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BGP/MPLS Layer 3 VPN Multicast Management Information Base

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 and/or monitor Multicast communication over IP Virtual Private Networks (VPNs) supported by the Multiprotocol Label Switching/Border Gateway Protocol (MPLS/BGP) on a Provider Edge (PE) router.

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 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc8503.

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1. Introduction

[RFC6513], [RFC6514], and [RFC6625] specify procedures for supporting multicast in Multiprotocol Label Switching/Border Gateway Protocol (MPLS/BGP) Layer 3 (IP) Virtual Private Networks (VPNs). Throughout this document, we will use the term "MVPN" (for "multicast VPN") [RFC6513] to refer to a BGP/MPLS IP VPN that supports multicast.

Provider Edge (PE) routers that attach to a particular MVPN exchange customer multicast (C-multicast) routing information with neighboring PEs. In [RFC6513], two basic methods for exchanging C-multicast routing information are defined: (1) Protocol Independent Multicast (PIM) [RFC7761] and (2) BGP.

In the rest of this document, we will use the term "PIM-MVPN" to refer to the case where PIM is used for exchanging C-multicast routing information and "BGP-MVPN" to refer to the case where BGP is used for exchanging C-multicast routing information.

This document describes managed objects to configure and/or monitor MVPNs. Most of the managed objects are common to both PIM-MVPN and BGP-MVPN, and some managed objects are BGP-MVPN specific.

1.1. Terminology

This document adopts the definitions, abbreviations, and mechanisms described in [RFC4364], [RFC6513], and [RFC6514]. Familiarity with multicast, MPLS, Layer 3 (L3) VPN, and MVPN concepts and/or mechanisms is assumed. Some terms specifically related to this document are explained below.

An MVPN can be realized by using various kinds of transport mechanisms for forwarding a packet to all or a subset of PEs across service provider networks. Such transport mechanisms are referred to as provider tunnels (P-tunnels).

A Provider Multicast Service Interface (PMSI) [RFC6513] is a conceptual interface instantiated by a P-tunnel. A PE uses a PMSI to send customer multicast traffic to all or some PEs in the same VPN.

There are two kinds of PMSIs: Inclusive PMSI (I-PMSI) and Selective PMSI (S-PMSI) [RFC6513]. An I-PMSI enables a PE attached to a particular MVPN to transmit a message to all PEs in the same MVPN. An S-PMSI enables a PE to transmit a message to a selected set of PEs in the same MVPN.

As described in [RFC4382], each PE maintains one default forwarding table and zero or more Virtual Routing and Forwarding (VRF) tables. Throughout this document, we will use the term "MVRF" (for "multicast VRF") to refer to a VRF that contains multicast routing information.

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 BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

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 RFC 3410 [RFC3410].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIv2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].

3. BGP-MPLS-LAYER3-VPN-MULTICAST-MIB

This document defines BGP-MPLS-LAYER3-VPN-MULTICAST-MIB, a MIB module for monitoring and/or configuring MVPNs on PEs. This MIB module will be used in conjunction with MPLS-L3VPN-STD-MIB [RFC4382] and IPMCAST-MIB [RFC5132].

3.1. Summary of the MIB Module

BGP-MPLS-LAYER3-VPN-MULTICAST-MIB provides the following functionalities.

- Monitoring attributes of MVPNs on a PE
- Configuring timers and thresholds related to an MVPN on a PE
- Notifying creation, deletion, and modification of MVRFs on a PE
- Monitoring PMSI attributes
- Monitoring statistics of advertisements exchanged by a PE
- Monitoring routing information for multicast destinations
- Monitoring next hops for each multicast destination

To provide these functionalities, BGP-MPLS-LAYER3-VPN-MULTICAST-MIB defines the following tables.

- mvpnGenericTable

  This table contains generic information about MVPNs on a PE. Each entry in this table represents an instance of an MVPN on a PE and contains generic information related to the MVPN. For each entry in this table, there MUST be a corresponding VRF in MPLS-L3VPN-STD-MIB [RFC4382].

- mvpnBgpTable

  This table contains information specific to BGP-MVPNs. Each BGP-MVPN on a PE will have an entry in this table.

- mvpnPmsiTable

  This table contains managed objects representing attribute information that is common to I-PMSIs and S-PMSIs on a PE.

- mvpnSpmsiTable

  This table contains managed objects representing attribute information specific to S-PMSIs. An S-PMSI represented in this table will have a corresponding entry in mvpnPmsiTable.

- mvpnAdvtStatsTable

  This table contains statistics pertaining to I-PMSI and S-PMSI advertisements sent/received.

- mvpnMrouteTable

  This table contains multicast routing information in MVRFs on a PE.

- mvpnMrouteNextHopTable

  This table contains information on the next hops for routing IP multicast datagrams in MVPNs on a PE.

