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Definition of Managed Objects for the Manet Simplified Multicast Framework Relay Set Process
draft-ietf-manet-smf-mib-06

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 for configuring aspects of the Simplified Multicast Forwarding (SMF) process for Mobile Ad-Hoc Networks (MANETs). The SMF-MIB also reports state information, performance metrics, and notifications. In addition to configuration, the additional state and performance information is useful to operators troubleshooting multicast forwarding problems.

Status of This Memo

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes objects for configuring aspects of a process implementing Simplified Multicast Forwarding (SMF) [RFC6621] for Mobile Ad-Hoc Networks (MANETs). SMF provides multicast Duplicate Packet Detection (DPD) and supports algorithms for constructing an estimate of a MANET Minimum Connected Dominating Set (MCDS) for efficient multicast forwarding. The SMF-MIB also reports state information, performance metrics, and notifications. In addition to configuration, this additional state and performance information is useful to operators troubleshooting multicast forwarding problems.

2. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of RFC 3410 [RFC3410].

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

3. Conventions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

4. Overview

SMF provides methods for implementing DPD-based multicast forwarding with the optional use of Connected Dominating Set (CDS)-based relay sets. The CDS provides a complete connected coverage of the nodes comprising the MANET. The MCDS is the smallest set of MANET nodes (comprising a connected cluster) which cover all the nodes in the cluster with their transmissions. As the density of the MANET nodes increase, the fraction of nodes required in an MCDS decreases. Using the MCDS as a multicast forwarding set then becomes an efficient multicast mechanism for MANETs.

Various algorithms for the construction of estimates of the MCDS exist. The Simplified Multicast Framework [RFC6621] describes some of these. It further defines various operational modes for a node which is participating in the collective creation of the MCDS estimates. These modes depend upon the set of related MANET routing and discovery protocols and mechanisms in operation in the specific MANET node.

A SMF router's MIB contains SMF process configuration parameters (e.g. specific CDS algorithm), state information (e.g., current membership in the CDS), performance counters (e.g., packet counters), and notifications.

4.1. SMF Management Model

This section describes the management model for the SMF node process.

Figure 1 (reproduced from Figure 4 of [RFC6621]) shows the relationship between the SMF Relay Set selection algorithm and the related algorithms, processes and protocols running in the MANET nodes. The Relay Set Selection Algorithm (RSSA) can rely upon topology information gotten from the MANET Neighborhood Discovery Protocol (NHDP), from the specific MANET routing protocol running on the node, or from Layer 2 information passed up to the higher layer protocol processes.

```
       ______________                ____________
      |              |              |            |
      | Neighborhood |              | Relay Set  |
      |  Discovery   |------------->| Selection  |
      |   Protocol   |   neighbor   | Algorithm  |
      |______________|     info     |____________|
             \                               /
              \                             /
       neighbor\                           / forwarding
         info*  \      _____________      /    status
                 \    |             |    /
                  `-->| Forwarding  |<--'
                      |   Process   |
    ----------------->|_____________|----------------->
     incoming packet,                   forwarded packets
     interface id*, and
     previous hop*
```

Figure 1: SMF Node Architecture

4.2. Terms

The following definitions apply throughout this document:

- Configuration Objects - switches, tables, objects which are initialized to default settings or set through the management interface defined by this MIB.

- Tunable Configuration Objects - objects whose values affect timing or attempt bounds on the SMF RS process.

- State Objects - automatically generated values which define the current operating state of the SMF RS process in the router.

- Performance Objects - automatically generated values which help an administrator or automated tool to assess the performance of the CDS multicast process on the router and the overall multicast performance within the MANET routing domain.

5. Structure of the MIB Module

This section presents the structure of the SMF-MIB module. The objects are arranged into the following groups:

- smfMIBNotifications - defines the notifications associated with the SMF-MIB.

o smfMIBObjects - defines the objects forming the basis for the SMF-MIB. These objects are divided up by function into the following groups:

  * Capabilities Group - This group contains the SMF objects that the device uses to advertise its local capabilities with respect to, e.g., the supported RSSAs.

  * Configuration Group - This group contains the SMF objects that configure specific options that determine the overall operation of the SMF RSSA and the resulting multicast performance.

  * State Group - Contains information describing the current state of the SMF RSSA process such as the Neighbor Table.

  * Performance Group - Contains objects which help to characterize the performance of the SMF RSSA process, typically statistics counters.

o smfMIBConformance - defines minimal and full conformance of implementations to this SMF-MIB.

5.1. Textual Conventions

The textual conventions defined within the SMF-MIB are as follows:

o The SmfStatus is defined within the SMF-MIB. This contains the current operational status of the SMF process on an interface.

o The SmfOpModeID represents an index that identifies a specific SMF operational mode.

o The SmfRssaID represents an index that identifies, through reference, a specific RSSA available for operation on the device.

5.2. The Capabilities Group

The SMF device supports a set of capabilities. The list of capabilities which the device can advertise are:

o Operational Mode - topology information from NHDP, CDS-aware unicast routing or Cross-layer from Layer 2.

o SMF RSSA - the specific RSSA operational on the device. Note that configuration, state and performance objects related to a specific RSSA must be defined within another separate MIB.

5.3. The Configuration Group

The SMF device is configured with a set of controls. Some of the prominent configuration controls for the SMF device follow:

- o Operational Mode - topology information from NHDP, CDS-aware unicast routing or Cross-layer from Layer 2.

- o SMF RSSA - the specific RSSA operational on the device.

- o Duplicate Packet detection for IPv4 - Identification-based or Hash-based DPD.

- o Duplicate Packet detection for IPv6 - Identification-based or Hash-based DPD.

- o SMF Type Message TLV - if NHDP mode is selected, then is the SMF Type Message TLV may be included in the NHDP exchanges.

- o SMF Address Block TLV - if NHDP mode is selected, then is the SMF Address Block TLV should be included in the NHDP exchanges.

5.4. The State Group

The State sub-tree reports current state information, e.g.,

- o Node RSSA State - is the node currently in or out of the Relay Set.

- o Neighbors Table - a table containing current neighbors and their operational RSSA.

5.5. The Performance Group

The Performance sub-tree reports primarily counters that relate to SMF RSSA performance. The SMF performance counters consists of per node and per interface objects:

- o Total multicast packets received.

- o Total multicast packets forwarded.

- o Total duplicate multicast packets detected.

- o Per interface statistics table with the following entries:

  * Multicast packets received.

   * Multicast packets forwarded.

   * Duplicate multicast packets detected.

5.6. The Notifications Group

The Notifications Sub-tree contains the list of notifications supported within the SMF-MIB and their intended purpose or utility.

5.7. Tables and Indexing

The SMF-MIB module contains a number of tables which record data related to:

o configuration and operation of packet forwarding the local router,

o configuration and operation of local MANET interfaces on the router, and

o configuration and operation of various RSSA algorithms for packet forwarding.

The SMF-MIB module's tables are indexed via the following constructs:

o smfOpModeCapabilitiesID - which is the index for each of the SMF modes.

o smfRssaCapabilitiesID - which is the index for each of the RSSAs supported by this specific device.

o smfConfiguredAddrForwardingAddrType and smfConfiguredAddrForwardingFirstAddr - indexes to multicast addresses which are forwarded by the SMF process.

o smfIfIndex - which is the IfIndex of the local router on which SMF is configured.

o smfDiscoveredAddrForwardingAddrType and smfDiscoveredAddrForwardingFirstAddr - indexes to discovered multicast addresses which are forwarded by the SMF process.

o smfNeighborIpAddrType, smfNeighborIpAddr, and smfNeighborPrefixLen - which is the index set of interface specific neighbor nodes to this SMF device.

These tables and their indexing are:

- o smfOpModeCapabilitiesTable - identifies the resident set of SMF Operational Modes on this router. This table has 'INDEX { smfOpModeCapabilitiesID }.

- o smfRssaCapabilitiesTable - contains reference to the specific set of RSSAs currently supported on this device. This table has 'INDEX { smfRssaCapabilitiesID }'.

