

Network Working Group
Request for Comments: 5132
Obsoletes: 2932
Category: Standards Track

D. McWalter
Data Connection Ltd
D. Thaler
Microsoft Corporation
A. Kessler
Cisco Systems
December 2007

IP Multicast MIB

Status of This Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

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 objects used for managing multicast function, independent of the specific multicast protocol(s) in use. This document obsoletes RFC 2932.

Table of Contents

1. Introduction	2
1.1. Terminology	2
2. History	2
3. The Internet-Standard Management Framework	2
4. Overview	3
5. IMPORTED MIB Modules and REFERENCE Clauses	4
6. Definitions	4
7. Security Considerations	54
7.1. SNMPv3	54
7.2. Writeable Objects	54
7.3. Readable Objects	55
8. IANA Considerations	55
9. Acknowledgements	55
10. References	56
10.1. Normative References	56
10.2. Informative References	57

1. Introduction

This MIB describes objects used for managing IP multicast function, including IP multicast routing. These objects are independent of the specific multicast routing protocol in use. Managed objects specific to particular multicast protocols are defined elsewhere.

1.1. Terminology

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 [RFC2119].

2. History

This document obsoletes [RFC2932]. The MIB module defined by this document is a re-working of the MIB module from [RFC2932], with changes that include the following:

- o This MIB module includes support for IPv6 addressing and the IPv6 scoped address architecture. [RFC2932] supported only IPv4.
- o This MIB module allows several multicast protocols to perform routing on a single interface, where [RFC2932] assumed each interface supported at most one multicast routing protocol. Multicast routing protocols are now per-route, see `ipMcastRouteProtocol`.
- o This MIB module includes objects that are not specific to multicast routing. It allows management of multicast function on systems that do not perform routing, whereas [RFC2932] was restricted to multicast routing.
- o This MIB module includes a table of Source-Specific Multicast (SSM) address ranges to which SSM semantics [RFC3569] should be applied.
- o This MIB module includes a table of local applications that are receiving multicast data.
- o This MIB module includes a table of multicast scope zones.

3. 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], [RFC2579] and [RFC2580]).

4. Overview

This MIB module contains two scalars and eight tables. The tables are:

1. The IP Multicast Interface Table, which contains multicast information specific to interfaces.
2. The IP Multicast SSM Range Table, which contains one row per range of multicast group addresses to which Source-Specific Multicast semantics [RFC3569] should be applied.
3. The IP Multicast Route Table, which contains multicast routing information for IP datagrams sent by particular sources to the IP multicast groups known to a system.
4. The IP Multicast Routing Next Hop Table, which contains information about next-hops for the routing of IP multicast datagrams. Each entry is one of a list of next-hops on outgoing interfaces for particular sources sending to a particular multicast group address.
5. The IP Multicast Scope Boundary Table, which contains the boundaries configured for multicast scopes [RFC2365].
6. The IP Multicast Scope Name Table, which contains human-readable names for multicast scopes.
7. The IP Multicast Local Listener Table, which contains identifiers for local applications that are receiving multicast data.
8. The IP Multicast Zone Table, which contains an entry for each scope zone known to a system, and maps each zone to the multicast address range that is the corresponding scope.

This MIB module uses textual conventions defined in the IF-MIB [RFC2863], the INET-ADDRESS-MIB [RFC4001] and the IANA-RTPROTO-MIB.

5. IMPORTed MIB Modules and REFERENCE Clauses

The MIB modules defined in this document IMPORTs definitions normatively from the following MIB modules, beyond [RFC2578], [RFC2579], and [RFC2580]: HCNUM-TC [RFC2856], IF-MIB [RFC2863], IANA-RTPROTO-MIB, SNMP-FRAMEWORK-MIB [RFC3411], INET-ADDRESS-MIB [RFC4001], and LANGTAG-TC-MIB [RFC5131].

This MIB module also includes REFERENCE clauses that make normative references to Administratively Scoped IP Multicast [RFC2365], Unicast-Prefix-based IPv6 Multicast Addresses [RFC3306], IPv6 Scoped Address Architecture [RFC4007], and IPv6 Addressing Architecture [RFC4291].

Finally, this MIB module makes informative references to several RFCs in the text of DESCRIPTION clauses, including sysApplMIB [RFC2287], IP-MIB [RFC4293], Source-Specific Multicast [RFC3569], Protocol Independent Multicast-Sparse Mode version 2 (PIM-SMv2) Protocol Specification [RFC4601], Bidirectional Protocol Independent Multicast (BIDIR-PIM) [RFC5015], and Tags for Identifying Languages [RFC4646].

6. Definitions

IPMCAST-MIB DEFINITIONS ::= BEGIN

IMPORTS

MODULE-IDENTITY, OBJECT-TYPE,		
mib-2, Unsigned32, Counter64,		
Gauge32, TimeTicks	FROM SNMPv2-SMI	-- [RFC2578]
RowStatus, TruthValue,		
StorageType, TimeStamp	FROM SNMPv2-TC	-- [RFC2579]
MODULE-COMPLIANCE, OBJECT-GROUP	FROM SNMPv2-CONF	-- [RFC2580]
CounterBasedGauge64	FROM HCNUM-TC	-- [RFC2856]
InterfaceIndexOrZero,		
InterfaceIndex	FROM IF-MIB	-- [RFC2863]
IANAipRouteProtocol,		
IANAipMRouteProtocol	FROM IANA-RTPROTO-MIB	
SnmpAdminString	FROM SNMP-FRAMEWORK-MIB	-- [RFC3411]
InetAddress, InetAddressType,		
InetAddressPrefixLength,		
InetAddressIndex, InetVersion	FROM INET-ADDRESS-MIB	-- [RFC4001]
LangTag	FROM LANGTAG-TC-MIB;	-- [RFC5131]

ipMcastMIB MODULE-IDENTITY

LAST-UPDATED "200711090000Z" -- 9 November 2007
 ORGANIZATION "IETF MBONE Deployment (MBONED) Working Group"
 CONTACT-INFO "David McWalter
 Data Connection Limited

100 Church Street
Enfield, EN2 6BQ
UK

Phone: +44 208 366 1177
EMail: dmcw@dataconnection.com

Dave Thaler
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
US

Phone: +1 425 703 8835
EMail: dthaler@dthaler.microsoft.com

Andrew Kessler
Cisco Systems
425 E. Tasman Drive
San Jose, CA 95134
US

Phone: +1 408 526 5139
EMail: kessler@cisco.com"

DESCRIPTION

"The MIB module for management of IP Multicast, including multicast routing, data forwarding, and data reception.

Copyright (C) The IETF Trust (2007). This version of this MIB module is part of RFC 5132; see the RFC itself for full legal notices."

REVISION "200711090000Z" -- 9 November 2007

DESCRIPTION "Initial version, published as RFC 5132.

This MIB module obsoletes IPMROUTE-STD-MIB defined by [RFC2932]. Changes include the following:

- o This MIB module includes support for IPv6 addressing and the IPv6 scoped address architecture. [RFC2932] supported only IPv4.
- o This MIB module allows several multicast protocols to perform routing on a single interface, where [RFC2932] assumed each interface supported at most one multicast routing protocol. Multicast routing protocols are now per-route, see ipMcastRouteProtocol.

- o This MIB module includes objects that are not specific to multicast routing. It allows management of multicast function on systems that do not perform routing, whereas [RFC2932] was restricted to multicast routing.
- o This MIB module includes a table of Source-Specific Multicast (SSM) address ranges to which SSM semantics [RFC3569] should be applied.
- o This MIB module includes a table of local applications that are receiving multicast data.
- o This MIB module includes a table of multicast scope zones."

```
::= { mib-2 168 }
```

```
--
```

```
-- Top-level structure of the MIB
```

```
--
```

```
ipMcast      OBJECT IDENTIFIER ::= { ipMcastMIB 1 }
```

```
ipMcastEnabled OBJECT-TYPE
```

```
    SYNTAX      TruthValue
```

```
    MAX-ACCESS  read-write
```

```
    STATUS      current
```

```
    DESCRIPTION
```

```
        "The enabled status of IP Multicast function on this
        system."
```

```
        The storage type of this object is determined by
        ipMcastDeviceConfigStorageType."
```

```
::= { ipMcast 1 }
```

```
ipMcastRouteEntryCount OBJECT-TYPE
```

```
    SYNTAX      Gauge32
```

```
    MAX-ACCESS  read-only
```

```
    STATUS      current
```

```
    DESCRIPTION
```

```
        "The number of rows in the ipMcastRouteTable. This can be
        used to check for multicast routing activity, and to monitor
        the multicast routing table size."
```

```
::= { ipMcast 2 }
```

```
ipMcastDeviceConfigStorageType OBJECT-TYPE
```

```
    SYNTAX      StorageType
```

```
    MAX-ACCESS  read-write
```

```

STATUS      current
DESCRIPTION
    "The storage type used for the global IP multicast
    configuration of this device, comprised of the objects
    listed below.  If this storage type takes the value
    'permanent', write-access to the listed objects need not be
    allowed.

    The objects described by this storage type are:
    ipMcastEnabled."
    DEFVAL { nonVolatile }
    ::= { ipMcast 11 }

--
-- The Multicast Interface Table
--

ipMcastInterfaceTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF IpMcastInterfaceEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The (conceptual) table used to manage the multicast
        protocol active on an interface."
    ::= { ipMcast 3 }

ipMcastInterfaceEntry OBJECT-TYPE
    SYNTAX      IpMcastInterfaceEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "An entry (conceptual row) containing the multicast protocol
        information for a particular interface.

        Per-interface multicast forwarding statistics are also
        available in ipIfStatsTable."
    REFERENCE  "RFC 4293 ipIfStatsTable"
    INDEX      { ipMcastInterfaceIPVersion,
                ipMcastInterfaceIfIndex }
    ::= { ipMcastInterfaceTable 1 }

IpMcastInterfaceEntry ::= SEQUENCE {
    ipMcastInterfaceIPVersion      InetVersion,
    ipMcastInterfaceIfIndex        InterfaceIndex,
    ipMcastInterfaceTtl            Unsigned32,
    ipMcastInterfaceRateLimit      Unsigned32,
    ipMcastInterfaceStorageType    StorageType
}