3.2. MIB Module Definitions

This MIB module makes reference to the following documents: [RFC2003], [RFC2784], [RFC2863], [RFC3032], [RFC4001], and [RFC8502].

```
BGP-MPLS-LAYER3-VPN-MULTICAST-MIB DEFINITIONS ::= BEGIN

IMPORTS
   MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
   Counter32, Counter64, Gauge32, Unsigned32, TimeTicks,
   mib-2
      FROM SNMPv2-SMI                          -- RFC 2578

   MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
      FROM SNMPv2-CONF                         -- RFC 2580

   RowPointer, TimeStamp, DateAndTime
      FROM SNMPv2-TC                           -- RFC 2579

   InterfaceIndex, InterfaceIndexOrZero
      FROM IF-MIB                              -- RFC 2863

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

   mplsL3VpnVrfName, MplsL3VpnRouteDistinguisher
      FROM MPLS-L3VPN-STD-MIB                  -- RFC 4382

   IANAipRouteProtocol, IANAipMRouteProtocol
   FROM IANA-RTPROTO-MIB
     -- http://www.iana.org/assignments/ianaiprouteprotocol-mib
```

```
    L2L3VpnMcastProviderTunnelType
       FROM L2L3-VPN-MULTICAST-TC-MIB;         -- RFC 8502

  mvpnMIB MODULE-IDENTITY
     LAST-UPDATED "201812140000Z"  -- 14 December 2018
     ORGANIZATION "IETF BESS Working Group"
     CONTACT-INFO
                  "Hiroshi Tsunoda
                   Tohoku Institute of Technology
                   35-1, Yagiyama Kasumi-cho
                   Taihaku-ku, Sendai, 982-8577
                   Japan
                   Email: tsuno@m.ieice.org"

     DESCRIPTION
          "This MIB module contains managed object definitions to
           configure and/or monitor Multicast communication over IP
           Virtual Private Networks (VPNs) supported by the
           Multiprotocol Label Switching/Border Gateway Protocol
           (MPLS/BGP) on a Provider Edge (PE) router.

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           (http://trustee.ietf.org/license-info).
          "

     -- Revision History

     REVISION "201812140000Z"  -- 14 December 2018
     DESCRIPTION
         "Initial version, published as RFC 8503."

     ::= { mib-2 243 }

  -- Top-level components of this MIB module.
  mvpnNotifications OBJECT IDENTIFIER ::= { mvpnMIB 0 }

  -- Scalars, Tables
  mvpnObjects       OBJECT IDENTIFIER ::= { mvpnMIB 1 }

  -- Conformance Information
  mvpnConformance   OBJECT IDENTIFIER ::= { mvpnMIB 2 }
```

```
  -- MVPN Objects
  mvpnScalars       OBJECT IDENTIFIER ::= { mvpnObjects 1 }

  -- Scalar Objects

  mvpnMvrfs OBJECT-TYPE
     SYNTAX        Gauge32
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The total number of Multicast Virtual Routing and
          Forwarding (MVRF) tables that are present on
          this Provider Edge (PE) router.  This includes MVRFs
          for IPv4, IPv6, and Multipoint LDP (mLDP) C-multicast.
         "
     ::= { mvpnScalars 1 }

  mvpnV4Mvrfs OBJECT-TYPE
     SYNTAX        Gauge32
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The number of MVRFs for IPv4 C-multicast on this PE.
         "
     ::= { mvpnScalars 2 }

  mvpnV6Mvrfs OBJECT-TYPE
     SYNTAX        Gauge32
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The number of MVRFs for IPv6 C-multicast on this PE.
         "
     ::= { mvpnScalars 3 }

  mvpnMldpMvrfs OBJECT-TYPE
     SYNTAX         Gauge32
     MAX-ACCESS     read-only
     STATUS         current
     DESCRIPTION
         "The number of MVRFs on this PE that use BGP for
          exchanging mLDP C-multicast routing information.
         "
     ::= { mvpnScalars 4 }
```

```
  mvpnPimV4Mvrfs OBJECT-TYPE
     SYNTAX         Gauge32
     MAX-ACCESS     read-only
     STATUS         current
     DESCRIPTION
         "The number of MVRFs on this PE that use Provider
          Independent Multicast (PIM) for exchanging IPv4
          C-multicast routing information.
         "
     ::= { mvpnScalars 5 }

  mvpnPimV6Mvrfs OBJECT-TYPE
     SYNTAX         Gauge32
     MAX-ACCESS     read-only
     STATUS         current
     DESCRIPTION
         "The number of MVRFs on this PE that use PIM for
          exchanging IPv6 C-multicast routing information.
         "
     ::= { mvpnScalars 6 }

  mvpnBgpV4Mvrfs OBJECT-TYPE
     SYNTAX         Gauge32
     MAX-ACCESS     read-only
     STATUS         current
     DESCRIPTION
         "The number of MVRFs on this PE that use BGP for
          exchanging IPv4 C-multicast routing information.
         "
     ::= { mvpnScalars 7 }

  mvpnBgpV6Mvrfs OBJECT-TYPE
     SYNTAX         Gauge32
     MAX-ACCESS     read-only
     STATUS         current
     DESCRIPTION
         "The number of MVRFs on this PE that use BGP for
          exchanging IPv6 C-multicast routing information.
         "
     ::= { mvpnScalars 8 }

  mvpnSPTunnelLimit OBJECT-TYPE
     SYNTAX        Unsigned32 (1..4294967295)
     MAX-ACCESS    read-write
     STATUS        current
     DESCRIPTION
         "The maximum number of selective provider tunnels that
          are allowed for a particular MVPN on this PE.
```

```
        "
    REFERENCE
        "RFC 6513, Section 13"
    ::= { mvpnScalars 9 }

  mvpnBgpCmcastRouteWithdrawalTimer OBJECT-TYPE
    SYNTAX        Unsigned32
    UNITS         "milliseconds"
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
        "A configurable timer to control the delay
         of C-multicast route withdrawal advertisements.
        "
    REFERENCE
        "RFC 6514, Section 16.1.1"
    ::= { mvpnScalars 10 }

  mvpnBgpSrcSharedTreeJoinTimer OBJECT-TYPE
    SYNTAX        Unsigned32
    UNITS         "milliseconds"
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
        "A configurable timer to control the delay
         of Source/Shared Tree Join C-multicast route
         advertisements.
        "
    REFERENCE
        "RFC 6514, Section 16.1.2"
    ::= { mvpnScalars 11 }

  -- Generic MVRF Information Table

  mvpnGenericTable  OBJECT-TYPE
    SYNTAX        SEQUENCE OF MvpnGenericEntry
    MAX-ACCESS    not-accessible
    STATUS        current
    DESCRIPTION
        "A conceptual table containing generic information about
         MVPNs on this PE.
        "
    ::= { mvpnObjects 2 }

  mvpnGenericEntry OBJECT-TYPE
    SYNTAX        MvpnGenericEntry
    MAX-ACCESS    not-accessible
    STATUS        current
```

```
    DESCRIPTION
        "A conceptual row that represents an MVPN on this PE.
         The MVPN represented by this entry will have one or more
         corresponding P-Multicast Service Interfaces (PMSIs)
         and a corresponding VRF in MPLS-L3VPN-STD-MIB (RFC 4382).
        "
    INDEX {
            mplsL3VpnVrfName
          }
    ::= { mvpnGenericTable 1 }

  MvpnGenericEntry ::= SEQUENCE {
    mvpnGenMvrfLastAction       INTEGER,
    mvpnGenMvrfLastActionTime   DateAndTime,
    mvpnGenMvrfCreationTime     DateAndTime,
    mvpnGenCmcastRouteProtocol  INTEGER,
    mvpnGenIpmsiInfo            RowPointer,
    mvpnGenInterAsPmsiInfo      RowPointer,
    mvpnGenUmhSelection         INTEGER,
    mvpnGenCustomerSiteType     INTEGER
  }

  mvpnGenMvrfLastAction OBJECT-TYPE
    SYNTAX      INTEGER {
                          createdMvrf             (1),
                          deletedMvrf             (2),
                          modifiedMvrfIpmsiConfig (3),
                          modifiedMvrfSpmsiConfig (4)
                        }
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "This object describes the last action pertaining
         to the MVPN represented by this entry.

         The enumerated action types and the corresponding
         descriptions are as follows:

           createdMvrf:
             MVRF was created for this MVPN on the PE.

           deletedMvrf:
             MVRF for this MVPN was deleted from the PE.
             A conceptual row in this table will never have
             mvpnGenMvrfLastAction equal to deletedMvrf,
             because in that case, the row itself will not exist
             in the table.
```

```
              This value for mvpnGenMvrfLastAction is defined
              solely for use in the mvpnMvrfActionChange
              notification.

            modifiedMvrfIpmsiConfig:
              An I-PMSI for this MVPN was configured, deleted,
              or changed.

            modifiedMvrfSpmsiConfig:
              An S-PMSI for this MVPN was configured, deleted,
              or changed.
          "
      ::= { mvpnGenericEntry 2 }

  mvpnGenMvrfLastActionTime OBJECT-TYPE
      SYNTAX        DateAndTime
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
          "The timestamp when the last action, given in
           the corresponding mvpnGenMvrfLastAction object,
           was carried out.
          "
      ::= { mvpnGenericEntry 3 }

  mvpnGenMvrfCreationTime OBJECT-TYPE
      SYNTAX        DateAndTime
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
          "The timestamp when the MVRF was created for
           the MVPN represented by this entry.
          "
      ::= { mvpnGenericEntry 4 }

  mvpnGenCmcastRouteProtocol OBJECT-TYPE
      SYNTAX        INTEGER {
                              pim (1),
                              bgp (2)
                            }
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
          "The protocol used to signal C-multicast routing
           information across the provider core for the MVPN
           represented by this entry.
```

```
          The enumerated protocols and the corresponding
          descriptions are as follows:

            pim : PIM (PIM-MVPN)
            bgp : BGP (BGP-MVPN)
        "
    REFERENCE
        "RFC 6513, Section 5"
    ::= { mvpnGenericEntry 5 }

  mvpnGenIpmsiInfo OBJECT-TYPE
    SYNTAX        RowPointer
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
        "A pointer to a conceptual row representing
         the corresponding I-PMSI in mvpnPmsiTable.
         If there is no I-PMSI for the MVPN
         represented by this entry, the
         value of this object will be zeroDotZero.
        "
    ::= { mvpnGenericEntry 6 }

  mvpnGenInterAsPmsiInfo OBJECT-TYPE
    SYNTAX        RowPointer
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
        "A pointer to a conceptual row representing
         the corresponding segmented Inter-AS I-PMSI in mvpnPmsiTable.
         If there is no segmented Inter-AS I-PMSI for the MVPN,
         the value of this object will be zeroDotZero.
        "
    ::= { mvpnGenericEntry 7 }

  mvpnGenUmhSelection OBJECT-TYPE
    SYNTAX        INTEGER {
                            highestPeAddress  (1),
                            cRootGroupHashing (2),
                            ucastUmhRoute     (3)
                          }
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
        "The Upstream Multicast Hop (UMH) selection method for the
         MVPN represented by this entry.
```

```
          The enumerated methods and the corresponding