- o smfConfiguredAddrForwardingTable - contains information on multicast addresses which are to be forwarded by the SMF process on this device. This table has 'INDEX { smfConfiguredAddrForwardingAddrType, smfConfiguredAddrForwardingFirstAddr }'.

- o smfInterfaceTable - describes the SMF interfaces on this device that are participating in the SMF packet forwarding process. This table has 'INDEX { smfIfIndex }'.

- o smfDiscoveredAddrForwardingTable - contains discovered address for SMF packet forwarding. This table has 'INDEX { smfDiscoveredAddrForwardingAddrType, smfDiscoveredAddrForwardingFirstAddr }'.

- o smfNeighborTable - describes the current neighbor nodes, their addresses and the SMF RSSA and the interface on which they can be reached. This table has 'INDEX { smfNeighborIpAddrType, smfNeighborIpAddr, smfNeighborPrefixLen }'.

- o smfIpv4InterfaceTable - contains the IPv4 related SMF statistics per each SMF interface on this device. This table has 'INDEX { smfIfIndex }'.

- o smfIpv6InterfaceTable - contains the IPv6 related SMF statistics per each SMF interface on this device. This table has 'INDEX { smfIfIndex }'.

6. Relationship to Other MIB Modules

6.1. Relationship to the SNMPv2-MIB

The 'system' group in the SNMPv2-MIB [RFC3418] is defined as being mandatory for all systems, and the objects apply to the entity as a whole. The 'system' group provides identification of the management entity and certain other system-wide data. The SMF-MIB does not duplicate those objects.

6.2. MIB modules required for IMPORTS

The textual conventions imported for use in the SMF-MIB are as follows. The MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE, Counter32, Unsigned32, Integer32 and mib-2 textual conventions are imported from RFC 2578 [RFC2578]. The TEXTUAL-CONVENTION, RowStatus and TruthValue textual conventions are imported from RFC 2579 [RFC2579]. The MODULE-COMPLIANCE, OBJECT-GROUP and NOTIFICATION-GROUP textual conventions are imported from RFC 2580 [RFC2580]. The InterfaceIndexOrZero textual convention is imported from RFC 2863 [RFC2863]. The SnmpAdminString textual convention is imported from RFC 3411 [RFC3411]. The InetAddress, InetAddressType and InetAddressPrefixLength textual conventions are imported from RFC 4001 [RFC4001].

6.3. Relationship to the Future RSSA-MIBs

In a sense, the SMF-MIB is a general front-end to a set of, yet to be developed, RSSA-specific MIBs. These RSSA-specific MIBs will define the objects for the configuration, state, performance and notification objects required for the operation of these specific RSSAs. The SMF-MIB Capabilities Group allows the remote management station the ability to query the router to discover the set of supported RSSAs.