```

ipMcastInterfaceIPVersion OBJECT-TYPE

SYNTAX InetVersion
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
 "The IP version of this row."
::= { ipMcastInterfaceEntry 1 }

ipMcastInterfaceIfIndex OBJECT-TYPE

SYNTAX InterfaceIndex
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
 "The index value that uniquely identifies the interface to which this entry is applicable. The interface identified by a particular value of this index is the same interface as identified by the same value of the IF-MIB's ifIndex."
::= { ipMcastInterfaceEntry 2 }

ipMcastInterfaceTtl OBJECT-TYPE

SYNTAX Unsigned32 (0..256)
MAX-ACCESS read-write
STATUS current
DESCRIPTION
 "The datagram Time to Live (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 the interface. The default value of 0 means all multicast packets are forwarded out the interface. A value of 256 means that no multicast packets are forwarded out the interface."
DEFVAL { 0 }
::= { ipMcastInterfaceEntry 3 }

ipMcastInterfaceRateLimit OBJECT-TYPE

SYNTAX Unsigned32
MAX-ACCESS read-write
STATUS current
DESCRIPTION
 "The rate-limit, in kilobits per second, of forwarded multicast traffic on the interface. A rate-limit of 0 indicates that no rate limiting is done."
DEFVAL { 0 }
::= { ipMcastInterfaceEntry 4 }

ipMcastInterfaceStorageType OBJECT-TYPE

SYNTAX StorageType
MAX-ACCESS read-write


```

STATUS      current
DESCRIPTION
    "The storage type for this row.  Rows having the value
    'permanent' need not allow write-access to any columnar
    objects in the row."
    DEFVAL { nonVolatile }
    ::= { ipMcastInterfaceEntry 5 }

--
-- The SSM Range Table
--

ipMcastSsmRangeTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF IpMcastSsmRangeEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "This table is used to create and manage the range(s) of
        group addresses to which SSM semantics should be applied."
    REFERENCE   "RFC 3569"
    ::= { ipMcast 4 }

ipMcastSsmRangeEntry OBJECT-TYPE
    SYNTAX      IpMcastSsmRangeEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "An entry (conceptual row) containing a range of group
        addresses to which SSM semantics should be applied.

        Object Identifiers (OIDs) are limited to 128
        sub-identifiers, but this limit is not enforced by the
        syntax of this entry.  In practice, this does not present
        a problem, because IP address types allowed by conformance
        statements do not exceed this limit."
    REFERENCE   "RFC 3569"
    INDEX       { ipMcastSsmRangeAddressType,
                  ipMcastSsmRangeAddress,
                  ipMcastSsmRangePrefixLength }
    ::= { ipMcastSsmRangeTable 1 }

IpMcastSsmRangeEntry ::= SEQUENCE {
    ipMcastSsmRangeAddressType  InetAddressType,
    ipMcastSsmRangeAddress      InetAddress,
    ipMcastSsmRangePrefixLength InetAddressPrefixLength,
    ipMcastSsmRangeRowStatus    RowStatus,
    ipMcastSsmRangeStorageType  StorageType
}

```

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

"The address type of the multicast group prefix."

::= { ipMcastSsmRangeEntry 1 }

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

"The multicast group address which, when combined with ipMcastSsmRangePrefixLength, gives the group prefix for this SSM range. The InetAddressType is given by ipMcastSsmRangeAddressType.

This address object is only significant up to ipMcastSsmRangePrefixLength bits. The remaining address bits are set to zero. This is especially important for this index field, which is part of the index of this entry. Any non-zero bits would signify an entirely different entry.

For IPv6 SSM address ranges, only ranges prefixed by FF3x::/16 are permitted, where 'x' is a valid IPv6 RFC 4291 multicast address scope. The syntax of the address range is given by RFC 3306, Sections 4 and 7.

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 indicate that this SSM range entry applies only within the given zone. Zone index zero is not valid in this table.

If non-global scope SSM range entries are present, then consistent ipMcastBoundaryTable entries are required on routers at the zone boundary."

REFERENCE "RFC 2365, RFC 4291 Section 2.7, RFC 3306 Sections 4, 6, and 7"

::= { ipMcastSsmRangeEntry 2 }

`ipMcastSsmRangePrefixLength OBJECT-TYPE``SYNTAX InetAddressPrefixLength``MAX-ACCESS not-accessible``STATUS current``DESCRIPTION`

"The length in bits of the mask which, when combined with

ipMcastSsmRangeAddress, gives the group prefix for this SSM range.

The InetAddressType is given by ipMcastSsmRangeAddressType. For values 'ipv4' and 'ipv4z', this object must be in the range 4..32. For values 'ipv6' and 'ipv6z', this object must be in the range 8..128."

REFERENCE "RFC 2365, RFC 4291 Section 2.7, RFC 3306 Sections 4, 6, and 7"

::= { ipMcastSsmRangeEntry 3 }

ipMcastSsmRangeRowStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The status of this row, by which rows in this table can be created and destroyed.

This status object can be set to active(1) without setting any other columnar objects in this entry.

All writeable objects in this entry can be modified when the status of this entry is active(1)."

::= { ipMcastSsmRangeEntry 4 }

ipMcastSsmRangeStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The storage type for this row. Rows having the value 'permanent' need not allow write-access to any columnar objects in the row."

DEFVAL { nonVolatile }

::= { ipMcastSsmRangeEntry 5 }

--

-- The IP Multicast Routing Table

--

ipMcastRouteTable OBJECT-TYPE

SYNTAX SEQUENCE OF IpMcastRouteEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The (conceptual) table containing multicast routing information for IP datagrams sent by particular sources

to the IP multicast groups known to this router."
 ::= { ipMcast 5 }

ipMcastRouteEntry OBJECT-TYPE

SYNTAX IpMcastRouteEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry (conceptual row) containing the multicast routing information for IP datagrams from a particular source and addressed to a particular IP multicast group address.

OIDs are limited to 128 sub-identifiers, but this limit is not enforced by the syntax of this entry. In practice, this does not present a problem, because IP address types allowed by conformance statements do not exceed this limit."

INDEX { ipMcastRouteGroupAddressType,
 ipMcastRouteGroup,
 ipMcastRouteGroupPrefixLength,
 ipMcastRouteSourceAddressType,
 ipMcastRouteSource,
 ipMcastRouteSourcePrefixLength }
 ::= { ipMcastRouteTable 1 }

IpMcastRouteEntry ::= SEQUENCE {

ipMcastRouteGroupAddressType	InetAddressType,
ipMcastRouteGroup	InetAddress,
ipMcastRouteGroupPrefixLength	InetAddressPrefixLength,
ipMcastRouteSourceAddressType	InetAddressType,
ipMcastRouteSource	InetAddress,
ipMcastRouteSourcePrefixLength	InetAddressPrefixLength,
ipMcastRouteUpstreamNeighborType	InetAddressType,
ipMcastRouteUpstreamNeighbor	InetAddress,
ipMcastRouteInIfIndex	InterfaceIndexOrZero,
ipMcastRouteTimeStamp	TimeStamp,
ipMcastRouteExpiryTime	TimeTicks,
ipMcastRouteProtocol	IANAipMRouteProtocol,
ipMcastRouteRtProtocol	IANAipRouteProtocol,
ipMcastRouteRtAddressType	InetAddressType,
ipMcastRouteRtAddress	InetAddress,
ipMcastRouteRtPrefixLength	InetAddressPrefixLength,
ipMcastRouteRtType	INTEGER,
ipMcastRouteOctets	Counter64,
ipMcastRoutePkts	Counter64,
ipMcastRouteTtlDropOctets	Counter64,
ipMcastRouteTtlDropPackets	Counter64,
ipMcastRouteDifferentInIfOctets	Counter64,
ipMcastRouteDifferentInIfPackets	Counter64,

```

    ipMcastRouteBps                               CounterBasedGauge64
}

ipMcastRouteGroupAddressType OBJECT-TYPE
    SYNTAX      InetAddressType
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "A value indicating the address family of the address
        contained in ipMcastRouteGroup.  Legal values correspond to
        the subset of address families for which multicast
        forwarding is supported."
    ::= { ipMcastRouteEntry 1 }

ipMcastRouteGroup OBJECT-TYPE
    SYNTAX      InetAddress
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The IP multicast group address which, when combined with
        the corresponding value specified in
        ipMcastRouteGroupPrefixLength, identifies the groups for
        which this entry contains multicast routing information.

        This address object is only significant up to
        ipMcastRouteGroupPrefixLength bits.  The remaining address
        bits are set to zero.  This is especially important for this
        index field, which is part of the index of this entry.  Any
        non-zero bits would signify an entirely different entry.

        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 indicate that this
        forwarding state applies only within the given zone.  Zone
        index zero is not valid in this table."
    ::= { ipMcastRouteEntry 2 }

ipMcastRouteGroupPrefixLength OBJECT-TYPE
    SYNTAX      InetAddressPrefixLength
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The length in bits of the mask which, when combined with
        the corresponding value of ipMcastRouteGroup, identifies the
        groups for which this entry contains multicast routing
        information.

        The InetAddressType is given by

```

ipMcastRouteGroupAddressType. For values 'ipv4' and 'ipv4z', this object must be in the range 4..32. For values 'ipv6' and 'ipv6z', this object must be in the range 8..128."