          descriptions are as follows:

            highestPeAddress  : PE with the highest address
                                  (see RFC 6513, Section 5.1.3)
            cRootGroupHashing : hashing based on (c-root, c-group)
            ucastUmhRoute     : per-unicast route towards c-root
        "
    REFERENCE
        "RFC 6513, Section 5.1"
    ::= { mvpnGenericEntry 8 }

  mvpnGenCustomerSiteType OBJECT-TYPE
    SYNTAX        INTEGER {
                            senderReceiver (1),
                            receiverOnly   (2),
                            senderOnly     (3)
                          }
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
        "The type of the customer site, connected to
         the MVPN represented by this entry.

         The enumerated types and the corresponding
         descriptions are as follows:

           senderReceiver : Site is both sender and receiver
           receiverOnly   : Site is receiver only
           senderOnly     : Site is sender only
        "
    REFERENCE
        "RFC 6513, Section 2.3"
    ::= { mvpnGenericEntry 9 }

  -- Generic BGP-MVPN Table

  mvpnBgpTable OBJECT-TYPE
    SYNTAX        SEQUENCE OF MvpnBgpEntry
    MAX-ACCESS    not-accessible
    STATUS        current
    DESCRIPTION
        "A conceptual table that supplements mvpnGenericTable
         with BGP-MVPN-specific information for BGP-MVPNs on this PE.
        "
    ::= { mvpnObjects 3 }
```

```
  mvpnBgpEntry OBJECT-TYPE
     SYNTAX           MvpnBgpEntry
     MAX-ACCESS       not-accessible
     STATUS           current
     DESCRIPTION
         "A conceptual row corresponding to a BGP-MVPN on this PE.
         "
     INDEX {
             mplsL3VpnVrfName
           }
  ::= { mvpnBgpTable 1 }

  MvpnBgpEntry ::= SEQUENCE {
     mvpnBgpMode                              INTEGER,
     mvpnBgpVrfRouteImportExtendedCommunity MplsL3VpnRouteDistinguisher,
     mvpnBgpSrcASExtendedCommunity          Unsigned32,
     mvpnBgpMsgRateLimit                    Unsigned32,
     mvpnBgpMaxSpmsiAdRoutes                Unsigned32,
     mvpnBgpMaxSpmsiAdRouteFreq             Unsigned32,
     mvpnBgpMaxSrcActiveAdRoutes            Unsigned32,
     mvpnBgpMaxSrcActiveAdRouteFreq         Unsigned32
  }

  mvpnBgpMode OBJECT-TYPE
     SYNTAX        INTEGER {
                             other   (0),
                             rptSpt  (1),
                             sptOnly (2)
                           }
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The inter-site C-tree mode used by the BGP-MVPN
          represented by this entry.

            other   : none of the following
            rptSpt  : inter-site shared tree mode
                      (Rendezvous Point Tree (RPT) and
                      source-specific shortest-path tree (SPT))
            sptOnly : inter-site source-only tree mode
         "
     REFERENCE
         "RFC 6513, Section 9.3.1"
     ::= { mvpnBgpEntry 1 }

  mvpnBgpVrfRouteImportExtendedCommunity OBJECT-TYPE
     SYNTAX             MplsL3VpnRouteDistinguisher
     MAX-ACCESS         read-only
```

```
    STATUS             current
    DESCRIPTION
        "The VRF Route Import Extended Community added by this PE
         to unicast VPN routes that it advertises for the BGP-MVPN
         corresponding to this entry.
        "
    REFERENCE
        "RFC 6514, Section 7
        "
    ::= { mvpnBgpEntry 2 }

  mvpnBgpSrcASExtendedCommunity OBJECT-TYPE
    SYNTAX            Unsigned32
    MAX-ACCESS        read-only
    STATUS            current
    DESCRIPTION
        "The Source AS Extended Community added by this PE
         to the unicast VPN routes that it advertises for
         the BGP-MVPN represented by this entry.
        "
    REFERENCE
        "RFC 6514, Section 6
        "
    ::= { mvpnBgpEntry 3 }

  mvpnBgpMsgRateLimit OBJECT-TYPE
    SYNTAX        Unsigned32 (0..4294967295)
    UNITS         "messages per second"
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
        "The configurable upper bound for the rate of the BGP
         C-multicast routing information message exchange between
         this PE and other PEs in the BGP-MVPN corresponding to
         this entry.
        "
    REFERENCE
        "RFC 6514, Section 17"
    ::= { mvpnBgpEntry 4 }

  mvpnBgpMaxSpmsiAdRoutes OBJECT-TYPE
    SYNTAX        Unsigned32 (0..4294967295)
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
        "The configurable upper bound for the number of S-PMSI
         auto-discovery (A-D) routes for the BGP-MVPN
         corresponding to this entry.
```

```
        "
    REFERENCE
        "RFC 6514, Section 17"
    ::= { mvpnBgpEntry 5 }

  mvpnBgpMaxSpmsiAdRouteFreq OBJECT-TYPE
    SYNTAX        Unsigned32 (0..4294967295)
    UNITS         "routes per second"
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
        "The configurable upper bound for the frequency of
         S-PMSI A-D route generation for the BGP-MVPN
         corresponding to this entry.
        "
    REFERENCE
        "RFC 6514, Section 17"
    ::= { mvpnBgpEntry 6 }

  mvpnBgpMaxSrcActiveAdRoutes OBJECT-TYPE
    SYNTAX        Unsigned32 (0..4294967295)
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
        "The configurable upper bound for the number of
         Source Active A-D routes for the BGP-MVPN corresponding
         to this entry.
        "
    REFERENCE
        "RFC 6514, Section 17"
    ::= { mvpnBgpEntry 7 }

  mvpnBgpMaxSrcActiveAdRouteFreq OBJECT-TYPE
    SYNTAX        Unsigned32 (0..4294967295)
    UNITS         "routes per second"
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
        "The configurable upper bound for the frequency of Source
         Active A-D route generation for the BGP-MVPN corresponding
         to this entry.
        "
    REFERENCE
        "RFC 6514, Section 17"
    ::= { mvpnBgpEntry 8 }
```

```
  -- Table of PMSI Information

  mvpnPmsiTable  OBJECT-TYPE
     SYNTAX        SEQUENCE OF MvpnPmsiEntry
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "A conceptual table containing information related
          to PMSIs on this PE.
         "
     ::= { mvpnObjects 4 }

  mvpnPmsiEntry OBJECT-TYPE
     SYNTAX        MvpnPmsiEntry
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "A conceptual row corresponding to a
          PMSI on this PE.
         "
     INDEX       {
                   mvpnPmsiTunnelIfIndex
                 }
     ::= { mvpnPmsiTable 1 }

  MvpnPmsiEntry ::= SEQUENCE {
     mvpnPmsiTunnelIfIndex          InterfaceIndex,
     mvpnPmsiRD                     MplsL3VpnRouteDistinguisher,
     mvpnPmsiTunnelType             L2L3VpnMcastProviderTunnelType,
     mvpnPmsiTunnelAttribute        RowPointer,
     mvpnPmsiTunnelPimGroupAddrType InetAddressType,
     mvpnPmsiTunnelPimGroupAddr     InetAddress,
     mvpnPmsiEncapsulationType      INTEGER
  }

  mvpnPmsiTunnelIfIndex OBJECT-TYPE
     SYNTAX        InterfaceIndex
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "A unique value for this conceptual row.  Its value
          will be the same as that of the ifIndex object instance
          for the corresponding PMSI in ifTable.
         "
     REFERENCE
         "RFC 2863, Section 3.1.5
         "
     ::= { mvpnPmsiEntry 1 }
```

```
  mvpnPmsiRD OBJECT-TYPE
     SYNTAX        MplsL3VpnRouteDistinguisher
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The Route Distinguisher for this I-PMSI.
         "
     ::= { mvpnPmsiEntry 3 }

  mvpnPmsiTunnelType OBJECT-TYPE
     SYNTAX        L2L3VpnMcastProviderTunnelType
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The type of tunnel used to
          instantiate the PMSI corresponding to this entry.
         "
     REFERENCE
         "RFC 6513, Section 2.6
         "
     ::= { mvpnPmsiEntry 4 }

  mvpnPmsiTunnelAttribute OBJECT-TYPE
     SYNTAX        RowPointer
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "A pointer to a conceptual row representing
          the P-tunnel used by the PMSI in
          l2L3VpnMcastPmsiTunnelAttributeTable.
         "
     ::= { mvpnPmsiEntry 5 }

  mvpnPmsiTunnelPimGroupAddrType OBJECT-TYPE
     SYNTAX        InetAddressType
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The InetAddressType of the mvpnPmsiTunnelPimGroupAddr object
          that follows.  When the PMSI corresponding to this entry
          does not use the PIM provider tunnel, i.e., the value of
          mvpnPmsiTunnelType is not one of pimSsm(3), pimAsm(4), or
          pimBidir(5), this object should be unknown(0).
         "
     ::= { mvpnPmsiEntry 6 }
```

```
  mvpnPmsiTunnelPimGroupAddr OBJECT-TYPE
     SYNTAX        InetAddress
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The tunnel address that is used by the PMSI
          corresponding to this entry.  When the PMSI
          corresponding to this entry does not use
          the PIM provider tunnel, i.e., the value of
          mvpnPmsiTunnelType is not one of pimSsm(3),
          pimAsm(4), or pimBidir(5), this
          object should be a zero-length octet string.
         "
     ::= { mvpnPmsiEntry 7 }

  mvpnPmsiEncapsulationType OBJECT-TYPE
     SYNTAX        INTEGER {
                             greIp (1),
                             ipIp  (2),
                             mpls  (3)
                           }
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The encapsulation type used for sending
          packets through the PMSI corresponding to this entry.

          The enumerated encapsulation types and the corresponding
          descriptions are as follows:

            greIp : Generic Routing Encapsulation (GRE)
                    (RFC 2784)
            ipIp  : IP-in-IP encapsulation (RFC 2003)
            mpls  : MPLS encapsulation (RFC 3032)
         "
     REFERENCE
         "RFC 2003
          RFC 2784
          RFC 3032
          RFC 6513, Section 12.1
         "
     ::= { mvpnPmsiEntry 8 }

  -- Table of S-PMSI-Specific Information

  mvpnSpmsiTable  OBJECT-TYPE
     SYNTAX        SEQUENCE OF MvpnSpmsiEntry
     MAX-ACCESS    not-accessible
```

```
    STATUS        current
    DESCRIPTION
        "A conceptual table containing information related
         to S-PMSIs on this PE.
         This table stores only S-PMSI-specific attribute
         information.  Generic PMSI attribute information of
         S-PMSIs is stored in mvpnPmsiTable.
        "
    ::= { mvpnObjects 5 }

  mvpnSpmsiEntry OBJECT-TYPE
    SYNTAX        MvpnSpmsiEntry
    MAX-ACCESS    not-accessible
    STATUS        current
    DESCRIPTION
        "A conceptual row corresponding to an S-PMSI on this PE.
         Implementers need to be aware that if the total number of
         octets in mplsL3VpnVrfName, mvpnSpmsiCmcastGroupAddr, and
         mvpnSpmsiCmcastSourceAddr exceeds 113, the OIDs of column
         instances in this row will have more than 128 sub-identifiers
         and cannot be accessed using SNMPv1, SNMPv2c, or SNMPv3.
