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## Multicast Source Discovery Protocol (MSDP) MIB

### Status of This Memo

This memo defines an Experimental Protocol for the Internet community. It does not specify an Internet standard of any kind. Discussion and suggestions for improvement are requested. Distribution of this memo is unlimited.

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### Abstract

This memo defines an experimental portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects used for managing Multicast Source Discovery Protocol (MSDP) (RFC 3618) speakers.

### Table of Contents

1. Introduction .....	2
2. The Internet-Standard Management Framework .....	2
3. Overview .....	2
4. Definitions .....	3
5. Security Considerations .....	28
6. IANA Considerations .....	29
7. Acknowledgements .....	30
8. References .....	30
8.1. Normative References .....	30
8.2. Informative References .....	30

## 1. Introduction

This memo defines an experimental portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects used for managing Multicast Source Discovery Protocol (MSDP) [1] speakers.

## 2. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of RFC 3410 [7].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIV2, which is described in STD 58, RFC 2578 [4], STD 58, RFC 2579 [5] and STD 58, RFC 2580 [6].

## 3. Overview

This MIB module contains four scalars and four tables, one deprecated. The tables are:

- o The deprecated Requests Table, containing the longest-match table used to determine the peer to send SA-Requests to for a given group. This table is deprecated because Requests were removed from MSDP before it became an RFC.
- o The Peer Table, containing information on the system's peers.
- o The Source-Active (SA) Cache Table, containing the SA cache entries.
- o The Mesh Group Table, containing the list of MSDP mesh groups to which this system belongs.

This MIB module uses the IpAddress SYNTAX, making it only suitable for IPv4 systems. Although the desired direction for MIBs is to use InetAddressType/InetAddress pairs to allow both IPv4 and IPv6 (and future formats as well), the MSDP protocol itself is IPv4-only, and the MSDP working group made an explicit decision not to create an IPv6 version of the protocol.

This MIB module is somewhat disorganized, with scalars before and after tables, holes in the OID space, tables with the RowStatus in the middle, and so on. This is because objects were added and removed as necessary as the MSDP protocol evolved, and the plan was to renumber the whole MIB when moving to the standard mib-2 tree. The MSDP Working Group then changed direction, publishing the MSDP protocol as Experimental. Since there were existing implementations using the strange object order under the experimental OID, the WG decided not to renumber the MIB and to publish it as experimental, keeping the experimental OID.

#### 4. Definitions

--  
--

MSDP-MIB DEFINITIONS ::= BEGIN

##### IMPORTS

MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,  
experimental, Counter32, Gauge32, TimeTicks, Integer32,  
IpAddress  
FROM SNMPv2-SMI  
RowStatus, TruthValue, TimeStamp, DisplayString  
FROM SNMPv2-TC  
MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP  
FROM SNMPv2-CONF;

##### msdpMIB MODULE-IDENTITY

LAST-UPDATED "200608010000Z"  
ORGANIZATION "IETF MBONED Working Group"  
CONTACT-INFO  
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MBONED Working Group: mboned@lists.uoregon.edu"

##### DESCRIPTION

"An experimental MIB module for MSDP Management and Monitoring.

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REVISION "200608010000Z"

DESCRIPTION

"Initial version, published as RFC 4624."

::= { experimental 92 }

msdpMIBObjects OBJECT IDENTIFIER ::= { msdpMIB 1 }

msdp OBJECT IDENTIFIER ::= { msdpMIBObjects 1 }

msdpEnabled OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The state of MSDP on this MSDP speaker - globally enabled or disabled.

Changes to this object should be stored to non-volatile memory."

::= { msdp 1 }

msdpCacheLifetime OBJECT-TYPE

SYNTAX TimeTicks

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The lifetime given to SA cache entries when created or refreshed. This is the [SG-State-Period] in the MSDP spec. A value of 0 means no SA caching is done by this MSDP speaker.

Changes to this object should be stored to non-volatile memory.

This object does not measure time per se; instead, it is the delta from the time at which an SA message is received at which it should be expired if not refreshed. (i.e., it is the value of msdpSACacheExpiryTime immediately after receiving an SA message applying to that row.) As such, TimeInterval would be a more appropriate SYNTAX; it remains TimeTicks for backwards compatibility."

REFERENCE "RFC 3618 section 5.3"

::= { msdp 2 }

msdpNumSACacheEntries OBJECT-TYPE

SYNTAX Gauge32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The total number of entries in the SA Cache table."

::= { msdp 3 }

--

-- The spec doesn't define SA-Hold-Down-Period any more.

-- msdpSAHoldDownPeriod OBJECT-TYPE

-- ::= { msdp 9 }

-- This object was introduced in error, with a similar definition  
-- to msdpCacheLifetime.

-- msdpSAStatePeriod OBJECT-TYPE

-- ::= { msdp 10 }

msdpRPAddress OBJECT-TYPE

SYNTAX IpAddress

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The Rendezvous Point (RP) address used when sourcing  
MSDP SA messages. May be 0.0.0.0 on non-RPs.