::= { ipMcastRouteEntry 3 }

ipMcastRouteSourceAddressType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A value indicating the address family of the address contained in ipMcastRouteSource.

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 ipMcastRouteGroupType."

::= { ipMcastRouteEntry 4 }

ipMcastRouteSource OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The network address which, when combined with the corresponding value of ipMcastRouteSourcePrefixLength, identifies the sources for which this entry contains multicast routing information.

This address object is only significant up to ipMcastRouteSourcePrefixLength bits. The remaining address bits are set to zero. This is especially important for this index field, which is part of the index of this entry. Any non-zero bits would signify an entirely different entry.

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 indicate that this source address applies only within the given zone. Zone index zero is not valid in this table."

::= { ipMcastRouteEntry 5 }

ipMcastRouteSourcePrefixLength OBJECT-TYPE

SYNTAX InetAddressPrefixLength

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The length in bits of the mask which, when combined with the corresponding value of ipMcastRouteSource, identifies the sources for which this entry contains multicast routing information.

The InetAddressType is given by ipMcastRouteSourceAddressType. For the value 'unknown', this object must be zero. For values 'ipv4' and 'ipv4z', this object must be in the range 4..32. For values 'ipv6' and 'ipv6z', this object must be in the range 8..128."

::= { ipMcastRouteEntry 6 }

ipMcastRouteUpstreamNeighborType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"A value indicating the address family of the address contained in ipMcastRouteUpstreamNeighbor.

An address type of unknown(0) indicates that the upstream neighbor is unknown, for example in BIDIR-PIM."

REFERENCE "RFC 5015"

::= { ipMcastRouteEntry 7 }

ipMcastRouteUpstreamNeighbor OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The address of the upstream neighbor (for example, RPF neighbor) from which IP datagrams from these sources to this multicast address are received."

::= { ipMcastRouteEntry 8 }

ipMcastRouteInIfIndex 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 to this multicast address are received. A value of 0 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"

::= { ipMcastRouteEntry 9 }

`ipMcastRouteTimeStamp OBJECT-TYPE``SYNTAX TimeStamp``MAX-ACCESS read-only``STATUS current``DESCRIPTION`

"The value of sysUpTime at which the multicast routing information represented by this entry was learned by the router.

If this information was present at the most recent re-initialization of the local management subsystem, then this object contains a zero value."

`::= { ipMcastRouteEntry 10 }``ipMcastRouteExpiryTime 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 0 indicates that the entry is not subject to aging. If ipMcastRouteNextHopState is pruned(1), this object represents the remaining time until the prune expires. If this timer expires, state reverts to forwarding(2). Otherwise, this object represents the time until this entry is removed from the table."

`::= { ipMcastRouteEntry 11 }``ipMcastRouteProtocol OBJECT-TYPE``SYNTAX IANAipMRouteProtocol``MAX-ACCESS read-only``STATUS current``DESCRIPTION`

"The multicast routing protocol via which this multicast forwarding entry was learned."

`::= { ipMcastRouteEntry 12 }``ipMcastRouteRtProtocol OBJECT-TYPE``SYNTAX IANAipRouteProtocol``MAX-ACCESS read-only``STATUS current``DESCRIPTION`

"The routing mechanism via which the route used to find the upstream or parent interface for this multicast forwarding entry was learned."

`::= { ipMcastRouteEntry 13 }``ipMcastRouteRtAddressType OBJECT-TYPE`

SYNTAX InetAddressType
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "A value indicating the address family of the address
 contained in ipMcastRouterRtAddress."
 ::= { ipMcastRouteEntry 14 }

ipMcastRouterRtAddress 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
 ipMcastRouteRtPrefixLength bits. The remaining address bits
 are 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 indicate that this
 forwarding state applies only within the given zone. Zone
 index zero is not valid in this table."
 ::= { ipMcastRouteEntry 15 }

ipMcastRouteRtPrefixLength 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.

 The InetAddressType is given by ipMcastRouterRtAddressType.
 For values 'ipv4' and 'ipv4z', this object must be in the
 range 4..32. For values 'ipv6' and 'ipv6z', this object
 must be in the range 8..128."
 ::= { ipMcastRouteEntry 16 }

ipMcastRouterRtType OBJECT-TYPE

SYNTAX INTEGER {
 unicast (1), -- Unicast route used in multicast RIB
 multicast (2) -- Multicast route
 }
MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The reason the given route was placed in the (logical) multicast Routing Information Base (RIB). A value of unicast means that the route would normally be placed only in the unicast RIB, but was placed in the multicast RIB due (instead or in addition) to local configuration, such as when running PIM over RIP. A value of multicast means that 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."

::= { ipMcastRouteEntry 17 }

ipMcastRouteOctets OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of octets contained in IP datagrams that were received from these sources and addressed to this multicast group address, and which were forwarded by this router.

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of routes being removed and replaced, which can be detected by observing the value of ipMcastRouteTimeStamp."

::= { ipMcastRouteEntry 18 }

ipMcastRoutePkts OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of packets routed using this multicast route entry.

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of routes being removed and replaced, which can be detected by observing the value of ipMcastRouteTimeStamp."

::= { ipMcastRouteEntry 19 }

ipMcastRouteTtlDropOctets 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 these sources and addressed to this multicast group address, which were dropped because the TTL (IPv4) or Hop Limit (IPv6) was decremented to zero, or to a value less than ipMcastInterfaceTtl for all next hops.

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of routes being removed and replaced, which can be detected by observing the value of ipMcastRouteTimeStamp."

::= { ipMcastRouteEntry 20 }

ipMcastRouteTtlDropPackets OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of packets that this router has received from these sources and addressed to this multicast group address, which were dropped because the TTL (IPv4) or Hop Limit (IPv6) was decremented to zero, or to a value less than ipMcastInterfaceTtl for all next hops.

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of routes being removed and replaced, which can be detected by observing the value of ipMcastRouteTimeStamp."

::= { ipMcastRouteEntry 21 }

ipMcastRouteDifferentInIfOctets 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 these sources and addressed to this multicast group address, which were dropped because they were received on an unexpected interface.

For RPF checking protocols (such as PIM-SM), these packets arrived on interfaces other than ipMcastRouteInIfIndex, and were dropped because of this failed RPF check. (RPF paths are 'Reverse Path Forwarding' paths; the unicast routes to the expected origin of multicast data flows).

Other protocols may drop packets on an incoming interface check for different reasons (for example, BIDIR-PIM performs a DF check on receipt of packets). All packets dropped as a result of an incoming interface check are counted here.

If this counter increases rapidly, this indicates a problem. A significant quantity of multicast data is arriving at this router on unexpected interfaces, and is not being forwarded.

For guidance, if the rate of increase of this counter exceeds 1% of the rate of increase of ipMcastRouteOctets, then there are multicast routing problems that require investigation.

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of routes being removed and replaced, which can be detected by observing the value of ipMcastRouteTimeStamp."

REFERENCE "RFC 4601 and RFC 5015"

::= { ipMcastRouteEntry 22 }

ipMcastRouteDifferentInIfPackets OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of packets which this router has received from these sources and addressed to this multicast group address, which were dropped because they were received on an unexpected interface.

For RPF checking protocols (such as PIM-SM), these packets arrived on interfaces other than ipMcastRouteInIfIndex, and were dropped because of this failed RPF check. (RPF paths are 'Reverse Path Forwarding' path; the unicast routes to the expected origin of multicast data flows).

Other protocols may drop packets on an incoming interface check for different reasons (for example, BIDIR-PIM performs a DF check on receipt of packets). All packets dropped as a result of an incoming interface check are counted here.

If this counter increases rapidly, this indicates a problem. A significant quantity of multicast data is arriving at this router on unexpected interfaces, and is not being forwarded.

For guidance, if the rate of increase of this counter

exceeds 1% of the rate of increase of ipMcastRoutePkts, then there are multicast routing problems that require investigation.

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of routes being removed and replaced, which can be detected by observing the value of ipMcastRouteTimeStamp."

REFERENCE "RFC 4601 and RFC 5015"

::= { ipMcastRouteEntry 23 }

ipMcastRouteBps OBJECT-TYPE

SYNTAX CounterBasedGauge64

UNITS "bits per second"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Bits per second forwarded by this router using this multicast routing entry.

This value is a sample; it is the number of bits forwarded during the last whole 1 second sampling period. The value during the current 1 second sampling period is not made available until the period is completed.

The quantity being sampled is the same as that measured by ipMcastRouteOctets. The units and the sampling method are different."

::= { ipMcastRouteEntry 24 }

--

-- The IP Multicast Routing Next Hop Table

--

ipMcastRouteNextHopTable OBJECT-TYPE

SYNTAX SEQUENCE OF IpMcastRouteNextHopEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The (conceptual) table containing information on the next-hops on outgoing interfaces for routing IP multicast datagrams. Each entry is one of a list of next-hops on outgoing interfaces for particular sources sending to a particular multicast group address."

::= { ipMcast 6 }

ipMcastRouteNextHopEntry OBJECT-TYPE

SYNTAX IpMcastRouteNextHopEntry

MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION

"An entry (conceptual row) in the list of next-hops on outgoing interfaces to which IP multicast datagrams from particular sources to an IP multicast group address are routed.

OIDs are limited to 128 sub-identifiers, but this limit is not enforced by the syntax of this entry. In practice, this does not present a problem, because IP address types allowed by conformance statements do not exceed this limit."