        "
    INDEX       {
                  mplsL3VpnVrfName,
                  mvpnSpmsiCmcastGroupAddrType,
                  mvpnSpmsiCmcastGroupAddr,
                  mvpnSpmsiCmcastGroupPrefixLen,
                  mvpnSpmsiCmcastSourceAddrType,
                  mvpnSpmsiCmcastSourceAddr,
                  mvpnSpmsiCmcastSourcePrefixLen
                }
    ::= { mvpnSpmsiTable 1 }

  MvpnSpmsiEntry ::= SEQUENCE {
    mvpnSpmsiCmcastGroupAddrType   InetAddressType,
    mvpnSpmsiCmcastGroupAddr       InetAddress,
    mvpnSpmsiCmcastGroupPrefixLen  InetAddressPrefixLength,
    mvpnSpmsiCmcastSourceAddrType  InetAddressType,
    mvpnSpmsiCmcastSourceAddr      InetAddress,
    mvpnSpmsiCmcastSourcePrefixLen InetAddressPrefixLength,
    mvpnSpmsiPmsiPointer           RowPointer
  }

  mvpnSpmsiCmcastGroupAddrType OBJECT-TYPE
    SYNTAX        InetAddressType
    MAX-ACCESS    not-accessible
    STATUS        current
```

```
    DESCRIPTION
        "The InetAddressType of the mvpnSpmsiCmcastGroupAddr object
         that follows.
        "
    ::= { mvpnSpmsiEntry 1 }

  mvpnSpmsiCmcastGroupAddr OBJECT-TYPE
    SYNTAX        InetAddress
    MAX-ACCESS    not-accessible
    STATUS        current
    DESCRIPTION
        "The group address of the C-flow assigned to the
         S-PMSI corresponding to this entry.
        "
    REFERENCE
        "RFC 6513, Section 3.1"
    ::= { mvpnSpmsiEntry 2 }

  mvpnSpmsiCmcastGroupPrefixLen OBJECT-TYPE
    SYNTAX        InetAddressPrefixLength
    MAX-ACCESS    not-accessible
    STATUS        current
    DESCRIPTION
        "The prefix length of the corresponding
         mvpnSpmsiCmcastGroupAddr object.
        "
    ::= { mvpnSpmsiEntry 3 }

  mvpnSpmsiCmcastSourceAddrType OBJECT-TYPE
    SYNTAX        InetAddressType
    MAX-ACCESS    not-accessible
    STATUS        current
    DESCRIPTION
        "The InetAddressType of the mvpnSpmsiCmcastSourceAddr object
         that follows.
        "
    ::= { mvpnSpmsiEntry 4 }

  mvpnSpmsiCmcastSourceAddr OBJECT-TYPE
    SYNTAX        InetAddress
    MAX-ACCESS    not-accessible
    STATUS        current
    DESCRIPTION
        "The source address of the C-flow assigned to the
         S-PMSI corresponding to this entry.
        "
    ::= { mvpnSpmsiEntry 5 }
```

```
  mvpnSpmsiCmcastSourcePrefixLen OBJECT-TYPE
     SYNTAX        InetAddressPrefixLength
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "The prefix length of the corresponding
          mvpnSpmsiCmcastSourceAddr object.
         "
     ::= { mvpnSpmsiEntry 6 }

  mvpnSpmsiPmsiPointer OBJECT-TYPE
     SYNTAX        RowPointer
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "A pointer to a conceptual row representing
          generic information of this S-PMSI in mvpnPmsiTable.
         "
     ::= { mvpnSpmsiEntry 7 }

  -- Table of Statistics Pertaining to
  -- Advertisements Sent/Received

  mvpnAdvtStatsTable OBJECT-TYPE
     SYNTAX        SEQUENCE OF MvpnAdvtStatsEntry
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "A conceptual table containing statistics pertaining to
          I-PMSI and S-PMSI advertisements sent/received by this PE.
         "
     ::= { mvpnObjects 6 }

  mvpnAdvtStatsEntry OBJECT-TYPE
     SYNTAX        MvpnAdvtStatsEntry
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "A conceptual row corresponding to statistics
          pertaining to advertisements sent/received
          for a particular MVPN on this PE.

          Implementers need to be aware that if the total number of
          octets in mplsL3VpnVrfName and mvpnAdvtPeerAddr exceeds 115,
          then OIDs of column instances in this row will have more than
          128 sub-identifiers and cannot be accessed using SNMPv1,
          SNMPv2c, or SNMPv3.
         "
```

```
    INDEX  {
             mplsL3VpnVrfName,
             mvpnAdvtType,
             mvpnAdvtPeerAddrType,
             mvpnAdvtPeerAddr
           }
    ::= { mvpnAdvtStatsTable 1 }

  MvpnAdvtStatsEntry ::= SEQUENCE {
     mvpnAdvtType                          INTEGER,
     mvpnAdvtPeerAddrType                  InetAddressType,
     mvpnAdvtPeerAddr                      InetAddress,
     mvpnAdvtSent                          Counter32,
     mvpnAdvtReceived                      Counter32,
     mvpnAdvtReceivedError                 Counter32,
     mvpnAdvtReceivedMalformedTunnelType Counter32,
     mvpnAdvtReceivedMalformedTunnelId   Counter32,
     mvpnAdvtLastSentTime                  DateAndTime,
     mvpnAdvtLastReceivedTime              DateAndTime,
     mvpnAdvtCounterDiscontinuityTime    TimeStamp
    }

  mvpnAdvtType OBJECT-TYPE
     SYNTAX        INTEGER {
                              intraAsIpmsi (0),
                              interAsIpmsi (1),
                              sPmsi        (2)
                            }
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "The PMSI type.

          The enumerated PMSI types and corresponding
          descriptions are as follows:

            intraAsIpmsi : Intra-AS Inclusive PMSI
            interAsIpmsi : Inter-AS Inclusive PMSI
            sPmsi        : Selective PMSI
         "
     REFERENCE
         "RFC 6513, Sec. 3.2.1"
     ::= { mvpnAdvtStatsEntry 1 }

  mvpnAdvtPeerAddrType OBJECT-TYPE
     SYNTAX        InetAddressType
     MAX-ACCESS    not-accessible
     STATUS        current
```

```
    DESCRIPTION
        "The InternetAddressType of the mvpnAdvtPeerAddr object
         that follows.
        "
    ::= { mvpnAdvtStatsEntry 2 }

  mvpnAdvtPeerAddr OBJECT-TYPE
    SYNTAX        InetAddress
    MAX-ACCESS    not-accessible
    STATUS        current
    DESCRIPTION
        "The address of a peer PE that exchanges advertisement with
         this PE.
        "
    ::= { mvpnAdvtStatsEntry 3 }

  mvpnAdvtSent OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
        "The number of advertisements successfully
         sent to the peer PE specified by the corresponding
         mvpnAdvtPeerAddr.

         Discontinuities in the value of this counter can
         occur at re-initialization of the management system
         and at other times as indicated by the corresponding
         mvpnAdvtCounterDiscontinuityTime object.
        "
    ::= { mvpnAdvtStatsEntry 4 }

  mvpnAdvtReceived OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
        "The number of advertisements received from the peer PE
         specified by the corresponding mvpnAdvtPeerAddr object.
         This includes advertisements that were discarded.

         Discontinuities in the value of this counter can
         occur at re-initialization of the management system
         and at other times as indicated by the corresponding
         mvpnAdvtCounterDiscontinuityTime object.
        "
    ::= { mvpnAdvtStatsEntry 5 }
```

```
  mvpnAdvtReceivedError OBJECT-TYPE
     SYNTAX        Counter32
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The total number of advertisements received from a peer PE,
          specified by the corresponding mvpnAdvtPeerAddr object,
          that were rejected due to an error(s) in the advertisement.
          The value of this object includes
          the error cases counted in the corresponding
          mvpnAdvtReceivedMalformedTunnelType and
          mvpnAdvtReceivedMalformedTunnelId objects.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnAdvtCounterDiscontinuityTime object.
         "
     ::= { mvpnAdvtStatsEntry 6 }

  mvpnAdvtReceivedMalformedTunnelType OBJECT-TYPE
     SYNTAX        Counter32
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The total number of advertisements received from the peer PE,
          specified by the corresponding mvpnAdvtPeerAddr object,
          that were rejected due to a malformed Tunnel Type
          in the PMSI Tunnel attribute.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnAdvtCounterDiscontinuityTime object.
         "
     REFERENCE
         "RFC 6514, Section 5"
     ::= { mvpnAdvtStatsEntry 7 }

  mvpnAdvtReceivedMalformedTunnelId   OBJECT-TYPE
     SYNTAX        Counter32
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The total number of advertisements received from the peer PE,
          specified by the corresponding mvpnAdvtPeerAddr object,
          that were rejected due to a malformed Tunnel Identifier
          in the PMSI Tunnel attribute.  Discontinuities in the value
```

```
          of this counter can occur at re-initialization of the
          management system and at other times as indicated by the
          corresponding mvpnAdvtCounterDiscontinuityTime object.
         "
     REFERENCE
         "RFC 6514, Section 5"
     ::= { mvpnAdvtStatsEntry 8 }

  mvpnAdvtLastSentTime   OBJECT-TYPE
     SYNTAX        DateAndTime
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The timestamp when the last advertisement
          was successfully sent by this PE.  If no
          advertisement has been sent since the
          last re-initialization of this PE, this
          object will have a zero-length string.
         "
     ::= { mvpnAdvtStatsEntry 9 }

  mvpnAdvtLastReceivedTime   OBJECT-TYPE
     SYNTAX        DateAndTime
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "The timestamp when the last advertisement
          was successfully received from the peer PE specified
          by the corresponding mvpnAdvtPeerAddr object and
          processed by this PE.
          If no advertisement has been received since the
          last re-initialization of this PE, this object
          will have a zero-length string.
         "
     ::= { mvpnAdvtStatsEntry 10 }

  mvpnAdvtCounterDiscontinuityTime 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 application's
          counters, viz., counters with the OID prefix
          'mvpnAdvtSent', 'mvpnAdvtReceived',
          'mvpnAdvtReceivedError',
          'mvpnAdvtReceivedMalformedTunnelType', or
          'mvpnAdvtReceivedMalformedTunnelId', suffered a
```

```
          discontinuity.
          If no such discontinuities have occurred since the
          last re-initialization of the local management
          subsystem, this object will have a zero value.
         "
    ::= { mvpnAdvtStatsEntry 11 }

  -- Table of Multicast Routes in an MVPN

  mvpnMrouteTable OBJECT-TYPE
     SYNTAX        SEQUENCE OF MvpnMrouteEntry
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "A conceptual table containing multicast routing information
          corresponding to the MVRFs present on the PE.
         "
     ::= { mvpnObjects 7 }

  mvpnMrouteEntry OBJECT-TYPE
     SYNTAX        MvpnMrouteEntry
     MAX-ACCESS    not-accessible
     STATUS        current
     DESCRIPTION
         "A conceptual row corresponding to a route for IP datagrams
          from a particular source and addressed to a particular
          IP multicast group address.

          Implementers need to be aware that if the total number of
