreamSessEntry ::= SEQUENCE {
    mplsMldpFecUpstreamSessFecIndex          MplsIndexType,
    mplsMldpFecUpstreamSessInSegIndex        MplsIndexType,
    mplsMldpFecUpstreamSessPrimary           INTEGER,
    mplsMldpFecUpstreamSessActive            INTEGER,
    mplsMldpFecUpstreamSessPackets           Counter64,
    mplsMldpFecUpstreamSessBytes             Counter64,
    mplsMldpFecUpstreamSessDiscontinuityTime TimeStamp
}

mplsMldpFecUpstreamSessFecIndex OBJECT-TYPE
SYNTAX        MplsIndexType
MAX-ACCESS    not-accessible
STATUS current
DESCRIPTION "This index identifies the mLDP FEC entry in the mplsMldpFecTable."
::= { mplsMldpFecUpstreamSessEntry 1 }

mplsMldpFecUpstreamSessInSegIndex OBJECT-TYPE
SYNTAX MplsIndexType
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION "This object identifies an upstream session from this mLDP LSP. Its value is unique within the context of the mLDP LSP. This contains the same value as the mplsInSegmentIndex in the MPLS-LSR-STD-MIBs mplsInSegmentTable."
::= { mplsMldpFecUpstreamSessEntry 2 }

mplsMldpFecUpstreamSessPrimary OBJECT-TYPE
SYNTAX INTEGER {
    primary(1),
    backup(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION "This indicated wether the received traffic from upstream is primary or backup. This is valid only if the MoFRR (mplsMldpFecMoFrr) is enabled on this FEC."
::= { mplsMldpFecUpstreamSessEntry 3 }

mplsMldpFecUpstreamSessActive OBJECT-TYPE
SYNTAX INTEGER {
    active(1),
    inactive(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION "This indicates whether the upstream session is active, means the LSR programmed the forwarding engine to receive the traffic from this upstream session. This will be Inactive if the LSR is wating for MBB Ack."
::= { mplsMldpFecUpstreamSessEntry 4 }

mplsMldpFecUpstreamSessPackets OBJECT-TYPE
SYNTAX       Counter64
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION  "This object represent the 64-bit value, which gives the number
of packets received by the mLDP LSP from this upstream
session. This object should be read in conjunction with
mplsMldpFecUpstreamSessDiscontinuityTime."

::= { mplsMldpFecUpstreamSessEntry 5 }

mplsMldpFecUpstreamSessBytes OBJECT-TYPE
SYNTAX       Counter64
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION  "This object represent the 64-bit value, which gives the number
of bytes received by the mLDP LSP from this upstream
session. This object should be read in conjunction with
mplsMldpFecUpstreamSessDiscontinuityTime."

::= { mplsMldpFecUpstreamSessEntry 6 }

mplsMldpFecUpstreamSessDiscontinuityTime OBJECT-TYPE
SYNTAX       TimeStamp
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION  "The value of sysUpTime on the most recent occasion at which
any one or more of this rows Counter32 or Counter64 objects
experienced a discontinuity. If no such discontinuity has
occurred since the last re-initialization of the local
management subsystem, then this object contains a zero
value."

::= { mplsMldpFecUpstreamSessEntry 7 }

-- End of mplsMldpFecBranchStatsTable

-- MPLS mLDP Interface Traffic Stats Table.

mplsMldpInterfaceStatsTable OBJECT-TYPE
SYNTAX       SEQUENCE OF MplsMldpInterfaceStatsEntry
MAX-ACCESS   not-accessible
STATUS       current
DESCRIPTION

"This table provides mLDP Traffic Stats on specified interface."

::= { mplsMldpObjects 6 }

mplsMldpInterfaceStatsEntry OBJECT-TYPE
SYNTAX MplsMldpInterfaceStatsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"An entry in this table is created by the LSR for each downstream branch (out-segment) from this LSR for this mLDP LSP. Each downstream session may represent a single out-segment. Each entry in the table is indexed by the four identifiers of the mLDP LSP, and the out-segment that identifies the outgoing branch."

INDEX { mplsMldpInterfaceIndex }

::= { mplsMldpInterfaceStatsTable 1 }

MplsMldpInterfaceStatsEntry ::= SEQUENCE {
  mplsMldpInterfaceIndex InterfaceIndex,
  mplsMldpInterfaceStatsSentPackets Counter64,
  mplsMldpInterfaceStatsSentBytes Counter64,
  mplsMldpInterfaceStatsRecvPackets Counter64,
  mplsMldpInterfaceStatsRecvBytes Counter64
}

mplsMldpInterfaceIndex OBJECT-TYPE
SYNTAX InterfaceIndex
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"This index identifies the specific interface."

::= { mplsMldpInterfaceStatsEntry 1 }

mplsMldpInterfaceStatsSentPackets OBJECT-TYPE
SYNTAX Counter64
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"This is 64 bit value, which gives the number of packets forwarded by all mLDP LSPs onto this interface."
::= { mplsMldpInterfaceStatsEntry 2 }

mplsMldpInterfaceStatsSentBytes OBJECT-TYPE
SYNTAX        Counter64
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
  "This is 64 bit value, which gives the number of bytes
  forwarded by all mLDP LSPs onto this interface."
::= { mplsMldpInterfaceStatsEntry 3 }

mplsMldpInterfaceStatsRecvPackets OBJECT-TYPE
SYNTAX        Counter64
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
  "This is 64 bit value, which gives the number of packets
  received by all mLDP LSPs from this interface."
::= { mplsMldpInterfaceStatsEntry 4 }

mplsMldpInterfaceStatsRecvBytes OBJECT-TYPE
SYNTAX        Counter64
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
  "This is 64 bit value, which gives the number of bytes
  received by all mLDP LSPs from this interface."
::= { mplsMldpInterfaceStatsEntry 5 }