7. Definitions

```
SMF-MIB DEFINITIONS ::= BEGIN

IMPORTS

   MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
   Counter32, Integer32, TimeTicks, experimental
      FROM SNMPv2-SMI                            -- [RFC2578]

   TEXTUAL-CONVENTION, RowStatus, TruthValue,
   DisplayString
      FROM SNMPv2-TC                             -- [RFC2579]

   MODULE-COMPLIANCE, OBJECT-GROUP,
   NOTIFICATION-GROUP
      FROM SNMPv2-CONF                           -- [RFC2580]

   InterfaceIndexOrZero
      FROM IF-MIB                                -- [RFC2863]
```

```
      SnmpAdminString
         FROM SNMP-FRAMEWORK-MIB                      -- [RFC3411]

      InetAddress, InetAddressType,
      InetAddressPrefixLength
         FROM INET-ADDRESS-MIB                        -- [RFC4001]
      ;

   smfMIB MODULE-IDENTITY
      LAST-UPDATED "201212011300Z"  -- December 01, 2012
      ORGANIZATION "IETF MANET Working Group"
      CONTACT-INFO
         "WG E-Mail: manet@ietf.org

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         "

      DESCRIPTION
         "This MIB module contains managed object definitions for
          the Manet SMF RSSA process defined in:

          [SMF] Macker, J.(ed.),
          Simplified Multicast Forwarding, RFC XXXX,
          July 2012.
```

```
          Copyright (C) The IETF Trust (2008). This version
          of this MIB module is part of RFC xxxx; see the RFC
          itself for full legal notices."

        -- Revision History
        REVISION    "201212011300Z"   -- December 01, 2012
        DESCRIPTION
           "Updated 9th revision of the
            draft of this MIB module published as
            draft-ietf-manet-smf-mib-06.txt. The changes
            made in this revision to the SMF-MIB include:
              - None.  Only changes to the surrounding
                textual material associated with this
                MIB module."
        REVISION    "201211051300Z"   -- November 05, 2012
        DESCRIPTION
           "Updated 8th revision of the
            draft of this MIB module published as
            draft-ietf-manet-smf-mib-05.txt. The changes
            made in this revision include:
              - Updated the smfInterfaceTable to reflect a
                sparse augmentation of the ifTable.
              - Added text discussing the tables and their
                indexing.
              - Added Applicability Statement.
              - Checked/updated DEFVAL, REFERENCES,
                UNITS and SIZE cluases in the MIB."
        REVISION    "201205281300Z"   -- May 28, 2012
        DESCRIPTION
           "Updated 7th revision of the
            draft of this MIB module published as
            draft-ietf-manet-smf-mib-04.txt. The changes
            made in this revision include:
              - Removed the bitmap switch in the notifications
                control group.
              - Moved the notification Objects group up
                to support reverse-mapping between SNMPv1
                traps and SNMPv2 nootifications.
              - Removed reference to the notifications
                state group.
              - Replaced smfIfIndex with smfIfName in
                notifications.
            "
        REVISION    "201110021300Z"   -- October 02, 2011
        DESCRIPTION
           "Updated 6th revision of the
            draft of this MIB module published as
            draft-ietf-manet-smf-mib-03.txt. The changes
```

```
            made in this revision include:
              - Added some notes to the MIB module
              - Clarified and defined default settings
            "
        REVISION    "201101161300Z"   -- January 16, 2011
        DESCRIPTION
           "Updated 5th revision of the
            draft of this MIB module published as
            draft-ietf-manet-smf-mib-02.txt. The changes
            made in this revision include:
              - Added the Notification Group and cleaned
                up the Conformance section
              - Completed the TEXTUAL CONVENTION for the
                smfOpMode.
              - Completed the Description clauses of
                several objects within the MIB.
              - Removed the routerPriority object.
              - Added the definition of a smfRouterID
                object and associated smfRouterIDAddrType
                object.
            "
        REVISION    "200910261300Z"   -- October 26, 2009
        DESCRIPTION
           "Updated draft of this MIB module published as
            draft-ietf-manet-smf-mib-01.txt. A few changes
            were made in the development of this draft.
            Specifically, the following changes were made:
               - Updated the textual material, included
                 section on IMPORTS, relationship to other
                 MIBs, etc.
           "
        REVISION    "200904211300Z"   -- April 21, 2009
        DESCRIPTION
           "Updated draft of this MIB module published as
            draft-ietf-manet-smf-mib-00.txt. A few changes
            were made in the development of this draft.
            Specifically, the following changes were made:
               - Removed the smfGatewayFilterTable from this
                 draft.  It is a useful construct, e.g.,
                 an IPTABLES-MIB, but might best be handled
                 as a seperate MIB and worked within a
                 security focused working group.
               - Removed the smfReportsGroup. This capability
                 is being replaced with a new and more general
                 method for offline reporting.  This is being
                 worked as a new MIB module refered to as the
                 REPORT-MIB.
               - Rev'd as a new MANET WG document.
```

```
          "
       REVISION    "200902271300Z"   -- February 27, 2009
       DESCRIPTION
          "Updated draft of this MIB module published as
           draft-cole-manet-smf-mib-02.txt. Fairly extensive
           revisions and additions to this MIB were made
           in this version. Specifically, the following
           changes were made in development of this version:
              - added a Capabilities Group within the Objects
                Group to allow the device to report supported
                capabilities, e.g., RSSAs supported.
              - added administrative status objects for device
                and interfaces
              - added multicast address forwarding tables, both
                for configured (within Configuration Group) and
                discovered (within the State Group).
              - added additional Performance counters related
                to DPD functions.
              - Split up the performance counters into IPv4
                and IPv6, for both global and per interface
                statistics.
              - Split out the reports capability into a seperate
                Reports Group under the Objects Group.
          "
       REVISION    "200811031300Z"   -- November 03, 2008
       DESCRIPTION
          "Updated draft of this MIB module published as
           draft-cole-manet-smf-mib-01.txt. Added gateway filter
           table and reports capabilities following rmon."
       REVISION    "200807071200Z"   -- July 07, 2008
       DESCRIPTION
          "Initial draft of this MIB module published as
           draft-cole-manet-smf-mib-00.txt."
       -- RFC-Editor assigns XXXX
       ::= { experimental 998 }   -- to be assigned by IANA



   --
   -- TEXTUAL CONVENTIONs
   --

   SmfStatus ::= TEXTUAL-CONVENTION
       STATUS       current
       DESCRIPTION
          "An indication of the operability of a SMF
          function or feature.  For example, the status
          of an interface: 'enabled' indicates that
```

```
          it is performing SMF functions,
          and 'disabled' indicates that it is not."
       SYNTAX  INTEGER {
                         enabled (1),
                         disabled (2)
                }

   SmfOpModeID ::= TEXTUAL-CONVENTION
       STATUS       current
       DESCRIPTION
           "An index that identifies through reference to a specific
            SMF operations mode.  There are basically three styles
            of SMF operation with reduced relay sets:

              Independent operation - SMF performs its own relay
                  set selection using information from an associated
                  MANET NHDP process.

              CDS-aware unicast routing operation - a coexistent
                  unicast routing protocol provides dynamic relay
                  set state based upon its own control plane
                  CDS or neighborhood discovery information.

              Cross-layer operation -  SMF operates using
                  neighborhood status and triggers from a
                  cross-layer information base for dynamic relay
                  set selection and maintenance."
       REFERENCE
          "Simplified Multicast Forwarding for MANET
           (SMF), Macker, J., July 2012."
       SYNTAX  INTEGER {
                         independent (1),
                         routing (2),
                         crossLayer (3)
                         -- future (4-255)
                }


   SmfRssaID ::= TEXTUAL-CONVENTION
       STATUS       current
       DESCRIPTION
           "An index that identifies through reference to a specific
            RSSA algorithms.  Several are currently defined
            in the appendix of SMF (RFC XXXX)."
       REFERENCE
          "Simplified Multicast Forwarding for MANET
           (SMF), Macker, J., July 2012."
       SYNTAX      INTEGER {
```

```
                          cF(1),
                          sMPR(2),
                          eCDS(3),
                          mprCDS(4)
                          -- future(5-127)
                          -- noStdAction(128-239)
                          -- experimental(240-255)
                  }


   --
   -- Top-Level Object Identifier Assignments
   --

   smfMIBNotifications OBJECT IDENTIFIER ::= { smfMIB 0 }
   smfMIBObjects       OBJECT IDENTIFIER ::= { smfMIB 1 }
   smfMIBConformance   OBJECT IDENTIFIER ::= { smfMIB 2 }



   --
   -- smfMIBObjects Assignments:
   --      smfCapabilitiesGroup  - 1
   --      smfConfigurationGroup - 2
   --      smfStateGroup         - 3
   --      smfPerformanceGroup   - 4
   --

   --
   -- smfCapabilitiesGroup
   --
   --    This group contains the SMF objects that identify specific
   --    capabilities within this device related to SMF functions.
   --

   smfCapabilitiesGroup  OBJECT IDENTIFIER ::= { smfMIBObjects 1 }

  --
   -- SMF Operational Mode Capabilities Table
   --

   smfOpModeCapabilitiesTable OBJECT-TYPE
       SYNTAX      SEQUENCE OF SmfOpModeCapabilitiesEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
           "The smfOpModeCapabilitiesTable identifies the
            resident set of SMF Operational Modes on this
```

```
            router."
       REFERENCE
          "Simplified Multicast Forwarding for MANET
           (SMF), Macker, J., July 2012."
       ::= { smfCapabilitiesGroup 1 }

   smfOpModeCapabilitiesEntry OBJECT-TYPE
       SYNTAX      SmfOpModeCapabilitiesEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
           "Information about a particular operational
            mode.
           "
       INDEX   { smfOpModeCapabilitiesID }
       ::= { smfOpModeCapabilitiesTable 1 }

   SmfOpModeCapabilitiesEntry ::= SEQUENCE {
         smfOpModeCapabilitiesID              SmfOpModeID,
         smfOpModeCapabilitiesName            SnmpAdminString,
         smfOpModeCapabilitiesReference       SnmpAdminString
   }

   smfOpModeCapabilitiesID     OBJECT-TYPE