Changes to this object should be stored to non-volatile  
memory."

::= { msdp 11 }

--

-- The MSDP Requests table

-- SA Requests were removed from the MSDP spec, so this entire table  
-- is deprecated.

msdpRequestsTable OBJECT-TYPE

SYNTAX SEQUENCE OF MsdpRequestsEntry

MAX-ACCESS not-accessible

STATUS deprecated

DESCRIPTION

"The (conceptual) table listing group ranges and MSDP peers  
used when deciding where to send an SA Request message, when  
required. If SA Requests are not enabled, this table may be  
empty.

In order to choose a peer to whom to send an SA Request for  
a given group, G, the subset of entries in this table whose  
(msdpRequestsPeerType, msdpRequestsPeer) tuple represents a

peer whose msdpPeerState is established are examined. The set is further reduced by examining only those entries for which msdpPeerRequestsGroupAddressType equals the address type of G. The entries with the highest value of msdpRequestsGroupPrefix are considered, where the group G falls within the range described by the combination of msdpRequestsGroup and msdpRequestsGroupPrefix. (This sequence is commonly known as a 'longest-match' lookup.)

Finally, if multiple entries remain, the entry with the lowest value of msdpRequestsPriority is chosen. The SA Request message is sent to the peer described by this row."

::= { msdp 4 }

msdpRequestsEntry OBJECT-TYPE

SYNTAX MsdpRequestsEntry

MAX-ACCESS not-accessible

STATUS deprecated

DESCRIPTION

"An entry (conceptual row) representing a group range used when deciding where to send an SA Request message."

INDEX { msdpRequestsGroupAddress, msdpRequestsGroupMask }

::= { msdpRequestsTable 1 }

MsdpRequestsEntry ::= SEQUENCE {

msdpRequestsGroupAddress IpAddress,

msdpRequestsGroupMask IpAddress,

msdpRequestsPeer IpAddress,

msdpRequestsStatus RowStatus

}

msdpRequestsGroupAddress OBJECT-TYPE

SYNTAX IpAddress

MAX-ACCESS not-accessible

STATUS deprecated

DESCRIPTION

"The group address that, when combined with the mask in this entry, represents the group range to which this row applies."

::= { msdpRequestsEntry 1 }

msdpRequestsGroupMask OBJECT-TYPE

SYNTAX IpAddress

MAX-ACCESS not-accessible

STATUS deprecated

DESCRIPTION

"The mask that, when combined with the group address

in this entry, represents the group range to which  
this row applies."  
::= { msdpRequestsEntry 2 }

msdpRequestsPeer OBJECT-TYPE

SYNTAX IPAddress

MAX-ACCESS read-create

STATUS deprecated

DESCRIPTION

"The peer to which MSDP SA Requests for groups matching  
this entry's group range will be sent. This object,  
combined with msdpRequestsPeerType, must match the INDEX  
of a row in the msdpPeerTable, and to be considered,  
this peer's msdpPeerState must be established."

::= { msdpRequestsEntry 3 }

msdpRequestsStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS deprecated

DESCRIPTION

"The status of this row, by which new rows may be added  
to the table or old rows may be deleted."

::= { msdpRequestsEntry 4 }

--

-- The MSDP Peer table

--

msdpPeerTable OBJECT-TYPE

SYNTAX SEQUENCE OF MsdpPeerEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The (conceptual) table listing the MSDP speaker's peers."

::= { msdp 5 }

msdpPeerEntry OBJECT-TYPE

SYNTAX MsdpPeerEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry (conceptual row) representing an MSDP peer.

If row creation is supported, dynamically added rows are  
added to the system's stable configuration (corresponding  
to a StorageType value of nonVolatile). "

```

INDEX      { msdpPeerRemoteAddress }
 ::= { msdpPeerTable 1 }

```

```

MsdpPeerEntry ::= SEQUENCE {
    msdpPeerRemoteAddress      IpAddress,
    msdpPeerState              INTEGER,
    msdpPeerRPFFailures        Counter32,
    msdpPeerInSAs              Counter32,
    msdpPeerOutSAs             Counter32,
    msdpPeerInSARRequests      Counter32,
    msdpPeerOutSARRequests     Counter32,
    msdpPeerInSAResponses      Counter32,
    msdpPeerOutSAResponses     Counter32,
    msdpPeerInControlMessages Counter32,
    msdpPeerOutControlMessages Counter32,
    msdpPeerInDataPackets      Counter32,
    msdpPeerOutDataPackets     Counter32,
    msdpPeerFsmEstablishedTransitions Counter32,
    msdpPeerFsmEstablishedTime Timestamp,
    msdpPeerInMessageTime      Timestamp,
    msdpPeerLocalAddress       IpAddress,
    msdpPeerConnectRetryInterval Integer32,
    msdpPeerHoldTimeConfigured Integer32,
    msdpPeerKeepAliveConfigured Integer32,
    msdpPeerDataTtl            Integer32,
    msdpPeerProcessRequestsFrom TruthValue,
    msdpPeerStatus             RowStatus,
    msdpPeerRemotePort         Integer32,
    msdpPeerLocalPort          Integer32,
    msdpPeerEncapsulationType  INTEGER,
    msdpPeerConnectionAttempts Counter32,
    msdpPeerInNotifications    Counter32,
    msdpPeerOutNotifications   Counter32,
    msdpPeerLastError          OCTET STRING,
    msdpPeerDiscontinuityTime  Timestamp
}