INDEX { ipMcastRouteNextHopGroupAddressType,
 ipMcastRouteNextHopGroup,
 ipMcastRouteNextHopGroupPrefixLength,
 ipMcastRouteNextHopSourceAddressType,
 ipMcastRouteNextHopSource,
 ipMcastRouteNextHopSourcePrefixLength,
 ipMcastRouteNextHopIfIndex,
 ipMcastRouteNextHopAddressType,
 ipMcastRouteNextHopAddress }
 ::= { ipMcastRouteNextHopTable 1 }

```
IpMcastRouteNextHopEntry ::= SEQUENCE {
    ipMcastRouteNextHopGroupAddressType    InetAddressType,
    ipMcastRouteNextHopGroup                InetAddress,
    ipMcastRouteNextHopGroupPrefixLength    InetAddressPrefixLength,
    ipMcastRouteNextHopSourceAddressType    InetAddressType,
    ipMcastRouteNextHopSource                InetAddress,
    ipMcastRouteNextHopSourcePrefixLength    InetAddressPrefixLength,
    ipMcastRouteNextHopIfIndex              InterfaceIndex,
    ipMcastRouteNextHopAddressType          InetAddressType,
    ipMcastRouteNextHopAddress              InetAddress,
    ipMcastRouteNextHopState                INTEGER,
    ipMcastRouteNextHopTimeStamp            TimeStamp,
    ipMcastRouteNextHopExpiryTime           TimeTicks,
    ipMcastRouteNextHopClosestMemberHops    Unsigned32,
    ipMcastRouteNextHopProtocol             IANAipMRouteProtocol,
    ipMcastRouteNextHopOctets               Counter64,
    ipMcastRouteNextHopPkts                 Counter64
}
```

ipMcastRouteNextHopGroupAddressType OBJECT-TYPE

SYNTAX InetAddressType
 MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION

"A value indicating the address family of the address

contained in ipMcastRouteNextHopGroup. Legal values correspond to the subset of address families for which multicast forwarding is supported."

::= { ipMcastRouteNextHopEntry 1 }

ipMcastRouteNextHopGroup OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The IP multicast group address which, when combined with the corresponding value specified in ipMcastRouteNextHopGroupPrefixLength, identifies the groups for which this entry contains multicast forwarding information.

This address object is only significant up to ipMcastRouteNextHopGroupPrefixLength bits. The remaining address bits are set to zero. This is especially important for this index field, which is part of the index of this entry. Any non-zero bits would signify an entirely different entry.

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 indicate that this forwarding state applies only within the given zone. Zone index zero is not valid in this table."

::= { ipMcastRouteNextHopEntry 2 }

ipMcastRouteNextHopGroupPrefixLength OBJECT-TYPE

SYNTAX InetAddressPrefixLength

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The length in bits of the mask which, when combined with the corresponding value of ipMcastRouteGroup, identifies the groups for which this entry contains multicast routing information.

The InetAddressType is given by ipMcastRouteNextHopGroupAddressType. For values 'ipv4' and 'ipv4z', this object must be in the range 4..32. For values 'ipv6' and 'ipv6z', this object must be in the range 8..128."

::= { ipMcastRouteNextHopEntry 3 }

ipMcastRouteNextHopSourceAddressType OBJECT-TYPE

SYNTAX InetAddressType
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"A value indicating the address family of the address contained in ipMcastRouteNextHopSource.

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 ipMcastRouteNextHopGroupType."

::= { ipMcastRouteNextHopEntry 4 }

ipMcastRouteNextHopSource OBJECT-TYPE

SYNTAX InetAddress
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"The network address which, when combined with the corresponding value of the mask specified in ipMcastRouteNextHopSourcePrefixLength, identifies the sources for which this entry specifies a next-hop on an outgoing interface.

This address object is only significant up to ipMcastRouteNextHopSourcePrefixLength bits. The remaining address bits are set to zero. This is especially important for this index field, which is part of the index of this entry. Any non-zero bits would signify an entirely different entry.

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 indicate that this source address applies only within the given zone. Zone index zero is not valid in this table."

::= { ipMcastRouteNextHopEntry 5 }

ipMcastRouteNextHopSourcePrefixLength OBJECT-TYPE

SYNTAX InetAddressPrefixLength
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"The length in bits of the mask which, when combined with the corresponding value specified in ipMcastRouteNextHopSource, identifies the sources for which this entry specifies a next-hop on an outgoing interface.

The InetAddressType is given by ipMcastRouteNextHopSourceAddressType. For the value 'unknown', this object must be zero. For values 'ipv4' and 'ipv4z', this object must be in the range 4..32. For values 'ipv6' and 'ipv6z', this object must be in the range 8..128."

::= { ipMcastRouteNextHopEntry 6 }

ipMcastRouteNextHopIfIndex OBJECT-TYPE

SYNTAX InterfaceIndex

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The ifIndex value of the interface for the outgoing interface for this next-hop."

::= { ipMcastRouteNextHopEntry 7 }

ipMcastRouteNextHopAddressType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A value indicating the address family of the address contained in ipMcastRouteNextHopAddress."

::= { ipMcastRouteNextHopEntry 8 }

ipMcastRouteNextHopAddress 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 ipMcastRouteNextHopGroup. Non-Broadcast Multi-Access (NBMA) interfaces, however, may have multiple next-hop addresses out a single outgoing interface."

::= { ipMcastRouteNextHopEntry 9 }

ipMcastRouteNextHopState 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 value 'forwarding' indicates it is currently being used; the value 'pruned' indicates it is

```
        not."
 ::= { ipMcastRouteNextHopEntry 10 }

ipMcastRouteNextHopTimeStamp OBJECT-TYPE
    SYNTAX      TimeStamp
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The value of sysUpTime at which the multicast routing
        information represented by this entry was learned by the
        router.

        If this information was present at the most recent re-
        initialization of the local management subsystem, then this
        object contains a zero value."
 ::= { ipMcastRouteNextHopEntry 11 }

ipMcastRouteNextHopExpiryTime 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 ipMcastRouteNextHopState is pruned(1), the
        remaining time until the prune expires and the state reverts
        to forwarding(2).  Otherwise, the remaining time until this
        entry is removed from the table.  The time remaining may be
        copied from ipMcastRouteExpiryTime if the protocol in use
        for this entry does not specify next-hop timers.  The value
        0 indicates that the entry is not subject to aging."
 ::= { ipMcastRouteNextHopEntry 12 }

ipMcastRouteNextHopClosestMemberHops 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 this outgoing interface.  Any IP multicast datagrams for
        the group that have a TTL (IPv4) or Hop Count (IPv6) less
        than this number of hops will not be forwarded to this
        next-hop.

        A value of 0 means all multicast datagrams are forwarded out
        the interface.  A value of 256 means that no multicast
        datagrams are forwarded out 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 0."

```
::= { ipMcastRouteNextHopEntry 13 }
```

```
ipMcastRouteNextHopProtocol OBJECT-TYPE
```

```
SYNTAX      IANAipMRouteProtocol
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

```
DESCRIPTION
```

"The routing mechanism via which this next-hop was learned."

```
::= { ipMcastRouteNextHopEntry 14 }
```

```
ipMcastRouteNextHopOctets 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 this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of routes being removed and replaced, which can be detected by observing the value of ipMcastRouteNextHopTimeStamp."

```
::= { ipMcastRouteNextHopEntry 15 }
```

```
ipMcastRouteNextHopPkts OBJECT-TYPE
```

```
SYNTAX      Counter64
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

```
DESCRIPTION
```

"The number of packets which have been forwarded using this route."

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of routes being removed and replaced, which can be detected by observing the value of ipMcastRouteNextHopTimeStamp."

```
::= { ipMcastRouteNextHopEntry 16 }
```

```
--
```

```
-- The IP Multicast Scope Boundary Table
```

```
--
```

ipMcastBoundaryTable OBJECT-TYPE

SYNTAX SEQUENCE OF IpMcastBoundaryEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The (conceptual) table listing the system's multicast scope zone boundaries."

REFERENCE "RFC 4007 Section 5"

::= { ipMcast 7 }

ipMcastBoundaryEntry OBJECT-TYPE

SYNTAX IpMcastBoundaryEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry (conceptual row) describing one of this device's multicast scope zone boundaries."

OIDs are limited to 128 sub-identifiers, but this limit is not enforced by the syntax of this entry. In practice, this does not present a problem, because IP address types allowed by conformance statements do not exceed this limit."

REFERENCE "RFC 2365 Section 5, RFC 4007 Section 5"

INDEX { ipMcastBoundaryIfIndex,
ipMcastBoundaryAddressType,
ipMcastBoundaryAddress,
ipMcastBoundaryAddressPrefixLength }

::= { ipMcastBoundaryTable 1 }

IpMcastBoundaryEntry ::= SEQUENCE {

ipMcastBoundaryIfIndex	InterfaceIndex,
ipMcastBoundaryAddressType	InetAddressType,
ipMcastBoundaryAddress	InetAddress,
ipMcastBoundaryAddressPrefixLength	InetAddressPrefixLength,
ipMcastBoundaryTimeStamp	TimeStamp,
ipMcastBoundaryDroppedMcastOctets	Counter64,
ipMcastBoundaryDroppedMcastPkts	Counter64,
ipMcastBoundaryStatus	RowStatus,
ipMcastBoundaryStorageType	StorageType

}

ipMcastBoundaryIfIndex OBJECT-TYPE

SYNTAX InterfaceIndex

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The IfIndex value for the interface to which this boundary applies. Packets with a destination address in the

associated address/mask range will not be forwarded over this interface.

For IPv4, zone boundaries cut through links. Therefore, this is an external interface. This may be either a physical or virtual interface (tunnel, encapsulation, and so forth.)

For IPv6, zone boundaries cut through nodes. Therefore, this is a virtual interface within the node. This is not an external interface, either real or virtual. Packets crossing this interface neither arrive at nor leave the node, but only move between zones within the node."