       SYNTAX      SmfOpModeID
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
           "The index for this entry.  This object identifies
            the particular operational mode for this device."
       ::= { smfOpModeCapabilitiesEntry 1 }

   smfOpModeCapabilitiesName OBJECT-TYPE
       SYNTAX      SnmpAdminString
       MAX-ACCESS  read-only
       STATUS      current
       DESCRIPTION
           "The textual name of this operational
            mode.  Current operational modes include:
               Independent Mode,
               CDS-aware Routing Mode, and
               Cross-layer Mode.
            Others may be defined
            in future revisions of [SMF]."
       ::= { smfOpModeCapabilitiesEntry 2 }

   smfOpModeCapabilitiesReference OBJECT-TYPE
       SYNTAX      SnmpAdminString
```

```
       MAX-ACCESS  read-only
       STATUS      current
       DESCRIPTION
           "This object contains a reference to the document
            that defines this operational mode."
       ::= { smfOpModeCapabilitiesEntry 3 }


   --
   -- SMF RSSA Capabilities Table
   --

   smfRssaCapabilitiesTable OBJECT-TYPE
       SYNTAX      SEQUENCE OF SmfRssaCapabilitiesEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
           "The smfRssaCapabilitiesTable contains
            reference to the specific set of RSSAs
            currently supported on this device.
           "
       REFERENCE
          "Simplified Multicast Forwarding for MANET
           (SMF), Macker, J., July 2012."
       ::= { smfCapabilitiesGroup 2 }

   smfRssaCapabilitiesEntry OBJECT-TYPE
       SYNTAX      SmfRssaCapabilitiesEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
           "Information about a particular RSSA
            algorithm."
       INDEX   { smfRssaCapabilitiesID }
       ::= { smfRssaCapabilitiesTable 1 }

   SmfRssaCapabilitiesEntry ::= SEQUENCE {
         smfRssaCapabilitiesID              SmfRssaID,
         smfRssaCapabilitiesName            SnmpAdminString,
         smfRssaCapabilitiesReference       SnmpAdminString
   }

   smfRssaCapabilitiesID     OBJECT-TYPE
       SYNTAX      SmfRssaID
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
           "The index for this entry.  This object identifies
```

```
            the particular RSSA algorithm in this MIB
            module.  Example RSSAs are found in the
            appendix of [SMF].

            By default, the agent should support at least the
            Classical Flooding algorithm.  All compliant
            SMF forwarders must support Classical Flooding.
            Hence, at least one entry in this table must
            exist."
       ::= { smfRssaCapabilitiesEntry 1 }

   smfRssaCapabilitiesName OBJECT-TYPE
       SYNTAX      SnmpAdminString
       MAX-ACCESS  read-only
       STATUS      current
       DESCRIPTION
           "The textual name of this RSSA algorithm.
            Currently defined names are:
                Classical Flooding - cF,
                Source-based MultiPoint
                    Relay - sMPR,
                Essential Connecting Dominating
                    Set - eCDS,
                MultiPoint Relay Connected
                    Dominating Set - mprCDS.
           "
       ::= { smfRssaCapabilitiesEntry 2 }

   smfRssaCapabilitiesReference OBJECT-TYPE
       SYNTAX      SnmpAdminString
       MAX-ACCESS  read-only
       STATUS      current
       DESCRIPTION
           "This object contains a published reference
            to the document that defines this algorithm.
           "
       ::= { smfRssaCapabilitiesEntry 3 }




   --
   -- smfConfigurationGroup
   --
   --    This group contains the SMF objects that configure specific
   --    options that determine the overall performance and operation
   --    of the multicast forwarding process for the router device
   --    and its interfaces.
```

```
   --

   smfConfigurationGroup  OBJECT IDENTIFIER ::= { smfMIBObjects 2 }

   smfAdminStatus  OBJECT-TYPE
      SYNTAX      SmfStatus
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The configured status of the SMF process
          on this device.  Enabled(1) means that
          SMF is configured to run on this device.
          Disabled(2) mean that the SMF process
          is configured off.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage.
         "
   ::= { smfConfigurationGroup 1 }

   smfRouterIDAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The address type of the address used for
          SMF ID of this router as specified
          in the 'smfRouterID' next.

          Only the values ipv4(1) and ipv6(2)
          are supported.

          This can be set by the management station,
          the smfRouterID must be a routable address
          assigned to this router.  If the management
          station does not assign this value, then the
          router should choose the highest routable
          IP address assigned to this router.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      DEFVAL { ipv4 }
   ::= { smfConfigurationGroup 2 }

   smfRouterID  OBJECT-TYPE
      SYNTAX      InetAddress (SIZE(4|16))
```

```
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The IP address used as the SMF router ID.
          This can be set by the management station.
          If not explicitly set, then the device
          should select a routable IP address
          assigned to this router for use as
          the 'smfRouterID'.

          The smfRouterID is a logical identification
          that MUST be consistent across interoperable
          SMF neighborhoods and it is RECOMMENDED to be
          chosen as the numerically largest address
          contained in a node's 'Neighbor Address List'
          as defined in NHDP.  A smfRouterID MUST be
          unique within the scope of the operating
          MANET network regardless of the method used
          for selecting it.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
    ::= { smfConfigurationGroup 3 }

   smfConfiguredOpMode  OBJECT-TYPE
      SYNTAX      INTEGER {
                          withNHDP(1),
                          cdsAwareRouting(2),
                          crossLayer(3),
                          other(4)
                          }
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The SMF RSS node operational mode as defined
          in the TEXTUAL CONVENTION for `SmfOpModeID'
          and in [SMF]..

          The value withNHDP(1) indicates Independent
          Mode of operation.

          The value cdsAwareRouting(2) indicates
          CDS-aware Routing Mode of operation.
```

```
          The value crossLayer(3) indicates
          Cross-layer Mode of operation.

          The default value for this object is
          withNHDP(1).

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
      DEFVAL { withNHDP }
   ::= { smfConfigurationGroup 4 }


   smfConfiguredRssa  OBJECT-TYPE
      SYNTAX      SmfRssaID
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The SMF RSS currently operational algorithm
          as defined in the TEXTUAL CONVENTION for
          `SmfRssaID' and in [SMF].

           The deflaut value for this object is
           cF(1), i.e., Classical Flooding.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
      DEFVAL { cF }
   ::= { smfConfigurationGroup 5 }

   smfRssaMember  OBJECT-TYPE
      SYNTAX      INTEGER {
                          potential(1),
                          always(2),
                          never(3)
                          }
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The RSSA downselects a set of forwarders for
          multicast forwarding.  Sometimes it is useful
```

```
          to force an agent to be included or excluded
          from the resulting RSS.  This object is a
          switch to allow for this behavior.

          The value potential(1) allows the selected
          RSSA to determine if this agent is included
          or excluded from the RSS.

          The value always(1) forces the selected
          RSSA include this agent in the RSS.

          The value never(3) forces the selected
          RSSA to exclude this agent from the RSS.

          The default setting for this object is
          'potential(1)'.  Other settings could pose
          operational risks under certain conditions.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
      DEFVAL { potential }
   ::= { smfConfigurationGroup 6 }

   smfIpv4Dpd  OBJECT-TYPE
      SYNTAX      INTEGER {
                          hashBased(1),
                          identificationBased(2)
                          }
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The current method for IPv4 duplicate packet
          detection.

          The value hashBased(1) indicates that the
          routers duplicate packet detection is based
          upon comparing a hash over the packet fields.
          This is the default setting for this object.

          The value identificationBased(2)
          indicates that the duplicate packet
          detection relies upon header information
          in the multicast packets to identify
          previously received packets.
```

```
          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
      DEFVAL { hashBased }
   ::= { smfConfigurationGroup 7 }

   smfIpv6Dpd  OBJECT-TYPE
      SYNTAX      INTEGER {
                          hashBased(1),
                          identificationBased(2)
                          }
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The current method for IPv6 duplicate packet
          detection.

          The values indicate the type of method used
          for duplicate packet detection as described
          the previous description for the object
          `smfIpv4Dpd'.

          The default value for this object is
          hashBased(1).

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
      DEFVAL { hashBased }
   ::= { smfConfigurationGroup 8 }

   smfMaxPktLifetime  OBJECT-TYPE
      SYNTAX      Integer32 (0..65535)
      UNITS       "Seconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The estimate of the network packet
          traversal time.

          This object is persistent and when written
          the entity SHOULD save the change to
```

```
            non-volatile storage."
        REFERENCE
           "Simplified Multicast Forwarding for MANET
            (SMF), Macker, J., July 2012."
        DEFVAL { 60 }
    ::= { smfConfigurationGroup 9 }

    smfDpdMaxMemorySize  OBJECT-TYPE
        SYNTAX      Integer32 (0..65535)
        UNITS       "Kilo-Bytes"
        MAX-ACCESS  read-write
        STATUS      current
        DESCRIPTION
           "The locally reserved memory for storage
            of cached DPD records for both IPv4 and
            IPv6 methods.

            The local SMF device should protect itself
            against the SNMP manager from requesting
            too large a memory value.  If this is the case,
            an error indication should be returned in response
            to the SNMP SET request.

            This object is persistent and when written
            the entity SHOULD save the change to
            non-volatile storage."
        REFERENCE
           "Simplified Multicast Forwarding for MANET
            (SMF), Macker, J., July 2012."
        DEFVAL { 1024 }
    ::= { smfConfigurationGroup 10 }

    smfDpdEntryMaxLifetime  OBJECT-TYPE
        SYNTAX      Integer32 (0..65525)
        UNITS       "Seconds"
        MAX-ACCESS  read-write
        STATUS      current
        DESCRIPTION
           "The maximum lifetime of a cached DPD
            record in the local device storage.