```

```

msdpPeerRemoteAddress OBJECT-TYPE
    SYNTAX      IpAddress
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The address of the remote MSDP peer."
    ::= { msdpPeerEntry 1 }

```

-- dunno what happened to 2.

```

msdpPeerState OBJECT-TYPE

```



```
SYNTAX      INTEGER {
                                inactive(1),
                                listen(2),
                                connecting(3),
                                established(4),
                                disabled(5)
                        }
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The state of the MSDP TCP connection with this peer."
 ::= { msdpPeerEntry 3 }
```

msdpPeerRPFFailures OBJECT-TYPE

```
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The number of SA messages received from this peer that
    failed the Peer-RPF check.

    Discontinuities in the value of this counter can occur at
    re-initialization of the management system, and at other
    times as indicated by the value of
    msdpPeerDiscontinuityTime."
 ::= { msdpPeerEntry 4 }
```

msdpPeerInSAs OBJECT-TYPE

```
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The number of MSDP SA messages received on this
    connection.

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

msdpPeerOutSAs OBJECT-TYPE

```
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The number of MSDP SA messages transmitted on this
    connection."
```

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

::= { msdpPeerEntry 6 }

msdpPeerInSARequests OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of MSDP SA-Request messages received on this connection.

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

::= { msdpPeerEntry 7 }

msdpPeerOutSARequests OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of MSDP SA-Request messages transmitted on this connection.

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

::= { msdpPeerEntry 8 }

msdpPeerInSAResponses OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS deprecated

DESCRIPTION

"The number of MSDP SA-Response messages received on this connection.

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

::= { msdpPeerEntry 9 }

**msdpPeerOutSAResponses OBJECT-TYPE**

SYNTAX Counter32

MAX-ACCESS read-only

STATUS deprecated

DESCRIPTION

"The number of MSDP SA Response messages transmitted on this TCP connection.

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

::= { msdpPeerEntry 10 }

**msdpPeerInControlMessages OBJECT-TYPE**

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The total number of MSDP messages, excluding encapsulated data packets, received on this TCP connection.

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

::= { msdpPeerEntry 11 }

**msdpPeerOutControlMessages OBJECT-TYPE**

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The total number of MSDP messages, excluding encapsulated data packets, transmitted on this TCP connection.

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

::= { msdpPeerEntry 12 }

**msdpPeerInDataPackets OBJECT-TYPE**

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The total number of encapsulated data packets received

from this peer.

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

::= { msdpPeerEntry 13 }

msdpPeerOutDataPackets OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The total number of encapsulated data packets sent to this peer.

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

::= { msdpPeerEntry 14 }

msdpPeerFsmEstablishedTransitions OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The total number of times the MSDP FSM transitioned into the ESTABLISHED state."

REFERENCE "RFC 3618 section 11"

::= { msdpPeerEntry 15 }

msdpPeerFsmEstablishedTime OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This timestamp is set to the value of sysUpTime when a peer transitions into or out of the ESTABLISHED state.

It is set to zero when the MSDP speaker is booted."

REFERENCE "RFC 3618 section 11"

::= { msdpPeerEntry 16 }

msdpPeerInMessageTime OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The sysUpTime value when the last MSDP message was received from the peer. It is set to zero when the MSDP speaker is booted."

::= { msdpPeerEntry 17 }

msdpPeerLocalAddress OBJECT-TYPE

SYNTAX IPAddress

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The local IP address used for this entry's MSDP TCP connection."

::= { msdpPeerEntry 18 }

-- msdpPeerSAAdvPeriod ([SA-Advertisement-Timer]) has been removed.

-- ::= { msdpPeerEntry 19 }

-- RFC 3618, Section 5.1, says it MUST be 60 seconds.

msdpPeerConnectRetryInterval OBJECT-TYPE

SYNTAX Integer32 (1..65535)

UNITS "seconds"

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Time interval, in seconds, for the [ConnectRetry-period] for this peer."

REFERENCE "RFC 3618 section 5.6"

DEFVAL { 30 }

::= { msdpPeerEntry 20 }

msdpPeerHoldTimeConfigured OBJECT-TYPE

SYNTAX Integer32 (0|3..65535)

UNITS "seconds"

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Time interval, in seconds, for the [HoldTime-Period] configured for this MSDP speaker with this peer. If the value of this object is zero (0), the MSDP connection is never torn down due to the absence of messages from the peer."