REFERENCE "RFC 2365 Section 5, RFC 4007 Section 5"

::= { ipMcastBoundaryEntry 1 }

ipMcastBoundaryAddressType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A value indicating the address family of the address contained in ipMcastBoundaryAddress. Legal values correspond to the subset of address families for which multicast forwarding is supported."

::= { ipMcastBoundaryEntry 2 }

ipMcastBoundaryAddress OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The group address which, when combined with the corresponding value of ipMcastBoundaryAddressPrefixLength, identifies the group range for which the scoped boundary exists. Scoped IPv4 multicast address ranges must be prefixed by 239.0.0.0/8. Scoped IPv6 multicast address ranges are FF0x::/16, where x is a valid RFC 4291 multicast scope.

An IPv6 address prefixed by FF1x::/16 is a non-permanently-assigned address. An IPv6 address prefixed by FF3x::/16 is a unicast-prefix-based multicast addresses. A zone boundary for FF0x::/16 implies an identical boundary for these other prefixes. No separate FF1x::/16 or FF3x::/16 entries exist in this table.

This address object is only significant up to

ipMcastBoundaryAddressPrefixLength bits. The remaining address bits are set to zero. This is especially important for this index field, which is part of the index of this entry. Any non-zero bits would signify an entirely different entry."

::= { ipMcastBoundaryEntry 3 }

ipMcastBoundaryAddressPrefixLength OBJECT-TYPE

SYNTAX InetAddressPrefixLength

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The length in bits of the mask which when, combined with the corresponding value of ipMcastBoundaryAddress, identifies the group range for which the scoped boundary exists.

The InetAddressType is given by ipMcastBoundaryAddressType. For values 'ipv4' and 'ipv4z', this object must be in the range 4..32. For values 'ipv6' and 'ipv6z', this object must be set to 16."

::= { ipMcastBoundaryEntry 4 }

ipMcastBoundaryTimeStamp OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The value of sysUpTime at which the multicast boundary information represented by this entry was learned by the router.

If this information was present at the most recent re-initialization of the local management subsystem, then this object contains a zero value."

::= { ipMcastBoundaryEntry 5 }

ipMcastBoundaryDroppedMcastOctets OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of octets of multicast packets that have been dropped as a result of this zone boundary configuration.

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of boundary

configuration being removed and replaced, which can be detected by observing the value of ipMcastBoundaryTimeStamp."

```
::= { ipMcastBoundaryEntry 6 }
```

ipMcastBoundaryDroppedMcastPkts OBJECT-TYPE

SYNTAX Counter64

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of multicast packets that have been dropped as a result of this zone boundary configuration.

Discontinuities in this monotonically increasing value occur at re-initialization of the management system. Discontinuities can also occur as a result of boundary configuration being removed and replaced, which can be detected by observing the value of ipMcastBoundaryTimeStamp."

```
::= { ipMcastBoundaryEntry 7 }
```

ipMcastBoundaryStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The status of this row, by which rows in this table can be created and destroyed.

This status object can be set to active(1) without setting any other columnar objects in this entry.

All writeable objects in this entry can be modified when the status of this entry is active(1)."

```
::= { ipMcastBoundaryEntry 8 }
```

ipMcastBoundaryStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The storage type for this row. Rows having the value 'permanent' need not allow write-access to any columnar objects in the row."

DEFVAL { nonVolatile }

```
::= { ipMcastBoundaryEntry 9 }
```

--

```
-- The IP Multicast Scope Name Table
--
```

```
ipMcastScopeNameTable OBJECT-TYPE
```

```
    SYNTAX      SEQUENCE OF IpMcastScopeNameEntry
```

```
    MAX-ACCESS  not-accessible
```

```
    STATUS      current
```

```
    DESCRIPTION
```

```
        "The (conceptual) table listing multicast scope names."
```

```
    REFERENCE  "RFC 4007 Section 4"
```

```
    ::= { ipMcast 8 }
```

```
ipMcastScopeNameEntry OBJECT-TYPE
```

```
    SYNTAX      IpMcastScopeNameEntry
```

```
    MAX-ACCESS  not-accessible
```

```
    STATUS      current
```

```
    DESCRIPTION
```

```
        "An entry (conceptual row) that names a multicast address
        scope."
```

```
        OIDs are limited to 128 sub-identifiers, but this limit
        is not enforced by the syntax of this entry.  In practice,
        this does not present a problem, because IP address types
        allowed by conformance statements do not exceed this limit."
```

```
    REFERENCE  "RFC 4007 Section 4"
```

```
    INDEX      { ipMcastScopeNameAddressType,
                  ipMcastScopeNameAddress,
                  ipMcastScopeNameAddressPrefixLength,
                  ipMcastScopeNameLanguage }
```

```
    ::= { ipMcastScopeNameTable 1 }
```

```
IpMcastScopeNameEntry ::= SEQUENCE {
```

```
    ipMcastScopeNameAddressType      InetAddressType,
```

```
    ipMcastScopeNameAddress          InetAddress,
```

```
    ipMcastScopeNameAddressPrefixLength  InetAddressPrefixLength,
```

```
    ipMcastScopeNameLanguage          LangTag,
```

```
    ipMcastScopeNameString             SnmpAdminString,
```

```
    ipMcastScopeNameDefault             TruthValue,
```

```
    ipMcastScopeNameStatus              RowStatus,
```

```
    ipMcastScopeNameStorageType         StorageType
```

```
}
```

```
ipMcastScopeNameAddressType OBJECT-TYPE
```

```
    SYNTAX      InetAddressType
```

```
    MAX-ACCESS  not-accessible
```

```
    STATUS      current
```

```
    DESCRIPTION
```

```
        "A value indicating the address family of the address"
```


contained in ipMcastScopeNameAddress. Legal values correspond to the subset of address families for which multicast forwarding is supported."

::= { ipMcastScopeNameEntry 1 }

ipMcastScopeNameAddress OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The group address which, when combined with the corresponding value of ipMcastScopeNameAddressPrefixLength, identifies the group range associated with the multicast scope. Scoped IPv4 multicast address ranges must be prefixed by 239.0.0.0/8. Scoped IPv6 multicast address ranges are FF0x::/16, where x is a valid RFC 4291 multicast scope.

An IPv6 address prefixed by FF1x::/16 is a non-permanently-assigned address. An IPv6 address prefixed by FF3x::/16 is a unicast-prefix-based multicast addresses. A scope FF0x::/16 implies an identical scope name for these other prefixes. No separate FF1x::/16 or FF3x::/16 entries exist in this table.

This address object is only significant up to ipMcastScopeNameAddressPrefixLength bits. The remaining address bits are set to zero. This is especially important for this index field, which is part of the index of this entry. Any non-zero bits would signify an entirely different entry."

::= { ipMcastScopeNameEntry 2 }

ipMcastScopeNameAddressPrefixLength OBJECT-TYPE

SYNTAX InetAddressPrefixLength

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The length in bits of the mask which, when combined with the corresponding value of ipMcastScopeNameAddress, identifies the group range associated with the multicast scope.

The InetAddressType is given by ipMcastScopeNameAddressType. For values 'ipv4' and 'ipv4z', this object must be in the range 4..32. For values 'ipv6' and 'ipv6z', this object must be set to 16."

::= { ipMcastScopeNameEntry 3 }

`ipMcastScopeNameLanguage OBJECT-TYPE``SYNTAX LangTag``MAX-ACCESS not-accessible``STATUS current``DESCRIPTION`

"Language tag associated with the scope name."

`REFERENCE "RFC 4646"``::= { ipMcastScopeNameEntry 4 }``ipMcastScopeNameString OBJECT-TYPE``SYNTAX SnmpAdminString``MAX-ACCESS read-create``STATUS current``DESCRIPTION`

"The textual name associated with the multicast scope. The value of this object should be suitable for displaying to end-users, such as when allocating a multicast address in this scope.

When no name is specified, the default value of this object for IPv4 should be the string 239.x.x.x/y with x and y replaced with decimal values to describe the address and mask length associated with the scope.

When no name is specified, the default value of this object for IPv6 should be the string FF0x::/16, with x replaced by the hexadecimal value for the RFC 4291 multicast scope.

An IPv6 address prefixed by FF1x::/16 is a non-permanently-assigned address. An IPv6 address prefixed by FF3x::/16 is a unicast-prefix-based multicast addresses. A scope FF0x::/16 implies an identical scope name for these other prefixes. No separate FF1x::/16 or FF3x::/16 entries exist in this table."

`REFERENCE "RFC 2365, RFC 3306 Section 4, RFC 4291 Section 2.7"``::= { ipMcastScopeNameEntry 5 }``ipMcastScopeNameDefault OBJECT-TYPE``SYNTAX TruthValue``MAX-ACCESS read-create``STATUS current``DESCRIPTION`

"If true, indicates a preference that the name in the following language should be used by applications if no name is available in a desired language."

`DEFVAL { false }``::= { ipMcastScopeNameEntry 6 }`

ipMcastScopeNameStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The status of this row, by which rows in this table can be created and destroyed. Before the row can be activated, the object ipMcastScopeNameString must be set to a valid value. All writeable objects in this entry can be modified when the status is active(1)."

::= { ipMcastScopeNameEntry 7 }

ipMcastScopeNameStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The storage type for this row. Rows having the value 'permanent' need not allow write-access to any columnar objects in the row."

DEFVAL { nonVolatile }

::= { ipMcastScopeNameEntry 8 }

--

-- The Multicast Listeners Table

--

ipMcastLocalListenerTable OBJECT-TYPE

SYNTAX SEQUENCE OF IpMcastLocalListenerEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The (conceptual) table listing local applications or services that have joined multicast groups as listeners.