            If the memory is running low prior to the
            MaxLifetimes being exceeded, the local SMF
            devices should purge the oldest records first.

            This object is persistent and when written
            the entity SHOULD save the change to
            non-volatile storage."
```

```
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
      DEFVAL { 600 }
   ::= { smfConfigurationGroup 11 }


   --
   -- Configuration of messages to be included in
   -- NHDP message exchanges in support of SMF
   -- operations.
   --

   smfNhdpRssaMesgTLVIncluded  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "Indicates whether the associated NHDP messages
          include the RSSA Message TLV, or not.  This
          is an optional SMF operational setting.
          The value true(1) indicates that this TLV is
          included; the value false(2) indicates that it
          is not included.

          It is RECOMMENDED that the RSSA Message TLV
          be included in the NHDP messages.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
      DEFVAL { true }
   ::= { smfConfigurationGroup 12 }

   smfNhdpRssaAddrBlockTLVIncluded  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "Indicates whether the associated NHDP messages
          include the RSSA Address Block TLV, or not.
          This is an optional SMF operational setting.
          The value true(1) indicates that this TLV is
          included; the value false(2) indicates that it
          is not included.
```

```
          The smfNhdpRssaAddrBlockTLVIncluded is optional
          in all cases as it depends on the existence of
          an address block which may not be present.
          If this SMF device is configured with NHDP,
          then this object should be set to 'true(1)'.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
      DEFVAL { true }
   ::= { smfConfigurationGroup 13 }



   --
   -- Table identifying configured multicast addresses to be forwarded.
   --

   smfConfiguredAddrForwardingTable  OBJECT-TYPE
      SYNTAX     SEQUENCE OF SmfConfiguredAddrForwardingEntry
      MAX-ACCESS not-accessible
      STATUS     current
      DESCRIPTION
         "The (conceptual) table containing information on multicast
          addresses which are to be forwarded by the SMF process.

          Entries in this table are configured.  As well, addresses
          to be forwarded by the SMF device can be dynamically
          discovered by other means.  The corresponding state
          table, smfDiscoveredAddrForwardingTable, contains
          these additional, dynamically discovered address for
          forwarding.

          Each row is associated with a range of multicast
          addresses, and ranges for different rows must be disjoint.

          The objects in this table are persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfConfigurationGroup 15 }

   smfConfiguredAddrForwardingEntry OBJECT-TYPE
```

```
      SYNTAX     SmfConfiguredAddrForwardingEntry
      MAX-ACCESS not-accessible
      STATUS     current
      DESCRIPTION
         "An entry (conceptual row) containing the information on a
          particular multicast scope."
      INDEX { smfConfiguredAddrForwardingAddrType,
              smfConfiguredAddrForwardingFirstAddr }
      ::= { smfConfiguredAddrForwardingTable 1 }

   SmfConfiguredAddrForwardingEntry ::= SEQUENCE {
      smfConfiguredAddrForwardingAddrType      InetAddressType,
      smfConfiguredAddrForwardingFirstAddr     InetAddress,
      smfConfiguredAddrForwardingLastAddr      InetAddress,
      smfConfiguredAddrForwardingStatus        RowStatus
   }

   smfConfiguredAddrForwardingAddrType OBJECT-TYPE
      SYNTAX     InetAddressType
      MAX-ACCESS not-accessible
      STATUS     current
      DESCRIPTION
         "The type of the addresses in the multicast forwarding
          range.  Legal values correspond to the subset of
          address families for which multicast address allocation
          is supported.

          Only the values ipv4(1) and
          ipv6(2) are supported."
   ::= { smfConfiguredAddrForwardingEntry 1 }

   smfConfiguredAddrForwardingFirstAddr OBJECT-TYPE
      SYNTAX     InetAddress (SIZE(4|16))
      MAX-ACCESS not-accessible
      STATUS     current
      DESCRIPTION
         "The first address in the multicast scope range.  The type
          of this address is determined by the value of the
          smfConfiguredAddrForwardingAddrType object."
   ::= { smfConfiguredAddrForwardingEntry 2 }

   smfConfiguredAddrForwardingLastAddr OBJECT-TYPE
      SYNTAX     InetAddress (SIZE(4|16))
      MAX-ACCESS read-create
      STATUS     current
      DESCRIPTION
         "The last address in the multicast scope range.
          The type of this address is determined by the
```

```
          value of the smfConfiguredAddrForwardingAddrType
          object."
   ::= { smfConfiguredAddrForwardingEntry 3 }

   smfConfiguredAddrForwardingStatus OBJECT-TYPE
      SYNTAX     RowStatus
      MAX-ACCESS read-create
      STATUS     current
      DESCRIPTION
         "The status of this row, by which new entries may be
          created, or old entries deleted from this table.  If write
          access is supported, the other writable objects in this
          table may be modified even while the status is `active'."
   ::= { smfConfiguredAddrForwardingEntry 4 }



   --
   -- SMF Interfaces Configuration Table
   --

   smfInterfaceTable  OBJECT-TYPE
      SYNTAX      SEQUENCE OF SmfInterfaceEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The SMF Interface Table describes the SMF
          interfaces that are participating in the
          SMF packet forwarding process. The ifIndex is
          from the interfaces group defined in the
          Interfaces Group MIB (RFC 2863). As such,
          this table 'sparse augments' the ifTable
          specifically when SMF is to be configured to
          operate over this interface.

          A conceptual row in this table exists if and only
          if either a manager has explicitly created the row
          or there is an interface on the managed device
          that supports and runs SMF.

          The manager can create a row by setting
          rowStatus to 'createAndGo' or 'createAndWait'.
          Row objects having associated DEFVAL clauses are
          automatically defined by the agent with these
          values during row creation, unless the manager
          explicitly defines these object values during the
          row creation.
```

```
          If the corresponding entry with ifIndex value
          is deleted from the Interface Table, then the entry
          in this table is automatically deleted and
          SMF is disabled on this interface,
          and all configuration and state information
          related to this interface is to be removed
          from memory."
      REFERENCE
         "RFC 2863 - The Interfaces Group MIB, McCloghrie,
          K., and F. Kastenholtz, June 2000."
   ::= { smfConfigurationGroup 16 }

   smfInterfaceEntry OBJECT-TYPE
      SYNTAX      SmfInterfaceEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The SMF interface entry describes one SMF
          interface as indexed by its ifIndex.

          The objects in this table are persistent and when
          written the device SHOULD save the change to
          non-volatile storage.  For further information
          on the storage behavior for these objects, refer
          to the description for the smfIfRowStatus
          object."
      INDEX { smfIfIndex }
   ::= { smfInterfaceTable 1 }

   SmfInterfaceEntry ::=
      SEQUENCE {
         smfIfIndex        InterfaceIndexOrZero,
         smfIfName         DisplayString,
         smfIfAdminStatus  SmfStatus,
         smfIfRowStatus    RowStatus
         }

   smfIfIndex  OBJECT-TYPE
      SYNTAX      InterfaceIndexOrZero
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The ifIndex for this SMF interface. This value
          MUST correspond to an ifIndex referring
          to a valid entry in The Interfaces Table."
      REFERENCE
         "RFC 2863 - The Interfaces Group MIB, McCloghrie,
          K., and F. Kastenholtz, June 2000."
```

```
      ::= { smfInterfaceEntry 1 }

   smfIfName  OBJECT-TYPE
      SYNTAX      DisplayString
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The textual name of the interface.  The value of this
         object should be the name of the interface as assigned by
         the local device and should be suitable for use in commands
         entered at the device's `console'.  This might be a text
         name, such as `le0' or a simple port number, such as `1',
         depending on the interface naming syntax of the device.

         If there is no local name, or this object is otherwise not
         applicable, then this object contains a zero-length string."
   ::= { smfInterfaceEntry 2 }

   smfIfAdminStatus OBJECT-TYPE
      SYNTAX      SmfStatus
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
          "The SMF interface's administrative status.
          The value 'enabled' denotes that the interface
          is running the SMF forwarding process.
          The value 'disabled' denotes that the interface is
          external to the SMF forwarding process.
          "
      ::= { smfInterfaceEntry 3 }

   smfIfRowStatus  OBJECT-TYPE
      SYNTAX      RowStatus
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
         "This object permits management of the table
          by facilitating actions such as row creation,
          construction, and destruction. The value of
          this object has no effect on whether other
          objects in this conceptual row can be
          modified.

          An entry may not exist in the active(1) state unless all
          objects in the entry have a defined appropriate value.  For
          objects with DEFVAL clauses, the management station
          does not need to specify the value of this object in order
          for the row to transit to the active(1) state; the default
```

```
          value for this object is used.  For objects that do not
          have DEFVAL clauses, then the network manager MUST
          specify the value of this object prior to this row
          transitioning to the active(1) state.

          When this object transitions to active(1), all objects
          in this row SHOULD be written to non-volatile (stable)
          storage.  Read-create objects in this row MAY be modified.
          When an object in a row with smfIfRowStatus of active(1)
          is changed, then the updated value MUST be reflected in SMF
          and this new object value MUST be written to non-volatile
          storage.

          If this object is not equal to active(1), all associated
          entries in the smfIpv4InterfaceperfTable and the
          smfIpv6InterfacePerfTable MUST be deleted."
   ::= { smfInterfaceEntry 4 }


   --
   -- smfStateGroup
   --
   --    Contains information describing the current state of the SMF
   --    process such as the current inclusion in the RS or not.
   --

   smfStateGroup  OBJECT IDENTIFIER ::= { smfMIBObjects 3 }

   smfNodeRsStatusIncluded  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The current status of the SMF node in the context of
          the MANETs relay set. A value of true(1) indicates
          that the node is currently part of the MANET Relay
          Set. A value of false(2) indicates that the node
          is currently not part of the MANET Relay Set."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfStateGroup 1 }

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