REFERENCE "RFC 3618 section 5.4"

DEFVAL { 75 }

::= { msdpPeerEntry 21 }

msdpPeerKeepAliveConfigured OBJECT-TYPE

SYNTAX Integer32 (0|1..21845)

UNITS "seconds"  
MAX-ACCESS read-create  
STATUS current  
DESCRIPTION  
    "Time interval, in seconds, for the [KeepAlive-Period]  
    configured for this MSDP speaker with this peer. If the  
    value of this object is zero (0), no periodic KEEPALIVE  
    messages are sent to the peer after the MSDP connection  
    has been established."  
REFERENCE "RFC 3618 section 5.5"  
DEFVAL { 60 }  
::= { msdpPeerEntry 22 }

msdpPeerDataTtl OBJECT-TYPE  
SYNTAX Integer32 (0..255)  
MAX-ACCESS read-create  
STATUS current  
DESCRIPTION  
    "The minimum TTL a packet is required to have before it  
    may be forwarded using SA encapsulation to this peer."  
DEFVAL { 1 }  
::= { msdpPeerEntry 23 }

msdpPeerProcessRequestsFrom OBJECT-TYPE  
SYNTAX TruthValue  
MAX-ACCESS read-create  
STATUS deprecated  
DESCRIPTION  
    "This object indicates whether to process MSDP SA  
    Request messages from this peer. If True(1), MSDP SA  
    Request messages from this peer are processed and replied  
    to (if appropriate) with SA Response messages. If  
    False(2), MSDP SA Request messages from this peer are  
    silently ignored. It defaults to False when  
    msdpCacheLifetime is 0 and to True when msdpCacheLifetime  
    is non-0.  
  
    This object is deprecated because MSDP SA Requests were  
    removed from the MSDP specification."  
::= { msdpPeerEntry 24 }

msdpPeerStatus OBJECT-TYPE  
SYNTAX RowStatus  
MAX-ACCESS read-create  
STATUS current  
DESCRIPTION  
    "The RowStatus object by which peers can be added and  
    deleted. A transition to 'active' will cause the MSDP

'Enable MSDP peering with P' Event to be generated. A transition out of the 'active' state will cause the MSDP 'Disable MSDP peering with P' Event to be generated. Care should be used in providing write access to this object without adequate authentication.

msdpPeerRemoteAddress is the only variable that must be set to a valid value before the row can be activated. Since this is the table's INDEX, a row can be activated by simply setting the msdpPeerStatus variable.

It is possible to modify other columns in the same conceptual row when the status value is active(1)."

REFERENCE "RFC 3618 section 11.1"

::= { msdpPeerEntry 25 }

msdpPeerRemotePort OBJECT-TYPE

SYNTAX Integer32 (0..65535)

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The remote port for the TCP connection between the MSDP peers."

DEFVAL { 639 }

::= { msdpPeerEntry 26 }

msdpPeerLocalPort OBJECT-TYPE

SYNTAX Integer32 (0..65535)

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The local port for the TCP connection between the MSDP peers."

DEFVAL { 639 }

::= { msdpPeerEntry 27 }

-- msdpPeerEncapsulationState has been removed  
-- because there is no longer an encapsulation  
-- state machine.

-- ::= { msdpPeerEntry 28 }

msdpPeerEncapsulationType OBJECT-TYPE

SYNTAX INTEGER {  
none(0),  
tcp(1)  
}

MAX-ACCESS read-create

STATUS current

## DESCRIPTION

"The encapsulation in use when encapsulating data in SA messages to this peer."

::= { msdpPeerEntry 29 }

## msdpPeerConnectionAttempts OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

## DESCRIPTION

"The number of times the state machine has transitioned from INACTIVE to CONNECTING."

::= { msdpPeerEntry 30 }

## msdpPeerInNotifications OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS deprecated

## DESCRIPTION

"The number of MSDP Notification messages received from this peer.

This object is deprecated because MSDP Notifications have been removed from the spec."

::= { msdpPeerEntry 31 }

## msdpPeerOutNotifications OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS deprecated

## DESCRIPTION

"The number of MSDP Notification messages transmitted to this peer.

This object is deprecated because MSDP Notifications have been removed from the spec."

::= { msdpPeerEntry 32 }

## msdpPeerLastError OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (2))

MAX-ACCESS read-only

STATUS deprecated

## DESCRIPTION

"The last error code and subcode received via Notification from this peer. If no error has occurred, this field is zero. Otherwise, the first byte of this two-byte OCTET STRING contains the O-bit and error code, and the second byte contains the subcode."



This object is deprecated because MSDP Notifications have been removed from the spec."

```
DEFVAL { '0000'h }
 ::= { msdpPeerEntry 33 }
```

#### msdpPeerDiscontinuityTime OBJECT-TYPE

```
SYNTAX      TimeStamp
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
```

"The value of sysUpTime on the most recent occasion at which one or more of this entry's counters suffered a discontinuity. See the DESCRIPTION of each object to see if it is expected to have discontinuities. These discontinuities may occur at peer connection establishment.

If no such discontinuities have occurred since the last reinitialization of the local management subsystem, then this object contains a zero value."