Entries exist for all addresses in the multicast range for all applications and services as they are classified on this device."

::= { ipMcast 9 }

ipMcastLocalListenerEntry OBJECT-TYPE

SYNTAX IpMcastLocalListenerEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry (conceptual row) identifying a local application or service that has joined a multicast group as a listener."

OIDs are limited to 128 sub-identifiers, but this limit is not enforced by the syntax of this entry. In practice, this does not present a problem, because IP address types allowed by conformance statements do not exceed this limit."

```
INDEX      { ipMcastLocalListenerGroupAddressType,
              ipMcastLocalListenerGroupAddress,
              ipMcastLocalListenerSourceAddressType,
              ipMcastLocalListenerSourceAddress,
              ipMcastLocalListenerSourcePrefixLength,
              ipMcastLocalListenerIfIndex,
              ipMcastLocalListenerRunIndex }
 ::= { ipMcastLocalListenerTable 1 }
```

```
IpMcastLocalListenerEntry ::= SEQUENCE {
    ipMcastLocalListenerGroupAddressType    InetAddressType,
    ipMcastLocalListenerGroupAddress        InetAddress,
    ipMcastLocalListenerSourceAddressType   InetAddressType,
    ipMcastLocalListenerSourceAddress       InetAddress,
    ipMcastLocalListenerSourcePrefixLength  InetAddressPrefixLength,
    ipMcastLocalListenerIfIndex             InterfaceIndex,
    ipMcastLocalListenerRunIndex            Unsigned32
}
```

ipMcastLocalListenerGroupAddressType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A value indicating the address family of the address contained in ipMcastLocalListenerGroupAddress. Legal values correspond to the subset of address families for which multicast is supported."

```
::= { ipMcastLocalListenerEntry 1 }
```

ipMcastLocalListenerGroupAddress OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The IP multicast group for which this entry specifies locally joined applications or services."

```
::= { ipMcastLocalListenerEntry 2 }
```

ipMcastLocalListenerSourceAddressType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A value indicating the address family of the address contained in ipMcastLocalListenerSource.

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 ipMcastLocalListenerGroupAddressType."

::= { ipMcastLocalListenerEntry 3 }

ipMcastLocalListenerSourceAddress OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The network address which, when combined with the corresponding value of the mask specified in ipMcastLocalListenerSourcePrefixLength, identifies the sources for which this entry specifies a local listener.

This address object is only significant up to ipMcastLocalListenerSourcePrefixLength bits. The remaining address bits are set to zero. This is especially important for this index field, which is part of the index of this entry. Any non-zero bits would signify an entirely different entry.

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 indicate that this listener address applies only within the given zone. Zone index zero is not valid in this table."

::= { ipMcastLocalListenerEntry 4 }

ipMcastLocalListenerSourcePrefixLength OBJECT-TYPE

SYNTAX InetAddressPrefixLength

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The length in bits of the mask which, when combined with the corresponding value specified in ipMcastLocalListenerSource, identifies the sources for which this entry specifies a local listener.

The InetAddressType is given by ipMcastLocalListenerSourceAddressType. For the value 'unknown', this object must be zero. For values 'ipv4' and 'ipv4z', this object must be in the range 4..32. For values 'ipv6' and 'ipv6z', this object must be in the range

```

        8..128."
 ::= { ipMcastLocalListenerEntry 5 }

ipMcastLocalListenerIfIndex OBJECT-TYPE
    SYNTAX      InterfaceIndex
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The IfIndex value of the interface for which this entry
        specifies a local listener."
 ::= { ipMcastLocalListenerEntry 6 }

ipMcastLocalListenerRunIndex OBJECT-TYPE
    SYNTAX      Unsigned32 (0..2147483647)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "A unique value corresponding to a piece of software running
        on this router or host system. Where possible, this should
        be the system's native, unique identification number.

        This identifier is platform-specific. It may correspond to
        a process ID or application instance number.

        A value of zero indicates that the application instance(s)
        cannot be identified. A value of zero indicates that one or
        more unidentified applications have joined the specified
        multicast groups (for the specified sources) as listeners."
    REFERENCE "RFC 2287 sysApplRunIndex"
 ::= { ipMcastLocalListenerEntry 7 }

--
-- The Multicast Zone Table
--

ipMcastZoneTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF IpMcastZoneEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The (conceptual) table listing scope zones on this device."
    REFERENCE "RFC 4007 Section 5"
 ::= { ipMcast 10 }

ipMcastZoneEntry OBJECT-TYPE
    SYNTAX      IpMcastZoneEntry
    MAX-ACCESS  not-accessible
    STATUS      current

```

DESCRIPTION

"An entry (conceptual row) describing a scope zone on this device."

REFERENCE "RFC 4007 Section 5"

INDEX { ipMcastZoneIndex }

::= { ipMcastZoneTable 1 }

IpMcastZoneEntry ::= SEQUENCE {

ipMcastZoneIndex	InetZoneIndex,
ipMcastZoneScopeDefaultZoneIndex	InetZoneIndex,
ipMcastZoneScopeAddressType	InetAddressType,
ipMcastZoneScopeAddress	InetAddress,
ipMcastZoneScopeAddressPrefixLength	InetAddressPrefixLength

}

ipMcastZoneIndex OBJECT-TYPE

SYNTAX InetZoneIndex (1..4294967295)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This zone index uniquely identifies a zone on a device."

Each zone is for a given scope. Scope-level information in this table is for the unique scope that corresponds to this zone.

Zero is a special value used to request the default zone for a given scope. Zero is not a valid value for this object.

To test whether ipMcastZoneIndex is the default zone for this scope, test whether ipMcastZoneIndex is equal to ipMcastZoneScopeDefaultZoneIndex."

::= { ipMcastZoneEntry 1 }

ipMcastZoneScopeDefaultZoneIndex OBJECT-TYPE

SYNTAX InetZoneIndex (1..4294967295)

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The default zone index for this scope. This is the zone that this device will use if the default (zero) zone is requested for this scope."

Zero is not a valid value for this object."

::= { ipMcastZoneEntry 2 }

ipMcastZoneScopeAddressType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The IP address type for which this scope zone exists."
 ::= { ipMcastZoneEntry 3 }

ipMcastZoneScopeAddress OBJECT-TYPE

SYNTAX InetAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The multicast group address which, when combined with
ipMcastZoneScopeAddressPrefixLength, gives the multicast
address range for this scope. The InetAddressType is given
by ipMcastZoneScopeAddressType.

Scoped IPv4 multicast address ranges are prefixed by
239.0.0.0/8. Scoped IPv6 multicast address ranges are
FF0x::/16, where x is a valid RFC 4291 multicast scope.

An IPv6 address prefixed by FF1x::/16 is a non-permanently-
assigned address. An IPv6 address prefixed by FF3x::/16 is
a unicast-prefix-based multicast addresses. A scope
FF0x::/16 implies an identical scope for these other
prefixes. No separate FF1x::/16 or FF3x::/16 entries exist
in this table.

This address object is only significant up to
ipMcastZoneScopeAddressPrefixLength bits. The remaining
address bits are set to zero."

REFERENCE "RFC 2365, RFC 3306 Section 4, RFC 4291 Section 2.7"
 ::= { ipMcastZoneEntry 4 }

ipMcastZoneScopeAddressPrefixLength OBJECT-TYPE

SYNTAX InetAddressPrefixLength
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"The length in bits of the mask which, when combined
with ipMcastZoneScopeAddress, gives the multicast address
prefix for this scope.

The InetAddressType is given by ipMcastZoneScopeAddressType.
For values 'ipv4' and 'ipv4z', this object must be in the
range 4..32. For values 'ipv6' and 'ipv6z', this object
must be set to 16."

::= { ipMcastZoneEntry 5 }


```

--
-- Conformance information
--

ipMcastMIBConformance
    OBJECT IDENTIFIER ::= { ipMcastMIB 2 }
ipMcastMIBCompliances
    OBJECT IDENTIFIER ::= { ipMcastMIBConformance 1 }
ipMcastMIBGroups OBJECT IDENTIFIER ::= { ipMcastMIBConformance 2 }

--
-- Compliance statements
--

ipMcastMIBComplianceHost MODULE-COMPLIANCE
    STATUS current
    DESCRIPTION
        "The compliance statement for hosts supporting IPMCAST-MIB.

        Support for either InetAddressType ipv4 or ipv6 is
        mandatory; support for both InetAddressTypes ipv4 and ipv6
        is optional. Support for types ipv4z and ipv6z is
        optional.

        -- OBJECT      ipMcastLocalListenerGroupAddressType
        -- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
        --                                     ipv4z(3), ipv6z(4)}
        -- DESCRIPTION
        --      This compliance requires support for ipv4 or ipv6.
        --
        -- OBJECT      ipMcastLocalListenerGroupAddress
        -- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
        -- DESCRIPTION
        --      This compliance requires support for ipv4 or ipv6.
        --
        -- OBJECT      ipMcastLocalListenerSourceAddressType
        -- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
        --                                     ipv4z(3), ipv6z(4)}
        -- DESCRIPTION
        --      This compliance requires support for ipv4 or ipv6.
        --
        -- OBJECT      ipMcastLocalListenerSourceAddress
        -- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
        -- DESCRIPTION
        --      This compliance requires support for ipv4 or ipv6."

    MODULE -- this module
    MANDATORY-GROUPS { ipMcastMIBLocalListenerGroup,

```

ipMcastMIBBasicGroup }

OBJECT ipMcastEnabled

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT ipMcastDeviceConfigStorageType

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

GROUP ipMcastMIBSsmGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBRouteGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBRouteDiagnosticsGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBBoundaryIfGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBScopeNameGroup

DESCRIPTION

"This group is optional."