```
         "The number of times that the memory for caching
          records for DPD overran and records had to be flushed.
          The number of records to be flushed upon a buffer
          overflow is an implementation specific decision."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfStateGroup 2 }



   --
   -- Dynamically Discovered Multicast Addr Table
   --

   smfDiscoveredAddrForwardingTable  OBJECT-TYPE
      SYNTAX     SEQUENCE OF SmfDiscoveredAddrForwardingEntry
      MAX-ACCESS not-accessible
      STATUS     current
      DESCRIPTION
         "This state  table, smfDiscoveredAddrForwardingTable
          contains additional, dynamically discovered address
          for forwarding.

          Each row is associated with a range of
          multicast addresses, and ranges for different rows
          must be disjoint."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfStateGroup 3 }

   smfDiscoveredAddrForwardingEntry OBJECT-TYPE
      SYNTAX     SmfDiscoveredAddrForwardingEntry
      MAX-ACCESS not-accessible
      STATUS     current
      DESCRIPTION
         "An entry (conceptual row) containing the information on a
          particular multicast scope."
      INDEX { smfDiscoveredAddrForwardingAddrType,
              smfDiscoveredAddrForwardingFirstAddr }
      ::= { smfDiscoveredAddrForwardingTable 1 }

   SmfDiscoveredAddrForwardingEntry ::= SEQUENCE {
      smfDiscoveredAddrForwardingAddrType   InetAddressType,
      smfDiscoveredAddrForwardingFirstAddr  InetAddress,
      smfDiscoveredAddrForwardingLastAddr   InetAddress
   }
```

```
   smfDiscoveredAddrForwardingAddrType OBJECT-TYPE
      SYNTAX     InetAddressType
      MAX-ACCESS not-accessible
      STATUS     current
      DESCRIPTION
         "The type of the addresses in the multicast forwarding
          range.  Legal values correspond to the subset of
          address families for which multicast address allocation
          is supported.

          Only the values ipv4(1) and
          ipv6(2) are supported."
   ::= { smfDiscoveredAddrForwardingEntry 1 }

   smfDiscoveredAddrForwardingFirstAddr OBJECT-TYPE
      SYNTAX     InetAddress (SIZE(4|16))
      MAX-ACCESS not-accessible
      STATUS     current
      DESCRIPTION
         "The first address in the multicast scope range.  The type
          of this address is determined by the value of the
          smfConfiguredAddrForwardingAddrType object."
   ::= { smfDiscoveredAddrForwardingEntry 2 }

   smfDiscoveredAddrForwardingLastAddr OBJECT-TYPE
      SYNTAX     InetAddress (SIZE(4|16))
      MAX-ACCESS read-create
      STATUS     current
      DESCRIPTION
         "The last address in the multicast scope range.
          The type of this address is determined by the
          value of the smfConfiguredAddrForwardingAddrType
          object."
   ::= { smfDiscoveredAddrForwardingEntry 3 }


   --
   -- SMF Neighbor Table
   --

   smfNeighborTable  OBJECT-TYPE
      SYNTAX       SEQUENCE OF SmfNeighborEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
         "The SMF NeighborTable describes the
          current neighbor nodes, their address
          and SMF RSSA and the interface on which
```

```
         they can be reached."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012.
          Section 7: SMF Neighborhood Discovery
          Requirements."
   ::= { smfStateGroup 4 }

   smfNeighborEntry  OBJECT-TYPE
      SYNTAX       SmfNeighborEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
         "The SMF Neighbor Table contains the
          set of one-hop neighbors, the interface
          they are reachable on and the SMF RSSA
          they are currently running."
      INDEX { smfNeighborIpAddrType,
              smfNeighborIpAddr,
              smfNeighborPrefixLen }
   ::= { smfNeighborTable 1 }

   SmfNeighborEntry ::=
      SEQUENCE {
         smfNeighborIpAddrType        InetAddressType,
         smfNeighborIpAddr            InetAddress,
         smfNeighborPrefixLen         InetAddressPrefixLength,
         smfNeighborRSSA              SmfRssaID,
         smfNeighborNextHopInterface  InterfaceIndexOrZero
         }

   smfNeighborIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The neighbor IP address type.

          Only the values ipv4(1) and
          ipv6(2) are supported."
   ::= { smfNeighborEntry 1 }

   smfNeighborIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress (SIZE(4|16))
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The neighbor Inet IPv4 or IPv6 address."
```

```
   ::= { smfNeighborEntry 2 }

   smfNeighborPrefixLen  OBJECT-TYPE
      SYNTAX      InetAddressPrefixLength
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The prefix length. This is a decimal value that
          indicates the number of contiguous, higher-order
          bits of the address that make up the network
          portion of the address."
   ::= { smfNeighborEntry 3 }

   smfNeighborRSSA  OBJECT-TYPE
      SYNTAX       SmfRssaID
      MAX-ACCESS   read-only
      STATUS       current
      DESCRIPTION
         "The current RSSA running on the neighbor.
          The list is identical to that described
          above for the smfRssa object."
   ::= { smfNeighborEntry 4 }

   smfNeighborNextHopInterface OBJECT-TYPE
      SYNTAX       InterfaceIndexOrZero
      MAX-ACCESS   read-only
      STATUS       current
      DESCRIPTION
         "The interface ifIndex over which the
          neighbor is reachable in one-hop."
   ::= { smfNeighborEntry 5 }




   --
   -- SMF Performance Group
   --
   --    Contains objects which help to characterize the
   --    performance of the SMF RSSA process, such as statistics
   --    counters. There are two types of SMF RSSA statistics:
   --    global counters and per interface counters.
   --

   smfPerformanceGroup  OBJECT IDENTIFIER ::= { smfMIBObjects 4 }

   smfGlobalPerfGroup  OBJECT IDENTIFIER ::= { smfPerformanceGroup 1 }
```

```
   --
   -- IPv4 packet counters
   --

   smfIpv4MultiPktsRecvTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of
          multicast IPv4 packets received by the
          device."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 1 }

   smfIpv4MultiPktsForwardedTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of
          multicast IPv4 packets forwarded by the
          device."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 2 }

   smfIpv4DuplMultiPktsDetectedTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of duplicate
          multicast IPv4 packets detected by the
          device."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 3 }

   smfIpv4DroppedMultiPktsTTLExceededTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
```

```
         "A counter of the total number of dropped
          multicast IPv4 packets by the
          device due to TTL exceeded."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 4 }

   smfIpv4TTLLargerThanPreviousTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of IPv4 packets
          recieved which have a TTL larger than that
          of a previously received identical packet."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 5 }

   --
   -- IPv6 packet counters
   --

   smfIpv6MultiPktsRecvTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of
          multicast IPv6 packets received by the
          device."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 6 }

   smfIpv6MultiPktsForwardedTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of
          multicast IPv6 packets forwarded by the
          device."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
```

```
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 7 }

   smfIpv6DuplMultiPktsDetectedTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of duplicate
          multicast IPv6 packets detected by the
          device."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 8 }

   smfIpv6DroppedMultiPktsTTLExceededTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of dropped
          multicast IPv6 packets by the
          device due to TTL exceeded."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 9 }

   smfIpv6TTLLargerThanPreviousTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of IPv6 packets
          recieved which have a TTL larger than that
          of a previously recived identical packet."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 10 }

   smfIpv6HAVAssistsReqdTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of IPv6 packets
```