          octets in mplsL3VpnVrfName, mvpnMrouteCmcastGroupAddr, and
          mvpnMrouteCmcastSourceAddrs exceeds 113, the OIDs of column
          instances in this row will have more than 128 sub-identifiers
          and cannot be accessed using SNMPv1, SNMPv2c, or SNMPv3.
         "
     INDEX  {
               mplsL3VpnVrfName,
               mvpnMrouteCmcastGroupAddrType,
               mvpnMrouteCmcastGroupAddr,
               mvpnMrouteCmcastGroupPrefixLength,
               mvpnMrouteCmcastSourceAddrType,
               mvpnMrouteCmcastSourceAddrs,
               mvpnMrouteCmcastSourcePrefixLength
            }
     ::= { mvpnMrouteTable 1 }
```

```
  MvpnMrouteEntry ::= SEQUENCE {
     mvpnMrouteCmcastGroupAddrType       InetAddressType,
     mvpnMrouteCmcastGroupAddr           InetAddress,
     mvpnMrouteCmcastGroupPrefixLength   InetAddressPrefixLength,
     mvpnMrouteCmcastSourceAddrType      InetAddressType,
     mvpnMrouteCmcastSourceAddrs         InetAddress,
     mvpnMrouteCmcastSourcePrefixLength  InetAddressPrefixLength,
     mvpnMrouteUpstreamNeighborAddrType  InetAddressType,
     mvpnMrouteUpstreamNeighborAddr      InetAddress,
     mvpnMrouteInIfIndex                 InterfaceIndexOrZero,
     mvpnMrouteExpiryTime                TimeTicks,
     mvpnMrouteProtocol                  IANAipMRouteProtocol,
     mvpnMrouteRtProtocol                IANAipRouteProtocol,
     mvpnMrouteRtAddrType                InetAddressType,
     mvpnMrouteRtAddr                    InetAddress,
     mvpnMrouteRtPrefixLength            InetAddressPrefixLength,
     mvpnMrouteRtType                    INTEGER,
     mvpnMrouteOctets                    Counter64,
     mvpnMroutePkts                      Counter64,
     mvpnMrouteTtlDroppedOctets          Counter64,
     mvpnMrouteTtlDroppedPackets         Counter64,
     mvpnMrouteDroppedInOctets           Counter64,
     mvpnMrouteDroppedInPackets          Counter64,
     mvpnMroutePmsiPointer               RowPointer,
     mvpnMrouteNumberOfLocalReplication  Unsigned32,
     mvpnMrouteNumberOfRemoteReplication Unsigned32,
     mvpnMrouteCounterDiscontinuityTime  TimeStamp
  }

  mvpnMrouteCmcastGroupAddrType OBJECT-TYPE
     SYNTAX     InetAddressType
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The InetAddressType of the mvpnMrouteCmcastGroupAddr object
          that follows.
         "
     ::= { mvpnMrouteEntry 1 }

  mvpnMrouteCmcastGroupAddr OBJECT-TYPE
     SYNTAX     InetAddress
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The IP multicast group address that, along with
          the corresponding mvpnMrouteCmcastGroupPrefixLength object,
          identifies destinations for which this entry contains
          multicast routing information.
```

```
          This address object is only significant up to
          mvpnMrouteCmcastGroupPrefixLength bits.  The remaining
          address bits MUST be set to zero.

          For addresses of type 'ipv4z' or 'ipv6z', the appended zone
          index is significant even though it lies beyond the prefix
          length.  The use of these address types indicates that this
          forwarding state applies only within the given zone.  Zone
          index zero is not valid in this table.
        "
    ::= { mvpnMrouteEntry 2 }

  mvpnMrouteCmcastGroupPrefixLength OBJECT-TYPE
     SYNTAX     InetAddressPrefixLength
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The length in bits of the mask that, along with
          the corresponding mvpnMrouteCmcastGroupAddr object,
          identifies destinations for which this entry contains
          multicast routing information.

          If the corresponding InetAddressType is 'ipv4' or 'ipv4z',
          this object must be in the range 4..32.
          If the corresponding InetAddressType is 'ipv6' or 'ipv6z',
          this object must be in the range 8..128.
         "
     ::= { mvpnMrouteEntry 3 }

  mvpnMrouteCmcastSourceAddrType OBJECT-TYPE
     SYNTAX     InetAddressType
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The InetAddressType of the mvpnMrouteCmcastSourceAddrs object
          that follows.

          A value of unknown(0) indicates a non-source-specific entry,
          corresponding to all sources in the group.  Otherwise, the
          value MUST be the same as the value of
          mvpnMrouteCmcastGroupAddrType.
         "
     ::= { mvpnMrouteEntry 4 }

  mvpnMrouteCmcastSourceAddrs OBJECT-TYPE
     SYNTAX     InetAddress
     MAX-ACCESS not-accessible
     STATUS     current
```

```
    DESCRIPTION
        "The network address that, along with the
         corresponding mvpnMrouteCmcastSourcePrefixLength object,
         identifies the sources for which this entry contains
         multicast routing information.

         This address object is only significant up to
         mvpnMrouteCmcastSourcePrefixLength bits.
         The remaining address bits MUST be set to zero.

         For addresses of type 'ipv4z' or 'ipv6z', the appended zone
         index is significant even though it lies beyond the prefix
         length.  The use of these address types indicates that this
         source address applies only within the given zone.  Zone
         index zero is not valid in this table.
        "
    ::= { mvpnMrouteEntry 5 }

  mvpnMrouteCmcastSourcePrefixLength OBJECT-TYPE
    SYNTAX     InetAddressPrefixLength
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
        "The length in bits of the mask that, along with
         the corresponding mvpnMrouteCmcastSourceAddr object,
         identifies the sources for which this entry contains
         multicast routing information.

         If the corresponding InetAddressType is 'ipv4' or 'ipv4z',
         this object must be in the range 4..32.
         If the corresponding InetAddressType is 'ipv6' or 'ipv6z',
         this object must be in the range 8..128.
         If the corresponding InetAddressType is 'unknown',
         this object must be zero.
        "
    ::= { mvpnMrouteEntry 6 }

  mvpnMrouteUpstreamNeighborAddrType OBJECT-TYPE
    SYNTAX     InetAddressType
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "The InetAddressType of the mvpnMrouteUpstreamNeighborAddr
         object that follows.

         A value of unknown(0) indicates that the upstream
         neighbor is unknown, for example, in
         Bidirectional PIM (BIDIR-PIM).
```

```
        "
    REFERENCE
        "RFC 5015"
    ::= { mvpnMrouteEntry 7 }

  mvpnMrouteUpstreamNeighborAddr OBJECT-TYPE
    SYNTAX     InetAddress
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "The address of the upstream neighbor (for example,
         the Reverse Path Forwarding (RPF) neighbor) from
         which IP datagrams from these sources represented
         by this entry to this multicast address are received.
        "
    ::= { mvpnMrouteEntry 8 }

  mvpnMrouteInIfIndex OBJECT-TYPE
    SYNTAX     InterfaceIndexOrZero
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "The value of ifIndex for the interface on which IP
         datagrams sent by these sources represented by this entry to
         this multicast address are received.

         A value of zero indicates that datagrams are not
         subject to an incoming interface check but may be accepted
         on multiple interfaces (for example, in BIDIR-PIM).
        "
    REFERENCE
        "RFC 5015"
    ::= { mvpnMrouteEntry 9 }

  mvpnMrouteExpiryTime OBJECT-TYPE
    SYNTAX     TimeTicks
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "The minimum amount of time remaining before this entry will
         be aged out.  The value zero indicates that the entry is not
         subject to aging.  If the corresponding mvpnMrouteNextHopState
         object is pruned(1), this object represents the remaining
         time for the prune to expire after which the state will
         return to forwarding(2).
         If the corresponding mvpnMrouteNextHopState object is
         forwarding(2), this object indicates the time after which
         this entry will be removed from the table.
```

```
            "
        ::= { mvpnMrouteEntry 10 }

    mvpnMrouteProtocol OBJECT-TYPE
        SYNTAX     IANAipMRouteProtocol
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "The multicast routing protocol via which this multicast
             forwarding entry was learned.
            "
        ::= { mvpnMrouteEntry 11 }

    mvpnMrouteRtProtocol OBJECT-TYPE
        SYNTAX     IANAipRouteProtocol
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "The routing protocol via which the route used to find the
             upstream or parent interface for this multicast forwarding
             entry was learned.
            "
        ::= { mvpnMrouteEntry 12 }

    mvpnMrouteRtAddrType OBJECT-TYPE
        SYNTAX     InetAddressType
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "The InetAddressType of the mvpnMrouteRtAddr object
             that follows.
            "
        ::= { mvpnMrouteEntry 13 }

    mvpnMrouteRtAddr OBJECT-TYPE
        SYNTAX     InetAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "The address portion of the route used to find the upstream
             or parent interface for this multicast forwarding entry.

             This address object is only significant up to
             mvpnMrouteRtPrefixLength bits.  The remaining address bits
             MUST be set to zero.

             For addresses of type 'ipv4z' or 'ipv6z', the appended zone
             index is significant even though it lies beyond the prefix
```

```
          length.  The use of these address types indicates that this
          forwarding state applies only within the given zone.  Zone
          index zero is not valid in this table.
         "
    ::= { mvpnMrouteEntry 14 }

  mvpnMrouteRtPrefixLength OBJECT-TYPE
     SYNTAX     InetAddressPrefixLength
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The length in bits of the mask associated with the route
          used to find the upstream or parent interface for this
          multicast forwarding entry.

          If the corresponding InetAddressType is 'ipv4' or 'ipv4z',
          this object must be in the range 4..32.
          If the corresponding InetAddressType is 'ipv6' or 'ipv6z',
          this object must be in the range 8..128.
         "
     ::= { mvpnMrouteEntry 15 }

  mvpnMrouteRtType OBJECT-TYPE
     SYNTAX     INTEGER {
                          unicast   (1),
                          multicast (2)
                        }
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The reason for placing the route in the (logical)
          multicast Routing Information Base (RIB).

          The enumerated reasons and the corresponding
          descriptions are as follows:

            unicast:
              The route would normally be placed only in