```
 ::= { msdpPeerEntry 34 }
```

```
--
```

```
-- The MSDP Source-Active Cache table
```

```
--
```

#### msdpSACacheTable OBJECT-TYPE

```
SYNTAX      SEQUENCE OF MsdpSACacheEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
```

"The (conceptual) table listing the MSDP SA advertisements currently in the MSDP speaker's cache."

```
 ::= { msdp 6 }
```

#### msdpSACacheEntry OBJECT-TYPE

```
SYNTAX      MsdpSACacheEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
```

"An entry (conceptual row) representing an MSDP SA advertisement. The INDEX to this table includes msdpSACacheOriginRP for diagnosing incorrect MSDP advertisements; normally, a Group and Source pair would be unique.

Row creation is not permitted; msdpSACacheStatus may only be used to delete rows from this table."

```

INDEX      { msdpSACacheGroupAddr, msdpSACacheSourceAddr,
              msdpSACacheOriginRP }
 ::= { msdpSACacheTable 1 }

```

```

MsdpSACacheEntry ::= SEQUENCE {
    msdpSACacheGroupAddr      IpAddress,
    msdpSACacheSourceAddr     IpAddress,
    msdpSACacheOriginRP       IpAddress,
    msdpSACachePeerLearnedFrom IpAddress,
    msdpSACacheRPFPeer        IpAddress,
    msdpSACacheInSAs           Counter32,
    msdpSACacheInDataPackets   Counter32,
    msdpSACacheUpTime          TimeTicks,
    msdpSACacheExpiryTime      TimeTicks,
    msdpSACacheStatus          RowStatus
}

```

```

msdpSACacheGroupAddr OBJECT-TYPE
    SYNTAX      IpAddress
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The group address of the SA Cache entry."
    ::= { msdpSACacheEntry 1 }

```

```

msdpSACacheSourceAddr OBJECT-TYPE
    SYNTAX      IpAddress
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The source address of the SA Cache entry."
    ::= { msdpSACacheEntry 2 }

```

```

msdpSACacheOriginRP OBJECT-TYPE
    SYNTAX      IpAddress
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The RP of the SA Cache entry.  This field is in the INDEX
        in order to catch multiple RP's advertising the same
        source and group."
    ::= { msdpSACacheEntry 3 }

```

```

msdpSACachePeerLearnedFrom OBJECT-TYPE
    SYNTAX      IpAddress
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION

```

"The peer from which this SA Cache entry was last accepted. This address must correspond to the msdpPeerRemoteAddress value for a row in the MSDP Peer Table. This should be 0.0.0.0 on the router that originated the entry."

::= { msdpSACacheEntry 4 }

msdpSACacheRPFPeer OBJECT-TYPE

SYNTAX IpAddress

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The peer from which an SA message corresponding to this cache entry would be accepted (i.e., the RPF peer for msdpSACacheOriginRP). This may be different than msdpSACachePeerLearnedFrom if this entry was created by an MSDP SA-Response. This address must correspond to the msdpPeerRemoteAddress value for a row in the MSDP Peer Table, or it may be 0.0.0.0 if no RPF peer exists."

::= { msdpSACacheEntry 5 }

msdpSACacheInSAs OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of MSDP SA messages received relevant to this cache entry. This object must be initialized to zero when creating a cache entry."

::= { msdpSACacheEntry 6 }

msdpSACacheInDataPackets OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of MSDP-encapsulated data packets received relevant to this cache entry. This object must be initialized to zero when creating a cache entry."

::= { msdpSACacheEntry 7 }

msdpSACacheUpTime OBJECT-TYPE

SYNTAX TimeTicks

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The time since this entry was first placed in the SA cache."

The first epoch is the time that the entry was first placed in the SA cache, and the second epoch is the current time."

::= { msdpSACacheEntry 8 }

msdpSACacheExpiryTime OBJECT-TYPE

SYNTAX TimeTicks

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The time remaining before this entry will expire from the SA cache.

The first epoch is now, and the second epoch is the time that the entry will expire."

::= { msdpSACacheEntry 9 }

msdpSACacheStatus OBJECT-TYPE

SYNTAX RowStatus { active(1), destroy(6) }

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The status of this row in the table. The only allowable actions are to retrieve the status, which will be 'active', or to set the status to 'destroy' in order to remove this entry from the cache.

Row creation is not permitted.

No columnar objects are writable, so there are none that may be changed while the status value is active(1)."

::= { msdpSACacheEntry 10 }

--

-- MSDP Mesh Group Membership table

--

msdpMeshGroupTable OBJECT-TYPE

SYNTAX SEQUENCE OF MsdpMeshGroupEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The (conceptual) table listing MSDP Mesh Group configuration."

::= { msdp 12 }

msdpMeshGroupEntry OBJECT-TYPE

SYNTAX        MsdpMeshGroupEntry  
 MAX-ACCESS   not-accessible  
 STATUS        current  
 DESCRIPTION  
     "An entry (conceptual row) representing a peer in an MSDP  
     Mesh Group.

    If row creation is supported, dynamically added rows are  
     added to the system's stable configuration  
     (corresponding to a StorageType value of nonVolatile)."

INDEX         { msdpMeshGroupName, msdpMeshGroupPeerAddress }  
 ::= { msdpMeshGroupTable 1 }

MsdpMeshGroupEntry ::= SEQUENCE {  
     msdpMeshGroupName        DisplayString,  
     msdpMeshGroupPeerAddress    IpAddress,  
     msdpMeshGroupStatus        RowStatus  
 }

msdpMeshGroupName OBJECT-TYPE  
 SYNTAX        DisplayString (SIZE(1..64))  
 MAX-ACCESS   not-accessible  
 STATUS        current  
 DESCRIPTION  
     "The name of the mesh group."  
 ::= { msdpMeshGroupEntry 1 }

msdpMeshGroupPeerAddress OBJECT-TYPE  
 SYNTAX        IpAddress  
 MAX-ACCESS   not-accessible  
 STATUS        current  
 DESCRIPTION  
     "A peer address that is a member of the mesh group with  
     name msdpMeshGroupName. The msdpMeshGroupPeerAddress  
     must match a row in the msdpPeerTable."  
 ::= { msdpMeshGroupEntry 2 }

msdpMeshGroupStatus OBJECT-TYPE  
 SYNTAX        RowStatus  
 MAX-ACCESS   read-create  
 STATUS        current  
 DESCRIPTION  
     "This entry's status, by which new entries may be added  
     to the table and old entries deleted.

    msdpMeshGroupName and msdpMeshGroupPeerAddress must be  
     set to valid values before the row can be activated.  
     Since these are the table's INDEX, a row can be activated

by simply setting the msdpMeshGroupStatus variable.

It is not possible to modify other columns in the same conceptual row when the status value is active(1), because the only other objects in the row are part of the INDEX. Changing one of these changes the row, so an old row must be deleted and a new one created."