```
          recieved which required the HAV assist for DPD."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 11 }

   smfIpv6DpdHeaderInsertionsTotal  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of IPv6 packets
          recieved which the device inserted the
          DPD header option."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfGlobalPerfGroup 12 }


   --
   -- Per SMF Interface Performance Table
   --

   smfInterfacePerfGroup OBJECT IDENTIFIER ::= { smfPerformanceGroup 2 }

   smfIpv4InterfacePerfTable OBJECT-TYPE
      SYNTAX       SEQUENCE OF SmfIpv4InterfacePerfEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
         "The SMF Interface Performance Table
          describes the SMF statistics per
          interface."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfInterfacePerfGroup 1 }

   smfIpv4InterfacePerfEntry OBJECT-TYPE
      SYNTAX       SmfIpv4InterfacePerfEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
         "The SMF Interface Performance entry
          describes the statistics for a particular
          node interface."
      INDEX { smfIfIndex }
```

```
   ::= { smfIpv4InterfacePerfTable 1 }

   SmfIpv4InterfacePerfEntry ::=
      SEQUENCE {
         smfIpv4MultiPktsRecvPerIf               Counter32,
         smfIpv4MultiPktsForwardedPerIf          Counter32,
         smfIpv4DuplMultiPktsDetectedPerIf       Counter32,
         smfIpv4DroppedMultiPktsTTLExceededPerIf Counter32,
         smfIpv4TTLLargerThanPreviousPerIf       Counter32
         }

   smfIpv4MultiPktsRecvPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the number of
          multicast IP packets received by the
          device on this interface."
   ::= { smfIpv4InterfacePerfEntry 1 }

   smfIpv4MultiPktsForwardedPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the number of
          multicast IP packets forwarded by the
          device on this interface."
   ::= { smfIpv4InterfacePerfEntry 2 }

   smfIpv4DuplMultiPktsDetectedPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the number of duplicate
          multicast IP packets detected by the
          device on this interface."
   ::= { smfIpv4InterfacePerfEntry 3 }

   smfIpv4DroppedMultiPktsTTLExceededPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of dropped
          multicast IPv4 packets by the
```

```
           device due to TTL exceeded."
   ::= { smfIpv4InterfacePerfEntry 4 }

   smfIpv4TTLLargerThanPreviousPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of IPv4 packets
          recieved which have a TTL larger than that
          of a previously recived identical packet.
         "
   ::= { smfIpv4InterfacePerfEntry 5 }


   smfIpv6InterfacePerfTable OBJECT-TYPE
      SYNTAX       SEQUENCE OF SmfIpv6InterfacePerfEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
         "The SMF Interface Performance Table
          describes the SMF statistics per
          interface."
      REFERENCE
         "Simplified Multicast Forwarding for MANET
          (SMF), Macker, J., July 2012."
   ::= { smfInterfacePerfGroup 2 }

   smfIpv6InterfacePerfEntry OBJECT-TYPE
      SYNTAX       SmfIpv6InterfacePerfEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
         "The SMF Interface Performance entry
          describes the statistics for a particular
          node interface."
      INDEX { smfIfIndex }
   ::= { smfIpv6InterfacePerfTable 1 }

   SmfIpv6InterfacePerfEntry ::=
      SEQUENCE {
         smfIpv6MultiPktsRecvPerIf               Counter32,
         smfIpv6MultiPktsForwardedPerIf          Counter32,
         smfIpv6DuplMultiPktsDetectedPerIf       Counter32,
         smfIpv6DroppedMultiPktsTTLExceededPerIf Counter32,
         smfIpv6TTLLargerThanPreviousPerIf       Counter32,
         smfIpv6HAVAssistsReqdPerIf              Counter32,
         smfIpv6DpdHeaderInsertionsPerIf         Counter32
```

```
      }

   smfIpv6MultiPktsRecvPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the number of
          multicast IP packets received by the
          device on this interface."
   ::= { smfIpv6InterfacePerfEntry 1 }

   smfIpv6MultiPktsForwardedPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the number of
          multicast IP packets forwarded by the
          device on this interface."
   ::= { smfIpv6InterfacePerfEntry 2 }

   smfIpv6DuplMultiPktsDetectedPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the number of duplicate
          multicast IP packets detected by the
          device on this interface."
   ::= { smfIpv6InterfacePerfEntry 3 }

   smfIpv6DroppedMultiPktsTTLExceededPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the number of dropped
          multicast IP packets by the
          device on this interface due to TTL
          exceeded."
   ::= { smfIpv6InterfacePerfEntry 4 }

   smfIpv6TTLLargerThanPreviousPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
```

```
         "A counter of the total number of IPv6 packets
          recieved which have a TTL larger than that
          of a previously recived identical packet."
   ::= { smfIpv6InterfacePerfEntry 5 }

   smfIpv6HAVAssistsReqdPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of IPv6 packets
          recieved which required the HAV assist for DPD."
   ::= { smfIpv6InterfacePerfEntry 6 }

   smfIpv6DpdHeaderInsertionsPerIf  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter of the total number of IPv6 packets
          recieved which the device inserted the
          DPD header option."
   ::= { smfIpv6InterfacePerfEntry 7 }



   --
   -- Notifications
   --

smfMIBNotifObjects OBJECT IDENTIFIER ::= { smfMIBNotifications 0 }
smfMIBNotifControl OBJECT IDENTIFIER ::= { smfMIBNotifications 1 }


   -- smfMIBNotifObjects

   smfAdminStatusChange NOTIFICATION-TYPE
          OBJECTS { smfRouterIDAddrType, -- The originator of
                                         --   the notification.
                    smfRouterID,         -- The originator of
                                         --   the notification.
                    smfAdminStatus       -- The new status of the
                                         --   SMF process.
                  }
          STATUS       current
          DESCRIPTION
             "smfAdminStatusChange is a notification sent when a
              the 'smfAdminStatus' object changes."
```

```
          ::= { smfMIBNotifObjects 1 }

   smfConfiguredOpModeChange NOTIFICATION-TYPE
          OBJECTS { smfRouterIDAddrType, -- The originator of
                                         --   the notification.
                    smfRouterID,         -- The originator of
                                         --   the notification.
                    smfConfiguredOpMode  -- The new Operations
                                         --   Mode of the SMF
                                         --   process.
                  }
          STATUS       current
          DESCRIPTION
             "smfConfiguredOpModeChange is a notification
              sent when a the 'smfConfiguredOpMode' object
              changes."
          ::= { smfMIBNotifObjects 2 }

   smfConfiguredRssaChange NOTIFICATION-TYPE
          OBJECTS { smfRouterIDAddrType, -- The originator of
                                         --   the notification.
                    smfRouterID,         -- The originator of
                                         --   the notification.
                    smfConfiguredRssa    -- The new RSSA for
                                         --   the SMF process.
                  }
          STATUS       current
          DESCRIPTION
             "smfAdminStatusChange is a notification sent when a
              the 'smfConfiguredRssa' object changes."
          ::= { smfMIBNotifObjects 3 }

   smfIfAdminStatusChange NOTIFICATION-TYPE
          OBJECTS { smfRouterIDAddrType, -- The originator of
                                         --   the notification.
                    smfRouterID,         -- The originator of
                                         --   the notification.
                    smfIfName,           -- The interface whose
                                         --   status has changed.
                    smfIfAdminStatus     -- The new status of the
                                         --   SMF interface.
                  }
          STATUS       current
          DESCRIPTION
             "smfIfAdminStatusChange is a notification sent when a
              the 'smfIfAdminStatus' object changes."
          ::= { smfMIBNotifObjects 4 }
```