-- End of mplsMldpInterfaceStatsTable

-- Notifications.

mplsMldpFecUp NOTIFICATION-TYPE
OBJECTS     {
  mplsMldpFecAdminStatus,
  mplsMldpFecOperStatus
}
STATUS      current
DESCRIPTION
  "This notification is generated when a mplsMldpFecOperStatus
  object changes from down to up."
::= { mplsMldpNotifications 1 }
mplsMldpFecDown NOTIFICATION-TYPE
OBJECTS { mplsMldpFecAdminStatus, mplsMldpFecOperStatus }
STATUS current
DESCRIPTION "This notification is generated when a mplsMldpFecOperStatus object changes from up to down."
::= { mplsMldpNotifications 2 }

mplsMldpMoFrrStatusChange NOTIFICATION-TYPE
OBJECTS { mplsMldpFecUpstreamSessPrimary }
STATUS current
DESCRIPTION "This notification is generated when a mplsMldpFecUpstreamSessPrimary object changes from primary to backup and vice versa."
::= { mplsMldpNotifications 3 }

-- End of notifications.

--****************************************************************
-- Module Conformance Statement
--****************************************************************

mplsMldpConformance OBJECT IDENTIFIER ::= { mplsMldpStdMIB 3 }
mplsMldpGroups OBJECT IDENTIFIER ::= { mplsMldpConformance 1 }
mplsMldpCompliances OBJECT IDENTIFIER ::= { mplsMldpConformance 2 }

mplsMldpModuleCompliance MODULE-COMPLIANCE
STATUS current
DESCRIPTION "The Module is implemented with support for read-only. Only monitoring is available when using this MODULE-COMPLIANCE."

MODULE -- this module
MANDATORY-GROUPS { mplsMldpScalarsGroup, mplsMldpObjectsGroup, mplsMldpNotificationsGroup }
 ::= { mplsMldpCompliances 1 }

-- units of conformance

mplsMldpScalarsGroup OBJECT-GROUP

OBJECTS {
    mplsMldpP2mpCapable,
    mplsMldpP2mpCapable,
    mplsMldpMbbCapable,
    mplsMldpMbbTime,
    mplsMldpNumFecs,
    mplsMldpNumFecsActive,
    mplsMldpPrlCapable,
    mplsMldpMp2mpCapable,
    mplsMldpMptCapable,
    mplsMldpProtLsrCapable,
    mplsMldpProtLsrCapable,
    mplsMldpProtNodeProtCapable,
    mplsLdpPeerCapability
}

STATUS  current

DESCRIPTION
   "A collection of objects providing basic statistics and
capability information of mLDP implementation."

 ::= { mplsMldpGroups 1 }

mplsMldpObjectsGroup OBJECT-GROUP

OBJECTS {
    mplsMldpSessionStatsNumFecsSent,
    mplsMldpSessionStatsNumMbbReqSentState,
    mplsMldpSessionStatsNumFecsRcvd,
    mplsMldpSessionStatsNumFecsSent,
    mplsMldpSessionStatsNumMbbReqRcvdState,
    mplsMldpSessionStatsNumMbbResetAckByTimer,
    mplsMldpFecType,
    mplsMldpFecRootAddrType,
    mplsMldpFecRootAddr,
    mplsMldpFecOpaqueType,
    mplsMldpFecOpaqueGenLspId,
    mplsMldpFecOpaqueTransitSourceOrBidirAddrType,
    mplsMldpFecOpaqueTransitSourceOrBidirAddr,
    mplsMldpFecOpaqueTransitGroupAddrType,
    mplsMldpFecOpaqueTransitGroupAddr,
    mplsMldpFecAdminStatus,
    mplsMldpFecOperStatus,
    mplsMldpFecMoFrr,
    mplsMldpFecLsrState,
12. Security Considerations

This MIB module is useful for the configuration of certain objects and monitoring of mLDP LSPs.

There are no management objects defined in this MIB module that have a MAX-ACCESS clause of read-write and/or read-create. So, if this MIB module is implemented correctly, then there is no risk that an intruder can alter or create any management objects of this MIB module via direct SNMP SET 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:

- mplsMldpFecTable
- mplsLdpPeerCapabilityTable
- mplsMldpSessionStatsTable
- mplsMldpFecBranchStatsTable
- mplsMldpFecUpstreamSessTable
- mplsMldpInterfaceStatsTable
- mplsMldpNumFecs
- mplsMldpNumFecsActive
- mplsMldpMbbTime

Above listed tables and objects show information about the mLDP LSPs, its route through the network, and its traffic statistics. Knowledge of this information could be used to compromise the network, or simply to breach confidentiality. If an Administrator does not want to reveal this information, these tables and objects 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.

13. IANA Considerations

This is new MPLS MIB module, contained in this document and IANA is requested to assign an oid (mplsStdMIB YYY) under the mplsStdMIB subtree to the MPLS-MLDP-STD-MIB module specified in this document.

Below mplsMldpFecType values are defined in the section 2.2 and 3.3 of RFC6388. p2mp : 6 mp2mpUpstream : 7 mp2mpDownstream : 8

14. Acknowledgments

The authors wish to thank Santosh Esale, Alia Atlas and Martin Ehlers for doing the detailed review. Thanks to Adrian Farrel and Raveendra Torvi for their input to this work and for many helpful suggestions.

15. References

15.1. Normative References


15.2. Informative References


Authors’ Addresses