              the unicast RIB, but it was placed in the multicast
              RIB by local configuration, such as when running
              PIM over RIP.

            multicast:
              The route was explicitly added to the multicast RIB by
              the routing protocol, such as the Distance Vector
              Multicast Routing Protocol (DVMRP) or Multiprotocol BGP.
         "
     ::= { mvpnMrouteEntry 16 }
```

```
  mvpnMrouteOctets OBJECT-TYPE
     SYNTAX     Counter64
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The number of octets contained in IP datagrams that were
          received from sources represented by this entry and
          addressed to this multicast group address and that were
          forwarded by this router.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnMrouteCounterDiscontinuityTime object.
         "
     ::= { mvpnMrouteEntry 17 }

  mvpnMroutePkts OBJECT-TYPE
     SYNTAX     Counter64
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The number of packets routed using this multicast route
          entry.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnMrouteCounterDiscontinuityTime object.
         "
     ::= { mvpnMrouteEntry 18 }

  mvpnMrouteTtlDroppedOctets OBJECT-TYPE
     SYNTAX     Counter64
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The number of octets contained in IP datagrams that this
          router has received from sources represented by
          this entry and addressed to this multicast group address,
          which were dropped due to Time To Live (TTL) issues.
          TTL issues occur when the TTL (IPv4) or Hop Limit (IPv6)
          of the incoming packet was decremented to zero or to a
          value less than ipMcastInterfaceTtl of the corresponding
          interface.

          The ipMcastInterfaceTtl object is defined in IPMCAST-MIB
          (RFC 5132) and represents the datagram TTL
```

```
          threshold for the interface.  Any IP multicast datagrams
          with a TTL (IPv4) or Hop Limit (IPv6) less than this
          threshold will not be forwarded out of the interface.
          The default value of zero means all multicast packets are
          forwarded out of the interface.  A value of 256 means that
          no multicast packets are forwarded out of the interface.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnMrouteCounterDiscontinuityTime object.
         "
    REFERENCE
        "RFC 5132, Section 6
        "
    ::= { mvpnMrouteEntry 19 }

  mvpnMrouteTtlDroppedPackets OBJECT-TYPE
    SYNTAX     Counter64
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "The number of packets that this router has received from
         the sources represented by this entry and addressed to this
         multicast group address, which were dropped due to
         Time To Live (TTL) issues.  TTL issues occur when the
         TTL (IPv4) or Hop Limit (IPv6) of the incoming packet was
         decremented to zero or to a value less than
         ipMcastInterfaceTtl of the corresponding interface.

         The ipMcastInterfaceTtl object is defined in IPMCAST-MIB
         (RFC 5132) and represents the datagram TTL
         threshold for the interface.  Any IP multicast datagrams
         with a TTL (IPv4) or Hop Limit (IPv6) less than this
         threshold will not be forwarded out of the interface.
         The default value of zero means all multicast packets are
         forwarded out of the interface.  A value of 256 means that
         no multicast packets are forwarded out of the interface.

         Discontinuities in the value of this counter can
         occur at re-initialization of the management system
         and at other times as indicated by the corresponding
         mvpnMrouteCounterDiscontinuityTime object.
        "
    REFERENCE
        "RFC 5132, Section 6
        "
    ::= { mvpnMrouteEntry 20 }
```

```
  mvpnMrouteDroppedInOctets OBJECT-TYPE
     SYNTAX     Counter64
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The number of octets contained in IP datagrams that this
          router has received from sources represented by
          this entry and addressed to this multicast group address,
          which were dropped due to an error(s).
          The value of this object includes the octets counted
          in the corresponding mvpnMrouteTtlDroppedOctets object.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnMrouteCounterDiscontinuityTime object.
         "
     ::= { mvpnMrouteEntry 21 }

  mvpnMrouteDroppedInPackets OBJECT-TYPE
     SYNTAX     Counter64
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The number of packets that this router has received from
          sources represented by this entry and addressed to this
          multicast group address, which were dropped due to an
          error(s).  The value of this object includes the number
          of octets counted in the corresponding
          mvpnMrouteTtlDroppedPackets object.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnMrouteCounterDiscontinuityTime object.
         "
     ::= { mvpnMrouteEntry 22 }

  mvpnMroutePmsiPointer OBJECT-TYPE
     SYNTAX        RowPointer
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "A pointer to a conceptual row representing
          the corresponding I-PMSI in mvpnPmsiTable or S-PMSI
          in mvpnSpmsiTable that this C-multicast route is using.
         "
     ::= { mvpnMrouteEntry 23 }
```

```
  mvpnMrouteNumberOfLocalReplication OBJECT-TYPE
     SYNTAX        Unsigned32
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "Number of replications for local receivers.
          For example, if an ingress PE needs to send traffic out of
          N PE-CE interfaces, then mvpnMrouteNumberOfLocalReplication
          is N.
         "
     ::= { mvpnMrouteEntry 24 }

  mvpnMrouteNumberOfRemoteReplication OBJECT-TYPE
     SYNTAX        Unsigned32
     MAX-ACCESS    read-only
     STATUS        current
     DESCRIPTION
         "Number of local replications for remote PEs.  For example,
          if the number of remote PEs that need to receive traffic is N,
          then mvpnMrouteNumberOfRemoteReplication is N in case of
          Ingress Replication, but it may be less than N in case of
          RSVP-TE or mLDP Point-to-Multipoint (P2MP) tunnels, depending
          on the actual number of replications the PE needs to do.
         "
     ::= { mvpnMrouteEntry 25 }

  mvpnMrouteCounterDiscontinuityTime 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 application's
          counters, viz., counters with the OID prefix
          'mvpnMrouteOctets', 'mvpnMroutePkts',
          'mvpnMrouteTtlDroppedOctets',
          'mvpnMrouteTtlDroppedPackets',
          'mvpnMrouteDroppedInOctets', or 'mvpnMrouteDroppedInPackets',
          suffered a discontinuity.
          If no such discontinuities have occurred since the
          last re-initialization of the local management
          subsystem, this object will have a zero value.
         "
     ::= { mvpnMrouteEntry 26 }
```

```
  -- Table of Next Hops for Multicast Routes in an MVPN

  mvpnMrouteNextHopTable OBJECT-TYPE
     SYNTAX     SEQUENCE OF MvpnMrouteNextHopEntry
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "A conceptual table containing information on the
          next hops for routing IP multicast datagrams.
          Each entry is one of a list of next hops for
          a set of sources sending to a multicast group
          address.
         "
     ::= { mvpnObjects 8 }

  mvpnMrouteNextHopEntry OBJECT-TYPE
     SYNTAX     MvpnMrouteNextHopEntry
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "A conceptual row corresponding to a next hop to which
          IP multicast datagrams from a set of sources to
          an IP multicast group address are routed.

          Implementers need to be aware that if the total number of
          octets in mplsL3VpnVrfName, mvpnMrouteNextHopGroupAddr,
          mvpnMrouteNextHopSourceAddrs, and mvpnMrouteNextHopAddr
          exceeds 111, the OIDs of column instances in this row
          will have more than 128 sub-identifiers and cannot be
          accessed using SNMPv1, SNMPv2c, or SNMPv3.
         "
     INDEX      {
                  mplsL3VpnVrfName,
                  mvpnMrouteNextHopGroupAddrType,
                  mvpnMrouteNextHopGroupAddr,
                  mvpnMrouteNextHopGroupPrefixLength,
                  mvpnMrouteNextHopSourceAddrType,
                  mvpnMrouteNextHopSourceAddrs,
                  mvpnMrouteNextHopSourcePrefixLength,
                  mvpnMrouteNextHopIfIndex,
                  mvpnMrouteNextHopAddrType,
                  mvpnMrouteNextHopAddr
                }
     ::= { mvpnMrouteNextHopTable 1 }

  MvpnMrouteNextHopEntry ::= SEQUENCE {
     mvpnMrouteNextHopGroupAddrType            InetAddressType,
     mvpnMrouteNextHopGroupAddr                InetAddress,
```

```
    mvpnMrouteNextHopGroupPrefixLength        InetAddressPrefixLength,
    mvpnMrouteNextHopSourceAddrType           InetAddressType,
    mvpnMrouteNextHopSourceAddrs              InetAddress,
    mvpnMrouteNextHopSourcePrefixLength       InetAddressPrefixLength,
    mvpnMrouteNextHopIfIndex                  InterfaceIndex,
    mvpnMrouteNextHopAddrType                 InetAddressType,
    mvpnMrouteNextHopAddr                     InetAddress,
    mvpnMrouteNextHopState                    INTEGER,
    mvpnMrouteNextHopExpiryTime               TimeTicks,
    mvpnMrouteNextHopClosestMemberHops        Unsigned32,
    mvpnMrouteNextHopProtocol                 IANAipMRouteProtocol,
    mvpnMrouteNextHopOctets                   Counter64,
    mvpnMrouteNextHopPkts                     Counter64,
    mvpnMrouteNextHopCounterDiscontinuityTime TimeStamp
}

mvpnMrouteNextHopGroupAddrType OBJECT-TYPE
   SYNTAX     InetAddressType
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION
       "The InetAddressType of the mvpnMrouteNextHopGroupAddr object
        that follows.
       "
   ::= { mvpnMrouteNextHopEntry 1 }

mvpnMrouteNextHopGroupAddr OBJECT-TYPE
   SYNTAX     InetAddress
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION
       "The IP multicast group address that, along with
        the corresponding mvpnMrouteNextHopGroupPrefixLength object,
        identifies destinations for which this entry contains
        multicast forwarding information.

        This address object is only significant up to
        mvpnMrouteNextHopGroupPrefixLength bits.  The remaining
        address bits MUST be set to zero.

        For addresses of type 'ipv4z' or 'ipv6z', the appended zone
        index is significant even though it lies beyond the prefix
        length.  The use of these address types indicates that this
        forwarding state applies only within the given zone.  Zone
        index zero is not valid in this table.
       "
   ::= { mvpnMrouteNextHopEntry 2 }
```

```