::= { ipMcastMIBCompliances 1 }

ipMcastMIBComplianceRouter MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"The compliance statement for routers supporting
IPMCAST-MIB.

Support for either InetAddressType ipv4 or ipv6 is
mandatory; support for both InetAddressTypes ipv4 and ipv6
is optional. Support for types ipv4z and ipv6z is
optional.

-- OBJECT ipMcastSsmRangeAddressType

-- SYNTAX InetAddressType {ipv4(1), ipv6(2), ipv4z(3),
-- ipv6z(4)}

```
-- DESCRIPTION
--   This compliance requires support for ipv4 or ipv6.
--
-- OBJECT      ipMcastSsmRangeAddress
-- SYNTAX      InetAddress (SIZE (4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteGroupAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteGroup
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteSourceAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteSource
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteNextHopGroupAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteNextHopGroup
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteNextHopSourceAddressType
```

```

-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteNextHopSource
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteNextHopAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteNextHopAddress
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6."

```

```

MODULE -- this module
MANDATORY-GROUPS { ipMcastMIBRouteProtoGroup,
                    ipMcastMIBBasicGroup,
                    ipMcastMIBSsmGroup,
                    ipMcastMIBRouteGroup }

```

```

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

```

```

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

```

```

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

```

```

OBJECT      ipMcastInterfaceRateLimit
MIN-ACCESS read-only

```

DESCRIPTION

"Write access is not required."

OBJECT ipMcastInterfaceStorageType

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT ipMcastRouteUpstreamNeighborType

SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2),
ipv4z(3), ipv6z(4) }

DESCRIPTION

"This compliance requires support for unknown and either ipv4 or ipv6."

OBJECT ipMcastRouteUpstreamNeighbor

SYNTAX InetAddress (SIZE (0|4|8|16|20))

DESCRIPTION

"This compliance requires support for unknown and either ipv4 or ipv6."

OBJECT ipMcastRouterRtAddressType

SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2),
ipv4z(3), ipv6z(4) }

DESCRIPTION

"This compliance requires support for unknown and either ipv4 or ipv6."

OBJECT ipMcastRouterRtAddress

SYNTAX InetAddress (SIZE (0|4|8|16|20))

DESCRIPTION

"This compliance requires support for unknown and either ipv4 or ipv6."

OBJECT ipMcastSsmRangeRowStatus

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT ipMcastSsmRangeStorageType

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

GROUP ipMcastMIBRouteDiagnosticsGroup

DESCRIPTION

"This group is not mandatory, but SHOULD be supported where hardware permits."

GROUP ipMcastMIBPktsOutGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBHopCountGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBRouteOctetsGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBRouteBpsGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBLocalListenerGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBBoundaryIfGroup

DESCRIPTION

"This group is optional."

GROUP ipMcastMIBScopeNameGroup

DESCRIPTION

"This group is optional."

::= { ipMcastMIBCompliances 2 }

ipMcastMIBComplianceBorderRouter MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"The compliance statement for routers on scope boundaries supporting IPMCAST-MIB.

Support for either InetAddressType ipv4z or ipv6z is mandatory; support for both InetAddressTypes ipv4z and ipv6z is optional.

-- OBJECT ipMcastSsmRangeAddressType

-- SYNTAX InetAddressType {ipv4(1), ipv6(2), ipv4z(3),
-- ipv6z(4)}

-- DESCRIPTION

-- This compliance requires support for ipv4 or ipv6.

--

-- OBJECT ipMcastSsmRangeAddress

-- SYNTAX InetAddress (SIZE (4|8|16|20))

```
-- DESCRIPTION
--   This compliance requires support for ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteGroupAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 or ipv6.
--
-- OBJECT      ipMcastRouteGroup
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 and ipv4z or ipv6 and ipv6z.
--
-- OBJECT      ipMcastRouteSourceAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 and ipv4z or ipv6 and ipv6z.
--
-- OBJECT      ipMcastRouteSource
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 and ipv4z or ipv6 and ipv6z.
--
-- OBJECT      ipMcastRouteNextHopGroupAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 and ipv4z or ipv6 and ipv6z.
--
-- OBJECT      ipMcastRouteNextHopGroup
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 and ipv4z or ipv6 and ipv6z.
--
-- OBJECT      ipMcastRouteNextHopSourceAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--   This compliance requires support for unknown and
--   either ipv4 and ipv4z or ipv6 and ipv6z.
```

```

--
-- OBJECT      ipMcastRouteNextHopSource
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--      This compliance requires support for unknown and
--      either ipv4 and ipv4z or ipv6 and ipv6z.
--
-- OBJECT      ipMcastRouteNextHopAddressType
-- SYNTAX      InetAddressType {unknown(0), ipv4(1), ipv6(2),
--                               ipv4z(3), ipv6z(4)}
-- DESCRIPTION
--      This compliance requires support for unknown and
--      either ipv4 and ipv4z or ipv6 and ipv6z.
--
-- OBJECT      ipMcastRouteNextHopAddress
-- SYNTAX      InetAddress (SIZE (0|4|8|16|20))
-- DESCRIPTION
--      This compliance requires support for unknown and
--      either ipv4 and ipv4z or ipv6 and ipv6z.
--
-- OBJECT      ipMcastBoundaryAddressType
-- SYNTAX      InetAddressType {ipv4(1), ipv6(2)}
-- DESCRIPTION
--      This compliance requires support for ipv4 or ipv6.
--
-- OBJECT      ipMcastBoundaryAddress
-- SYNTAX      InetAddress (SIZE (4|16))
-- DESCRIPTION
--      This compliance requires support for ipv4 or ipv6.
--
-- OBJECT      ipMcastScopeNameAddressType
-- SYNTAX      InetAddressType {ipv4(1), ipv6(2)}
-- DESCRIPTION
--      This compliance requires support for ipv4 or ipv6.
--
-- OBJECT      ipMcastScopeNameAddress
-- SYNTAX      InetAddress (SIZE (4|16))
-- DESCRIPTION
--      This compliance requires support for ipv4 or ipv6."

```

```

MODULE  -- this module
MANDATORY-GROUPS { ipMcastMIBRouteProtoGroup,
                    ipMcastMIBBasicGroup,
                    ipMcastMIBSsmGroup,
                    ipMcastMIBRouteGroup,
                    ipMcastMIBBoundaryIfGroup,
                    ipMcastMIBScopeNameGroup }

```


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

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

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

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

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

OBJECT ipMcastRouteUpstreamNeighborType
SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2),
 ipv4z(3), ipv6z(4) }
DESCRIPTION
 "This compliance requires support for unknown and either ipv4
 and ipv4z, or ipv6 and ipv6z."

OBJECT ipMcastRouteUpstreamNeighbor
SYNTAX InetAddress (SIZE (0|4|8|16|20))
DESCRIPTION
 "This compliance requires support for unknown and either ipv4
 and ipv4z, or ipv6 and ipv6z."

OBJECT ipMcastRouterRtAddressType
SYNTAX InetAddressType { unknown(0), ipv4(1), ipv6(2),
 ipv4z(3), ipv6z(4) }
DESCRIPTION
 "This compliance requires support for unknown and either ipv4
 and ipv4z, or ipv6 and ipv6z."

OBJECT ipMcastRouterRtAddress
SYNTAX InetAddress (SIZE (0|4|8|16|20))
DESCRIPTION

"This compliance requires support for unknown and either ipv4 and ipv4z, or ipv6 and ipv6z."

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

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

GROUP ipMcastMIBRouteDiagnosticsGroup
DESCRIPTION
 "This group is not mandatory, but SHOULD be supported where hardware permits."

GROUP ipMcastMIBPktsOutGroup
DESCRIPTION
 "This group is optional."

GROUP ipMcastMIBHopCountGroup
DESCRIPTION
 "This group is optional."

GROUP ipMcastMIBRouteOctetsGroup
DESCRIPTION
 "This group is optional."

GROUP ipMcastMIBRouteBpsGroup
DESCRIPTION
 "This group is optional."

GROUP ipMcastMIBLocalListenerGroup
DESCRIPTION
 "This group is optional."

OBJECT ipMcastZoneScopeAddressType
SYNTAX InetAddressType { ipv4(1), ipv6(2) }
DESCRIPTION
 "This compliance requires support for ipv4 or ipv6."