```
::= { msdpMeshGroupEntry 3 }
```

-- Traps

```
msdpTraps OBJECT IDENTIFIER ::= { msdp 0 }
```

```
msdpEstablished NOTIFICATION-TYPE
```

```
OBJECTS { msdpPeerFsmEstablishedTransitions }
```

```
STATUS current
```

```
DESCRIPTION
```

"The MSDP Established event is generated when the MSDP FSM enters the ESTABLISHED state."

```
::= { msdpTraps 1 }
```

```
msdpBackwardTransition NOTIFICATION-TYPE
```

```
OBJECTS { msdpPeerState }
```

```
STATUS current
```

```
DESCRIPTION
```

"The MSDPBackwardTransition Event is generated when the MSDP FSM moves from a higher-numbered state to a lower-numbered state."

```
::= { msdpTraps 2 }
```

-- conformance information

```
msdpMIBConformance OBJECT IDENTIFIER ::= { msdp 8 }
```

```
msdpMIBCompliances OBJECT IDENTIFIER ::= { msdpMIBConformance 1 }
```

```
msdpMIBGroups OBJECT IDENTIFIER ::= { msdpMIBConformance 2 }
```

-- compliance statements

```
msdpMIBCompliance MODULE-COMPLIANCE
```

```
STATUS deprecated
```

```
DESCRIPTION
```

"The compliance statement for entities that implement a pre-RFC version of MSDP. This statement is deprecated because it includes objects used for managing/monitoring aspects of MSDP that were removed before it was published as an RFC."

```
MODULE -- this module
```

```
MANDATORY-GROUPS { msdpMIBGlobalsGroup, msdpMIBPeerGroup,
```

msdpMIBNotificationGroup }

GROUP msdpMIBEncapsulationGroup

DESCRIPTION

"This group is mandatory if MSDP encapsulation interfaces are not given their own interface index numbers."

GROUP msdpMIBSACacheGroup

DESCRIPTION

"This group is mandatory if the MSDP speaker has the ability to cache SA messages."

GROUP msdpMIBRequestsGroup

DESCRIPTION

"This group is mandatory if the MSDP speaker has the ability to send SA-Request messages and to parse SA-Response messages."

GROUP msdpMIBRPGGroup

DESCRIPTION

"This group is mandatory if the MSDP speaker sources (as opposed to forwards) MSDP messages."

GROUP msdpMIBMeshGroupGroup

DESCRIPTION

"This group is mandatory if the MSDP speaker can participate in MSDP Mesh Groups."

::= { msdpMIBCompliances 1 }

msdpMIBFullCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"The compliance statement for entities that implement MSDP (RFC3618)."

MODULE -- this module

MANDATORY-GROUPS { msdpMIBGlobalsGroup, msdpMIBPeerGroup2,  
msdpMIBSACacheGroup, msdpMIBEncapsulationGroup }

GROUP msdpMIBRPGGroup

DESCRIPTION

"This group is mandatory if the MSDP speaker sources (as opposed to forwards) MSDP messages."

GROUP msdpMIBMeshGroupGroup

DESCRIPTION

"This group is mandatory if the MSDP speaker can participate in MSDP Mesh Groups."

::= { msdpMIBCompliances 2 }

msdpMIBReadOnlyCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"The compliance statement for entities that implement MSDP (RFC3618), but do not permit configuration (or only permit