  mvpnMrouteNextHopGroupPrefixLength OBJECT-TYPE
     SYNTAX     InetAddressPrefixLength
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The length in bits of the mask that, along with
          the corresponding mvpnMrouteGroupAddr object,
          identifies destinations for which this entry contains
          multicast routing information.

          If the corresponding InetAddressType is 'ipv4' or 'ipv4z',
          this object must be in the range 4..32.
          If the corresponding InetAddressType is 'ipv6' or 'ipv6z',
          this object must be in the range 8..128.
         "
     ::= { mvpnMrouteNextHopEntry 3 }

  mvpnMrouteNextHopSourceAddrType OBJECT-TYPE
     SYNTAX     InetAddressType
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The InetAddressType of the mvpnMrouteNextHopSourceAddrs
          object that follows.

          A value of unknown(0) indicates a non-source-specific entry,
          corresponding to all sources in the group.  Otherwise, the
          value MUST be the same as the value of
          mvpnMrouteNextHopGroupAddrType.
         "
     ::= { mvpnMrouteNextHopEntry 4 }

  mvpnMrouteNextHopSourceAddrs OBJECT-TYPE
     SYNTAX     InetAddress
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The network address that, along with the
          corresponding mvpnMrouteNextHopSourcePrefixLength object,
          identifies the sources for which this entry specifies
          a next hop.

          This address object is only significant up to
          mvpnMrouteNextHopSourcePrefixLength bits.  The remaining
          address bits MUST be set to zero.

          For addresses of type 'ipv4z' or 'ipv6z', the appended zone
          index is significant even though it lies beyond the prefix
```

```
          length.  The use of these address types indicates that this
          source address applies only within the given zone.  Zone
          index zero is not valid in this table.
         "
    ::= { mvpnMrouteNextHopEntry 5 }

  mvpnMrouteNextHopSourcePrefixLength OBJECT-TYPE
     SYNTAX     InetAddressPrefixLength
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The length in bits of the mask that, along with
          the corresponding mvpnMrouteNextHopSourceAddrs object,
          identifies the sources for which this entry specifies
          a next hop.

          If the corresponding InetAddressType is 'ipv4' or 'ipv4z',
          this object must be in the range 4..32.
          If the corresponding InetAddressType is 'ipv6' or 'ipv6z',
          this object must be in the range 8..128.
          If the corresponding InetAddressType is 'unknown',
          this object must be zero.
         "
     ::= { mvpnMrouteNextHopEntry 6 }

  mvpnMrouteNextHopIfIndex OBJECT-TYPE
     SYNTAX     InterfaceIndex
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The ifIndex value of the outgoing interface
          for this next hop.
         "
     ::= { mvpnMrouteNextHopEntry 7 }

  mvpnMrouteNextHopAddrType OBJECT-TYPE
     SYNTAX     InetAddressType
     MAX-ACCESS not-accessible
     STATUS     current
     DESCRIPTION
         "The InetAddressType of the mvpnMrouteNextHopAddr object
          that follows.
         "
     ::= { mvpnMrouteNextHopEntry 8 }

  mvpnMrouteNextHopAddr OBJECT-TYPE
     SYNTAX     InetAddress
     MAX-ACCESS not-accessible
```

```
    STATUS     current
    DESCRIPTION
        "The address of the next hop specific to this entry.  For
         most interfaces, this is identical to
         mvpnMrouteNextHopGroupAddr.  Non-Broadcast Multi-Access
         (NBMA) interfaces, however, may have multiple next-hop
         addresses out of a single outgoing interface.
        "
    ::= { mvpnMrouteNextHopEntry 9 }

  mvpnMrouteNextHopState OBJECT-TYPE
    SYNTAX     INTEGER {
                         pruned(1),
                         forwarding(2)
                       }
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "An indication of whether the outgoing interface and next
         hop represented by this entry is currently being used to
         forward IP datagrams.

         The enumerated states and the corresponding
         descriptions are as follows:

           pruned     : this entry is not currently being used.
           forwarding : this entry is currently being used.
        "
    ::= { mvpnMrouteNextHopEntry 10 }

  mvpnMrouteNextHopExpiryTime OBJECT-TYPE
    SYNTAX     TimeTicks
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "The minimum amount of time remaining before this entry will
         be aged out.  If mvpnMrouteNextHopState is pruned(1),
         this object represents the remaining time for the prune
         to expire after which the state will return to forwarding(2).
         If mvpnMrouteNextHopState is forwarding(2),
         this object indicates the time after which this
         entry will be removed from the table.

         The value of zero indicates that the entry is not subject to
         aging.
        "
    ::= { mvpnMrouteNextHopEntry 11 }
```

```
  mvpnMrouteNextHopClosestMemberHops OBJECT-TYPE
     SYNTAX     Unsigned32 (0..256)
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The minimum number of hops between this router and any
          member of this IP multicast group reached via this next hop
          on the corresponding outgoing interface.  Any IP multicast
          datagram for the group that has a TTL (IPv4) or a Hop Count
          (IPv6) less than mvpnMrouteNextHopClosestMemberHops will
          not be forwarded through this interface.

          A value of zero means all multicast datagrams are forwarded
          out of the interface.  A value of 256 means that no multicast
          datagrams are forwarded out of the interface.

          This is an optimization applied by multicast routing
          protocols that explicitly track hop counts to downstream
          listeners.  Multicast protocols that are not aware of hop
          counts to downstream listeners set this object to zero.
         "
     ::= { mvpnMrouteNextHopEntry 12 }

  mvpnMrouteNextHopProtocol OBJECT-TYPE
     SYNTAX     IANAipMRouteProtocol
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The routing protocol via which this next hop was learned.
         "
     ::= { mvpnMrouteNextHopEntry 13 }

  mvpnMrouteNextHopOctets OBJECT-TYPE
     SYNTAX     Counter64
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The number of octets of multicast packets that have been
          forwarded using this route.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnMrouteNextHopCounterDiscontinuityTime object.
         "
     ::= { mvpnMrouteNextHopEntry 14 }
```

```
  mvpnMrouteNextHopPkts OBJECT-TYPE
     SYNTAX     Counter64
     MAX-ACCESS read-only
     STATUS     current
     DESCRIPTION
         "The number of packets that have been forwarded using this
          route.

          Discontinuities in the value of this counter can
          occur at re-initialization of the management system
          and at other times as indicated by the corresponding
          mvpnMrouteNextHopCounterDiscontinuityTime object.
         "
     ::= { mvpnMrouteNextHopEntry 15 }

  mvpnMrouteNextHopCounterDiscontinuityTime 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 application's
          counters, viz., counters with the OID prefix
          'mvpnMrouteNextHopOctets' or 'mvpnMrouteNextHopPackets',
          suffered a discontinuity.
          If no such discontinuities have occurred since the
          last re-initialization of the local management
          subsystem, this object will have a zero value.
         "
     ::= { mvpnMrouteNextHopEntry 16 }

  -- MVPN Notifications

  mvpnMvrfActionTaken NOTIFICATION-TYPE
     OBJECTS     {
                   mvpnGenMvrfCreationTime,
                   mvpnGenMvrfLastAction,
                   mvpnGenMvrfLastActionTime,
                   mvpnGenMvrfCreationTime,
                   mvpnGenCmcastRouteProtocol,
                   mvpnGenUmhSelection,
                   mvpnGenCustomerSiteType
                 }
     STATUS      current
     DESCRIPTION
         "mvpnMvrfActionTaken notifies about a change
          in an MVRF on the PE.  The change itself will be given by
          mvpnGenMvrfLastAction.
```

```
            "
        ::= { mvpnNotifications 1 }

    -- MVPN MIB Conformance Information

    mvpnGroups      OBJECT IDENTIFIER ::= { mvpnConformance 1 }
    mvpnCompliances OBJECT IDENTIFIER ::= { mvpnConformance 2 }

    -- Compliance Statements

        mvpnModuleFullCompliance MODULE-COMPLIANCE
           STATUS  current
           DESCRIPTION
                "Compliance statement for agents that provide full support
                 for BGP-MPLS-LAYER3-VPN-MULTICAST-MIB.
                "
           MODULE  -- this module
           MANDATORY-GROUPS {
               mvpnScalarGroup,
               mvpnGenericGroup,
               mvpnPmsiGroup,
               mvpnAdvtStatsGroup,
               mvpnMrouteGroup,
               mvpnMrouteNextHopGroup,
               mvpnNotificationGroup
           }

           GROUP mvpnBgpScalarGroup
               DESCRIPTION
                   "This group is mandatory for systems that support
                    BGP-MVPN.
                   "

           GROUP mvpnBgpGroup
               DESCRIPTION
                   "This group is mandatory for systems that support
                    BGP-MVPN.
                   "

           ::= { mvpnCompliances 1 }

        mvpnModuleReadOnlyCompliance MODULE-COMPLIANCE
           STATUS  current
           DESCRIPTION "Compliance requirement for implementations that
                        only provide read-only support for
                        BGP-MPLS-LAYER3-VPN-MULTICAST-MIB.  Such devices
                        can then be monitored but cannot be configured
                        using this MIB module.
```

```
                "
        MODULE  -- this module
        MANDATORY-GROUPS {
            mvpnScalarGroup,
            mvpnGenericGroup,
            mvpnPmsiGroup,
            mvpnAdvtStatsGroup,
            mvpnMrouteGroup,
            mvpnMrouteNextHopGroup,
            mvpnNotificationGroup
        }

        GROUP mvpnBgpScalarGroup
            DESCRIPTION
                "This group is mandatory for systems that support
                 BGP-MVPN.
                "
        GROUP mvpnBgpGroup
            DESCRIPTION
                "This group is mandatory for systems that support
                 BGP-MVPN.
                "

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

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

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

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

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

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

        OBJECT       mvpnBgpMaxSrcActiveAdRoutes
```