OBJECT ipMcastZoneScopeAddress
SYNTAX InetAddress (SIZE (4|16))
DESCRIPTION
 "This compliance requires support for ipv4 or ipv6."

```
 ::= { ipMcastMIBCompliances 3 }

--
-- Units of conformance
--
ipMcastMIBBasicGroup OBJECT-GROUP
    OBJECTS { ipMcastEnabled,
               ipMcastRouteEntryCount,
               ipMcastDeviceConfigStorageType
             }
    STATUS current
    DESCRIPTION
        "A collection of objects to support basic management of IP
        Multicast protocols."
    ::= { ipMcastMIBGroups 1 }

ipMcastMIBSsmGroup OBJECT-GROUP
    OBJECTS { ipMcastSsmRangeRowStatus,
              ipMcastSsmRangeStorageType
            }
    STATUS current
    DESCRIPTION
        "A collection of objects to support management of Source-
        Specific Multicast routing."
    ::= { ipMcastMIBGroups 2 }

ipMcastMIBRouteGroup OBJECT-GROUP
    OBJECTS { ipMcastInterfaceTtl,
              ipMcastInterfaceRateLimit,
              ipMcastInterfaceStorageType,
              ipMcastRouteUpstreamNeighborType,
              ipMcastRouteUpstreamNeighbor,
              ipMcastRouteInIfIndex,
              ipMcastRouteTimeStamp,
              ipMcastRouteExpiryTime,
              ipMcastRouteNextHopState,
              ipMcastRouteNextHopTimeStamp,
              ipMcastRouteNextHopExpiryTime
            }
    STATUS current
    DESCRIPTION
        "A collection of objects to support basic management of IP
        Multicast routing."
    ::= { ipMcastMIBGroups 3 }

ipMcastMIBRouteDiagnosticsGroup OBJECT-GROUP
    OBJECTS { ipMcastRoutePkts,
              ipMcastRouteTtlDropPackets,
              ipMcastRouteDifferentInIfPackets
```

```
    }
    STATUS current
    DESCRIPTION
        "A collection of routing diagnostic packet counters."
    ::= { ipMcastMIBGroups 4 }

ipMcastMIBPktsOutGroup OBJECT-GROUP
    OBJECTS { ipMcastRouteNextHopTimeStamp,
               ipMcastRouteNextHopPkts }
    STATUS current
    DESCRIPTION
        "A collection of objects to support management of packet
        counters for each outgoing interface entry of a route."
    ::= { ipMcastMIBGroups 5 }

ipMcastMIBHopCountGroup OBJECT-GROUP
    OBJECTS { ipMcastRouteNextHopClosestMemberHops }
    STATUS current
    DESCRIPTION
        "A collection of objects to support management of the use of
        hop counts in IP Multicast routing."
    ::= { ipMcastMIBGroups 6 }

ipMcastMIBRouteOctetsGroup OBJECT-GROUP
    OBJECTS { ipMcastRouteTimeStamp,
               ipMcastRouteOctets,
               ipMcastRouteTtlDropOctets,
               ipMcastRouteDifferentInIfOctets,
               ipMcastRouteNextHopTimeStamp,
               ipMcastRouteNextHopOctets }
    STATUS current
    DESCRIPTION
        "A collection of objects to support management of octet
        counters for each forwarding entry."
    ::= { ipMcastMIBGroups 7 }

ipMcastMIBRouteBpsGroup OBJECT-GROUP
    OBJECTS { ipMcastRouteBps }
    STATUS current
    DESCRIPTION
        "A collection of objects to support sampling of data rate
        in bits per second for each forwarding entry."
    ::= { ipMcastMIBGroups 8 }

ipMcastMIBRouteProtoGroup OBJECT-GROUP
    OBJECTS { ipMcastRouteProtocol, ipMcastRouteRtProtocol,
               ipMcastRouteRtAddressType, ipMcastRouteRtAddress,
               ipMcastRouteRtPrefixLength, ipMcastRouteRtType,
```

```
        ipMcastRouteNextHopProtocol }
STATUS    current
DESCRIPTION
    "A collection of objects providing information on the
    relationship between multicast routing information and the
    IP Forwarding Table."
 ::= { ipMcastMIBGroups 9 }

ipMcastMIBLocalListenerGroup OBJECT-GROUP
OBJECTS { ipMcastLocalListenerRunIndex }
STATUS    current
DESCRIPTION
    "A collection of objects to support management of local
    listeners on hosts or routers."
 ::= { ipMcastMIBGroups 10 }

ipMcastMIBBoundaryIfGroup OBJECT-GROUP
OBJECTS { ipMcastBoundaryTimeStamp,
          ipMcastBoundaryDroppedMcastOctets,
          ipMcastBoundaryDroppedMcastPkts,
          ipMcastBoundaryStatus,
          ipMcastBoundaryStorageType,
          ipMcastZoneScopeDefaultZoneIndex,
          ipMcastZoneScopeAddressType,
          ipMcastZoneScopeAddress,
          ipMcastZoneScopeAddressPrefixLength
        }
STATUS    current
DESCRIPTION
    "A collection of objects to support management of multicast
    scope zone boundaries."
 ::= { ipMcastMIBGroups 11 }

ipMcastMIBScopeNameGroup OBJECT-GROUP
OBJECTS { ipMcastScopeNameString, ipMcastScopeNameDefault,
          ipMcastScopeNameStatus, ipMcastScopeNameStorageType }
STATUS    current
DESCRIPTION
    "A collection of objects to support management of multicast
    address scope names."
 ::= { ipMcastMIBGroups 12 }

END
```

7. Security Considerations

7.1. SNMPv3

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

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [RFC3410], section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to access (read/change/create/delete) them.

7.2. Writeable Objects

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. This section discusses and lists these elements.

Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations.

In this MIB module, possible effects that can be induced by SET operations on writeable objects include:

- o Modifications to multicast routing behavior that prevent or disrupt services provided by the network, including (but not limited to) multicast data traffic delivery.
- o Modifications to multicast routing behavior that allow interception or subversion of information that is carried by the network. For example, attacks can be envisaged that would pass nominated multicast data streams through a nominated location, without the sources or listeners becoming aware of this subversion.

The following are the read-write and read-create objects defined in this MIB module.

```
ipMcastEnabled ipMcastDeviceConfigStorageType ipMcastInterfaceTtl
ipMcastInterfaceRateLimit ipMcastInterfaceStorageType
ipMcastSsmRangeRowStatus ipMcastSsmRangeStorageType
ipMcastBoundaryStatus ipMcastBoundaryStorageType
ipMcastScopeNameString ipMcastScopeNameDefault ipMcastScopeNameStatus
ipMcastScopeNameStorageType
```

7.3. Readable Objects

As well as the writeable objects discussed above, there are a number of readable objects (i.e., objects with a MAX-ACCESS other than not-accessible) that 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.

In this MIB module, possible effects that can be induced by GET and/or NOTIFY operations include:

- o Determination of the topology, disposition, and composition of the network. This information may be commercially sensitive, and may also be used in preparation for attacks, including any of the attacks described above.
- o Determination of whether multicast data is flowing in the network, or has flowed recently, as well as the locations of senders and recipients. An attacker can apply 'traffic analysis' to this data. In some cases, the information revealed by traffic analyses can be as damaging as full knowledge of the data being transported.

8. IANA Considerations

IPMCAST-MIB is rooted under the mib-2 subtree. IANA has assigned { mib-2 168 } to the IPMCAST-MIB module specified in this document.

9. Acknowledgements

This MIB module is based on the original work in [RFC2932] by K. McCloghrie, D. Farinacci, and D. Thaler.

Suggested IPv6 multicast MIBs by R. Sivaramu and R. Raghunarayan have been used for comparison while editing this MIB module.

The authors are grateful to Bill Fenner for fine ideas, and to Bharat Joshi for input and several corrections.

The authors also wish to thank John Flick, Bert Wijnen, and Stig Venaas for their reviewing and comments.

10. References

10.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC2365] Meyer, D., "Administratively Scoped IP Multicast", BCP 23, RFC 2365, July 1998.
- [RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.
- [RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Textual Conventions for SMIv2", STD 58, RFC 2579, April 1999.
- [RFC2580] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Conformance Statements for SMIv2", STD 58, RFC 2580, April 1999.
- [RFC2856] Bierman, A., McCloghrie, K., and R. Presuhn, "Textual Conventions for Additional High Capacity Data Types", RFC 2856, June 2000.
- [RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", RFC 2863, June 2000.
- [RFC3306] Haberman, B. and D. Thaler, "Unicast-Prefix-based IPv6 Multicast Addresses", RFC 3306, August 2002.
- [RFC3411] Harrington, D., Presuhn, R., and B. Wijnen, "An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks", STD 62, RFC 3411, December 2002.
- [RFC4001] Daniele, M., Haberman, B., Routhier, S., and J. Schoenwaelder, "Textual Conventions for Internet Network Addresses", RFC 4001, February 2005.

- [RFC4007] Deering, S., Haberman, B., Jinmei, T., Nordmark, E., and B. Zill, "IPv6 Scoped Address Architecture", RFC 4007, March 2005.
- [RFC4291] Hinden, R. and S. Deering, "IP Version 6 Addressing Architecture", RFC 4291, February 2006.
- [RFC5131] McWalter, D., "A MIB Textual Convention for Language Tags", RFC 5131, December 2007.

10.2. Informative References

- [RFC2287] Krupczak, C. and J. Saperia, "Definitions of System-Level Managed Objects for Applications", RFC 2287, February 1998.
- [RFC2932] McCloghrie, K., Farinacci, D., and D. Thaler, "IPv4 Multicast Routing MIB", RFC 2932, October 2000.
- [RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, December 2002.
- [RFC3569] Bhattacharyya, S., "An Overview of Source-Specific Multicast (SSM)", RFC 3569, July 2003.
- [RFC4293] Routhier, S., "Management Information Base for the Internet Protocol (IP)", RFC 4293, April 2006.
- [RFC4601] Fenner, B., Handley, M., Holbrook, H., and I. Kouvelas, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", RFC 4601, August 2006.
- [RFC4646] Phillips, A. and M. Davis, "Tags for Identifying Languages", BCP 47, RFC 4646, September 2006.
- [RFC5015] Handley, M., Kouvelas, I., Speakman, T., and L. Vicisano, "Bidirectional Protocol Independent Multicast (BIDIR-PIM)", RFC 5015, October 2007.

Authors' Addresses

David McWalter
Data Connection Ltd
100 Church Street
Enfield EN2 6BQ
UK

EMail: dmcw@dataconnection.com

Dave Thaler
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
USA

EMail: dthaler@windows.microsoft.com

Andrew Kessler
Cisco Systems
425 E. Tasman Drive
San Jose, CA 95134
USA

EMail: kessler@cisco.com

Full Copyright Statement

Copyright (C) The IETF Trust (2007).

This document is subject to the rights, licenses and restrictions contained in BCP 78, and except as set forth therein, the authors retain all their rights.

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY, THE IETF TRUST AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Intellectual Property

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in BCP 78 and BCP 79.

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at <http://www.ietf.org/ipr>.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at ietf-ipr@ietf.org.