```
        partial configuration) via SNMP."
MODULE  -- this module
MANDATORY-GROUPS { msdpMIBGlobalsGroup, msdpMIBPeerGroup2,
                    msdpMIBSACacheGroup, msdpMIBEncapsulationGroup }
GROUP   msdpMIBRPGGroup
DESCRIPTION
    "This group is mandatory if the MSDP speaker sources (as
    opposed to forwards) MSDP messages."
GROUP   msdpMIBMeshGroupGroup
DESCRIPTION
    "This group is mandatory if the MSDP speaker can participate
    in MSDP Mesh Groups."
OBJECT   msdpEnabled
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
OBJECT   msdpCacheLifetime
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
OBJECT   msdpPeerLocalAddress
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
OBJECT   msdpPeerConnectRetryInterval
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
OBJECT   msdpPeerHoldTimeConfigured
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
OBJECT   msdpPeerKeepAliveConfigured
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
OBJECT   msdpPeerDataTtl
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
OBJECT   msdpPeerStatus
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
OBJECT   msdpPeerEncapsulationType
MIN-ACCESS read-only
DESCRIPTION
    "Write access is not required."
```



```

    OBJECT      msdpSACacheStatus
    MIN-ACCESS  read-only
    DESCRIPTION
        "Write access is not required."
    OBJECT      msdpRPAddress
    MIN-ACCESS  read-only
    DESCRIPTION
        "Write access is not required."
    OBJECT      msdpMeshGroupStatus
    MIN-ACCESS  read-only
    DESCRIPTION
        "Write access is not required."
 ::= { msdpMIBCompliances 3 }

-- units of conformance

msdpMIBGlobalsGroup OBJECT-GROUP
    OBJECTS { msdpEnabled }
    STATUS      current
    DESCRIPTION
        "A collection of objects providing information on global MSDP
         state."
 ::= { msdpMIBGroups 1 }

msdpMIBPeerGroup OBJECT-GROUP
    OBJECTS { msdpPeerRPFFailures,
              msdpPeerState, msdpPeerInSAs, msdpPeerOutSAs,
              msdpPeerInSARRequests, msdpPeerOutSARRequests,
              msdpPeerInSAResponses, msdpPeerOutSAResponses,
              msdpPeerInNotifications, msdpPeerOutNotifications,
              msdpPeerInControlMessages, msdpPeerOutControlMessages,
              msdpPeerFsmEstablishedTransitions,
              msdpPeerFsmEstablishedTime,
              msdpPeerLocalAddress,
              msdpPeerRemotePort, msdpPeerLocalPort,
              msdpPeerConnectRetryInterval,
              msdpPeerHoldTimeConfigured,
              msdpPeerKeepAliveConfigured,
              msdpPeerInMessageTime,
              msdpPeerProcessRequestsFrom,
              msdpPeerConnectionAttempts,
              msdpPeerLastError,
              msdpPeerStatus,
              msdpPeerDiscontinuityTime
            }
    STATUS      deprecated
    DESCRIPTION
        "A collection of objects for managing MSDP peers.  This group

```

is deprecated in favor of msdpMIBPeerGroup2 because it contains objects for managing aspects of MSDP that were removed before it was published as an RFC."

::= { msdpMIBGroups 2 }

msdpMIBEncapsulationGroup OBJECT-GROUP

OBJECTS { msdpPeerInDataPackets, msdpPeerOutDataPackets,  
msdpPeerDataTtl,  
msdpPeerEncapsulationType  
}

STATUS current

DESCRIPTION

"A collection of objects for managing encapsulations if the MSDP encapsulation interfaces are not given interface indices."

::= { msdpMIBGroups 3 }

msdpMIBSACacheGroup OBJECT-GROUP

OBJECTS { msdpCacheLifetime, msdpNumSACacheEntries,  
msdpSACachePeerLearnedFrom,  
msdpSACacheRPFPeer, msdpSACacheInSAs,  
msdpSACacheInDataPackets,  
msdpSACacheUptime, msdpSACacheExpiryTime,  
msdpSACacheStatus }

STATUS current

DESCRIPTION

"A collection of objects for managing MSDP SA cache entries."

::= { msdpMIBGroups 4 }

msdpMIBNotificationGroup NOTIFICATION-GROUP

NOTIFICATIONS { msdpEstablished,  
msdpBackwardTransition }

STATUS current

DESCRIPTION

"A collection of notifications for signaling changes in MSDP peer relationships."

::= { msdpMIBGroups 5 }

msdpMIBRequestsGroup OBJECT-GROUP

OBJECTS { msdpRequestsPeer, msdpRequestsStatus }

STATUS deprecated

DESCRIPTION

"A collection of objects for managing MSDP Request transmission. This group is deprecated because Requests were removed from MSDP before its publication as an RFC."

::= { msdpMIBGroups 6 }

msdpMIBRPGroup OBJECT-GROUP