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

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

        ::= { mvpnCompliances 2 }

     mvpnModuleAdvtStatsCompliance MODULE-COMPLIANCE
        STATUS  current
        DESCRIPTION
             "Compliance statement for agents that support
              the monitoring of the statistics pertaining
              to advertisements sent/received by a PE.
             "
        MODULE  -- this module

        MANDATORY-GROUPS {
            mvpnAdvtStatsGroup
        }

        ::= { mvpnCompliances 3 }

  -- Units of Conformance

     mvpnScalarGroup    OBJECT-GROUP
         OBJECTS {
                   mvpnMvrfs,
                   mvpnV4Mvrfs,
                   mvpnV6Mvrfs,
                   mvpnPimV4Mvrfs,
                   mvpnPimV6Mvrfs,
                   mvpnSPTunnelLimit
                 }
         STATUS      current
         DESCRIPTION
             "These objects are used to monitor/manage
              global statistics and parameters.
             "
         ::= { mvpnGroups 1 }

     mvpnBgpScalarGroup    OBJECT-GROUP
         OBJECTS {
                   mvpnMldpMvrfs,
                   mvpnBgpV4Mvrfs,
                   mvpnBgpV6Mvrfs,
                   mvpnBgpCmcastRouteWithdrawalTimer,
```

```
                mvpnBgpSrcSharedTreeJoinTimer
            }
        STATUS      current
        DESCRIPTION
            "These objects are used to monitor/manage
             BGP-MVPN-specific global parameters.
            "
        ::= { mvpnGroups 2 }

    mvpnGenericGroup    OBJECT-GROUP
        OBJECTS {
                mvpnGenMvrfLastAction,
                mvpnGenMvrfLastActionTime,
                mvpnGenMvrfCreationTime,
                mvpnGenCmcastRouteProtocol,
                mvpnGenIpmsiInfo,
                mvpnGenInterAsPmsiInfo,
                mvpnGenUmhSelection,
                mvpnGenCustomerSiteType
            }
        STATUS      current
        DESCRIPTION
            "These objects are used to monitor MVPNs on a PE.
            "
        ::= { mvpnGroups 3 }

    mvpnBgpGroup    OBJECT-GROUP
        OBJECTS {
                mvpnBgpMode,
                mvpnBgpVrfRouteImportExtendedCommunity,
                mvpnBgpSrcASExtendedCommunity,
                mvpnBgpMsgRateLimit,
                mvpnBgpMaxSpmsiAdRoutes,
                mvpnBgpMaxSpmsiAdRouteFreq,
                mvpnBgpMaxSrcActiveAdRoutes,
                mvpnBgpMaxSrcActiveAdRouteFreq
            }
        STATUS      current
        DESCRIPTION
            "These objects are used to monitor/manage
             MVPN-wise BGP-specific parameters.
            "
        ::= { mvpnGroups 4 }

    mvpnPmsiGroup    OBJECT-GROUP
        OBJECTS {
                mvpnPmsiRD,
                mvpnPmsiTunnelType,
```

```
                    mvpnPmsiTunnelAttribute,
                    mvpnPmsiTunnelPimGroupAddrType,
                    mvpnPmsiTunnelPimGroupAddr,
                    mvpnPmsiEncapsulationType,
                    mvpnSpmsiPmsiPointer
                  }
        STATUS      current
        DESCRIPTION
            "These objects are used to monitor
             I-PMSI and S-PMSI tunnels on a PE.
            "
        ::= { mvpnGroups 5 }

    mvpnAdvtStatsGroup    OBJECT-GROUP
        OBJECTS {
                    mvpnAdvtSent,
                    mvpnAdvtReceived,
                    mvpnAdvtReceivedError,
                    mvpnAdvtReceivedMalformedTunnelType,
                    mvpnAdvtReceivedMalformedTunnelId,
                    mvpnAdvtLastSentTime,
                    mvpnAdvtLastReceivedTime,
                    mvpnAdvtCounterDiscontinuityTime
                  }
        STATUS      current
        DESCRIPTION
            "These objects are used to monitor
             the statistics pertaining to I-PMSI and S-PMSI
             advertisements sent/received by a PE.
            "
        ::= { mvpnGroups 6 }

    mvpnMrouteGroup    OBJECT-GROUP
        OBJECTS {
                    mvpnMrouteUpstreamNeighborAddrType,
                    mvpnMrouteUpstreamNeighborAddr,
                    mvpnMrouteInIfIndex,
                    mvpnMrouteExpiryTime,
                    mvpnMrouteProtocol,
                    mvpnMrouteRtProtocol,
                    mvpnMrouteRtAddrType,
                    mvpnMrouteRtAddr,
                    mvpnMrouteRtPrefixLength,
                    mvpnMrouteRtType,
                    mvpnMrouteOctets,
                    mvpnMroutePkts,
                    mvpnMrouteTtlDroppedOctets,
                    mvpnMrouteTtlDroppedPackets,
```

```
                    mvpnMrouteDroppedInOctets,
                    mvpnMrouteDroppedInPackets,
                    mvpnMroutePmsiPointer,
                    mvpnMrouteNumberOfLocalReplication,
                    mvpnMrouteNumberOfRemoteReplication,
                    mvpnMrouteCounterDiscontinuityTime
                  }
        STATUS      current
        DESCRIPTION
            "These objects are used to monitor multicast routing
             information corresponding to the MVRFs on a PE.
            "
        ::= { mvpnGroups 7 }

    mvpnMrouteNextHopGroup    OBJECT-GROUP
        OBJECTS {
                    mvpnMrouteNextHopState,
                    mvpnMrouteNextHopExpiryTime,
                    mvpnMrouteNextHopClosestMemberHops,
                    mvpnMrouteNextHopProtocol,
                    mvpnMrouteNextHopOctets,
                    mvpnMrouteNextHopPkts,
                    mvpnMrouteNextHopCounterDiscontinuityTime
                  }
        STATUS      current
        DESCRIPTION
            "These objects are used to monitor the information on
             next hops for routing datagrams to MVPNs on a PE.
            "
        ::= { mvpnGroups 8 }

    mvpnNotificationGroup NOTIFICATION-GROUP
        NOTIFICATIONS {
                     mvpnMvrfActionTaken
                      }
        STATUS  current
        DESCRIPTION
           "Objects required for MVPN notifications."
        ::= { mvpnGroups 9 }

  END
```

4. Security Considerations

This MIB module contains some read-only objects that may be deemed sensitive. It also contains some read-write objects whose settings will change the device's MVPN-related behavior. Appropriate security procedures that are related to SNMP in general but are not specific to this MIB module need to be implemented by concerned operators.

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write. 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. These are the tables and objects and their sensitivity/vulnerability:

- mvpnSPTunnelLimit

  The value of this object is used to control the maximum number of selective provider tunnels that a PE allows for a particular MVPN. Access to this object may be abused to impact the performance of the PE or prevent the PE from having new selective provider tunnels.

- mvpnBgpCmcastRouteWithdrawalTimer

  The value of this object is used to control the delay for the advertisement of withdrawals of C-multicast routes. Access to this object may be abused to impact the performance of a PE.

- mvpnBgpSrcSharedTreeJoinTimer

  The value of this object is used to control the delay for the advertisement of Source/Shared Tree Join C-multicast routes. Access to this object may be abused to impact the propagation of C-multicast routing information.

- mvpnBgpMsgRateLimit

  The value of this object is used to control the upper bound for the rate of BGP C-multicast routing information message exchange among PEs. Access to this object may be abused to impact the performance of the PE or disrupt the C-multicast routing information message exchange using BGP.

- mvpnBgpMaxSpmsiAdRoutes

  The value of this object is used to control the upper bound for the number of S-PMSI A-D routes. Access to this object may be abused to impact the performance of the PE or prevent the PE from receiving S-PMSI A-D routes.

- mvpnBgpMaxSpmsiAdRouteFreq

  The value of this object is used to control the upper bound for the frequency of S-PMSI A-D route generation. Access to this object may be abused to impact the performance of the PE or prevent the PE from generating new S-PMSI A-D routes.

- mvpnBgpMaxSrcActiveAdRoutes

  The value of this object is used to control the upper bound for the number of Source Active A-D routes. Access to this object may be abused to impact the performance of the PE or prevent the PE from receiving Source Active A-D routes.

- mvpnBgpMaxSrcActiveAdRouteFreq

  The value of this object is used to control the upper bound for the frequency of Source Active A-D route generation. Access to this object may be abused to impact the performance of the PE or prevent the PE from generating new Source Active A-D routes.

Some of the objects in this MIB module may be considered sensitive or vulnerable in some network environments. This includes INDEX objects with a MAX-ACCESS of not-accessible, and any indices from other modules exposed via AUGMENTS. 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 address-related objects in this MIB module may have impact on privacy and security. These objects may reveal the locations of senders and recipients.

  * mvpnPmsiTunnelPimGroupAddr

  * mvpnSpmsiCmcastGroupAddr

  * mvpnSpmsiCmcastSourceAddr

  * mvpnAdvtPeerAddr

* mvpnMrouteCmcastGroupAddr
* mvpnMrouteCmcastSourceAddrs
* mvpnMrouteUpstreamNeighborAddr
* mvpnMrouteRtAddr
* mvpnMrouteNextHopGroupAddr
* mvpnMrouteNextHopSourceAddrs
* mvpnMrouteNextHopAddr

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.

5. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER value recorded in the "SMI Network Management MGMT Codes Internet-standard MIB" registry:

Name	Description	OBJECT IDENTIFIER value
mvpnMIB	BGP-MPLS-LAYER3-VPN-MULTICAST-MIB	{ mib-2 243 }

6. References

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