```
OBJECTS { msdpRPAddress }
STATUS   current
DESCRIPTION
    "A collection of objects for MSDP speakers that source MSDP
    messages."
 ::= { msdpMIBGroups 7 }

msdpMIBMeshGroupGroup OBJECT-GROUP
OBJECTS { msdpMeshGroupStatus }
STATUS   current
DESCRIPTION
    "A collection of objects for MSDP speakers that can
    participate in MSDP mesh groups."
 ::= { msdpMIBGroups 8 }

msdpMIBPeerGroup2 OBJECT-GROUP
OBJECTS { msdpPeerRPFFailures,
          msdpPeerState, msdpPeerInSAs, msdpPeerOutSAs,
          msdpPeerInSARRequests, msdpPeerOutSARRequests,
          msdpPeerInControlMessages, msdpPeerOutControlMessages,
          msdpPeerFsmEstablishedTransitions,
          msdpPeerFsmEstablishedTime,
          msdpPeerLocalAddress,
          msdpPeerRemotePort, msdpPeerLocalPort,
          msdpPeerConnectRetryInterval,
          msdpPeerHoldTimeConfigured,
          msdpPeerKeepAliveConfigured,
          msdpPeerInMessageTime,
          msdpPeerConnectionAttempts,
          msdpPeerStatus,
          msdpPeerDiscontinuityTime
        }
STATUS   current
DESCRIPTION
    "A collection of objects for managing MSDP peers."
 ::= { msdpMIBGroups 9 }

END
```

## 5. Security Considerations

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. These are the tables and objects and their sensitivity/vulnerability:

### msdpEnabled

Obviously, by modifying msdpEnabled, an attacker could simply disable MSDP processing on the router.

### msdpCacheLifetime

If allowed to modify msdpCacheLifetime, an attacker could set the value to a value lower than a peer's refresh interval, causing all state to time out and be refreshed.

### msdpRequestsPeer, msdpRequestsStatus

If allowed to modify entries in the msdpRequestsTable, an attacker could cause this system to send MSDP Requests to an unknown system, or could simply remove the proper configuration. Note that the msdpRequestsTable is deprecated, and the MSDP Request functionality is not in the published MSDP spec.

### msdpPeerTable objects

The writable objects in the msdpPeerTable are:

msdpPeerLocalAddress, msdpPeerConnectRetryInterval, msdpPeerHoldTimeConfigured, msdpPeerKeepAliveConfigured, msdpPeerDataTtl, msdpPeerProcessRequestsFrom, msdpPeerStatus, and msdpPeerEncapsulationType. Of these, modifying msdpPeerIpAddress and msdpPeerStatus could cause a changed or deleted peer configuration. Modifying any of the other values could cause subtle protocol misbehavior.

### msdpSACacheStatus

This writable object can be used to remove valid values from the router's SA cache.

### msdpRPAddress

Changing this object can cause a failure of the Peer-RPF rules for SA messages sourced by this router.

### msdpMeshGroupStatus

This object can be used to change this router's idea of its mesh group membership and those of its peers. Misconfiguration of mesh groups can cause subtle protocol misbehavior.

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

- o The entire msdpPeerTable. Peer information can result in discovering internal topology, which many want to keep secret.
- o msdpNumSACacheEntries. The size of the SA Cache could reveal whether this system has MSDP entries for public and/or private groups.
- o The entire msdpSACacheTable. The active sources and groups in a network could be private.
- o The entire msdpMeshGroupTable. This information can also lead to internal topology information.

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 [6], 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 indeed GET or SET (change/create/delete) them.

## 6. IANA Considerations

Since this MIB is for an experimental protocol, it uses an experimental OID.

Decimal	Name	Description	References
-----	----	-----	-----
92	MSDP-MIB	Multicast Source Discovery MIB	RFC 4624

## 7. Acknowledgements

Tom Pusateri and Billy Ng both provided valuable input on early versions of this document. It was completed with feedback from Mike Davison and Ketan Talaulikar. Lucy Lynch provided a desperately needed reminder to finish this document.

## 8. References

### 8.1 Normative References

- [1] Fenner, B., Ed., and D. Meyer, Ed., "Multicast Source Discovery Protocol (MSDP)", RFC 3618, October 2003.
- [2] Blumenthal, U. and B. Wijnen, "User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)", STD 62, RFC 3414, December 2002.
- [3] Wijnen, B., Presuhn, R., and K. McCloghrie, "View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)", STD 62, RFC 3415, December 2002.
- [4] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.
- [5] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Textual Conventions for SMIv2", STD 58, RFC 2579, April 1999.
- [6] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Conformance Statements for SMIv2", STD 58, RFC 2580, April 1999.

### 8.2 Informative References

- [7] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, December 2002.

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