```
    smfDpdMemoryOverflowEvent NOTIFICATION-TYPE
          OBJECTS { smfRouterIDAddrType, -- The originator of
                                         --   the notification.
                    smfRouterID,         -- The originator of
                                         --   the notification.
                    smfDpdMemoryOverflow -- The counter of
                                         --   the overflows.
             }
          STATUS       current
          DESCRIPTION
             "smfDpdMemoryOverflowEvents is sent when the
              number of memory overflow events exceeds the
              the 'smfDpdMemoryOverflowThreshold' within the
              previous number of seconds defined by the
              'smfDpdMemoryOverflowWindow'."
          ::= { smfMIBNotifObjects 5 }

   smfIpv4DuplMultiPktsDetectedTotalEvents NOTIFICATION-TYPE
          OBJECTS { smfRouterIDAddrType, -- The originator of
                                         --   the notification.
                    smfRouterID,         -- The originator of
                                         --   the notification.
                    smfIpv4DuplMultiPktsDetectedTotal
                                         -- The counter of detected
                                         --   duplicates.
             }
          STATUS       current
          DESCRIPTION
             "smfIpv4DuplMultiPktsDetectedTotal is a
              notification sent when the number of
              IPv4 duplicate packets detected exceeds the
              'smfIpv4DuplMultiPktsDetectedTotalThreshold'
              during the previous number of seconds
              'smfIpv4DuplPktsDetectedTotalWindow'."
          ::= { smfMIBNotifObjects 6 }

   smfIpv6DuplMultiPktsDetectedTotalEvents NOTIFICATION-TYPE
          OBJECTS { smfRouterIDAddrType, -- The originator of
                                         --   the notification.
                    smfRouterID,         -- The originator of
                                         --   the notification.
                    smfIpv6DuplMultiPktsDetectedTotal
                                         -- The counter of detected
                                         --   duplicates.
             }
          STATUS       current
          DESCRIPTION
             "smfIpv6DuplMultiPktsDetectedTotal is a
```

```
              notification sent when the number of
              IPv6 duplicate packets detected exceeds the
              'smfIpv6DuplMultiPktsDetectedTotalThreshold'
              during the previous number of seconds
              'smfIpv6DuplPktsDetectedTotalWindow'."
          ::= { smfMIBNotifObjects 7 }


   -- smfMIBNotifControl
   smfDpdMemoryOverflowThreshold OBJECT-TYPE
          SYNTAX       Integer32 (0..255)
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A threshold value for the
              `smfDpdmemoryOverflowEvents' object.
              If the number of occurences exceeds
              this threshold within the previous
              number of seconds
              'smfDpdMemoryOverflowWindow',
              then the `smfDpdMemoryOverflowEvent'
              notification is sent."
           ::= { smfMIBNotifControl 1 }

   smfDpdMemoryOverflowWindow OBJECT-TYPE
          SYNTAX       TimeTicks
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A time window value for the
              `smfDpdmemoryOverflowEvents' object.
              If the number of occurences exceeds
              the `smfDpdMemoryOverflowThreshold'
              within the previous number of seconds
              'smfDpdMemoryOverflowWindow',
              then the `smfDpdMemoryOverflowEvent'
              notification is sent."
           ::= { smfMIBNotifControl 2 }

   smfIpv4DuplMultiPktsDetectedTotalThreshold OBJECT-TYPE
          SYNTAX       Integer32 (0..255)
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A threshold value for the
              `smfIpv4DuplMultiPktsDetectedTotal'
              object.  If the number of occurences
              exceeds this threshold within the
```

```
              previous number of seconds
              `smfIpv4DuplMultiPktsDetectedTotalWindow',
              then the
              `smfIpv4DuplMultiPktsDetectedTotalEvent'
              notification is sent."
           ::= { smfMIBNotifControl 3 }

   smfIpv4DuplMultiPktsDetectedTotalWindow OBJECT-TYPE
          SYNTAX       TimeTicks
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A time window value for the
              `smfIpv4DuplMultiPktsDetectedTotalEvents'
              object.  If the number of occurences
              exceeds the
              `smfIpv4DuplMultiPktsDetectedTotalThreshold'
              within the previous number of seconds
              'smfIpv4DuplMultiPktsDetectedTotalWindow',
              then the
              `smfIpv4DuplMultiPktsDetectedTotalEvent'
              notification is sent."
           ::= { smfMIBNotifControl 4 }

   smfIpv6DuplMultiPktsDetectedTotalThreshold OBJECT-TYPE
          SYNTAX       Integer32 (0..255)
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A threshold value for the
              `smfIpv6DuplMultiPktsDetectedTotal'
              object.  If the number of occurences
              exceeds this threshold within the
              previous number of seconds
              `smfIpv6DuplMultiPktsDetectedTotalWindow',
              then the
              `smfIpv6DuplMultiPktsDetectedTotalEvent'
              notification is sent."
           ::= { smfMIBNotifControl 5 }

   smfIpv6DuplMultiPktsDetectedTotalWindow OBJECT-TYPE
          SYNTAX       TimeTicks
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A time window value for the
              `smfIpv6DuplMultiPktsDetectedTotalEvents'
              object.  If the number of occurences
```

```
              exceeds the
              `smfIpv6DuplMultiPktsDetectedTotalThreshold'
              within the previous number of seconds
              'smfIpv6DuplMultiPktsDetectedTotalWindow',
              then the
              `smfIpv6DuplMultiPktsDetectedTotalEvent'
              notification is sent."
           ::= { smfMIBNotifControl 6 }


   --
   -- Compliance Statements
   --

   smfCompliances  OBJECT IDENTIFIER ::= { smfMIBConformance 1 }
   smfMIBGroups    OBJECT IDENTIFIER ::= { smfMIBConformance 2 }

   smfBasicCompliance  MODULE-COMPLIANCE
      STATUS current
      DESCRIPTION "The basic implementation requirements for
                  managed network entities that implement
                  the SMF RSSA process."
      MODULE  -- this module
      MANDATORY-GROUPS { smfCapabObjectsGroup,
                         smfConfigObjectsGroup }
   ::= { smfCompliances 1 }

   smfFullCompliance MODULE-COMPLIANCE
      STATUS current
      DESCRIPTION "The full implementation requirements for
                  managed network entities that implement
                  the SMF RSSA process."
      MODULE  -- this module
      MANDATORY-GROUPS { smfCapabObjectsGroup,
                         smfConfigObjectsGroup,
                         smfStateObjectsGroup,
                         smfPerfObjectsGroup,
                         smfNotifObjectsGroup,
                         smfNotificationsGroup
                       }
   ::= { smfCompliances 2 }

   --
   -- Units of Conformance
   --

   smfCapabObjectsGroup OBJECT-GROUP
      OBJECTS {
```

```
              smfOpModeCapabilitiesName,
              smfOpModeCapabilitiesReference,

              smfRssaCapabilitiesName,
              smfRssaCapabilitiesReference
      }
      STATUS  current
      DESCRIPTION
         "Set of SMF configuration objects implemented
          in this module."
   ::= { smfMIBGroups 1 }

   smfConfigObjectsGroup OBJECT-GROUP
      OBJECTS {
              smfAdminStatus,
              smfRouterIDAddrType,
              smfRouterID,
              smfIfName,
              smfConfiguredOpMode,
              smfConfiguredRssa,
              smfRssaMember,
              smfIpv4Dpd,
              smfIpv6Dpd,
              smfMaxPktLifetime,
              smfDpdMaxMemorySize,
              smfDpdEntryMaxLifetime,
              smfNhdpRssaMesgTLVIncluded,
              smfNhdpRssaAddrBlockTLVIncluded,

              smfConfiguredAddrForwardingLastAddr,
              smfConfiguredAddrForwardingStatus,

              smfIfAdminStatus,
              smfIfRowStatus
      }
      STATUS  current
      DESCRIPTION
         "Set of SMF configuration objects implemented
          in this module."
   ::= { smfMIBGroups 2 }

   smfStateObjectsGroup  OBJECT-GROUP
      OBJECTS {
              smfNodeRsStatusIncluded,
              smfDpdMemoryOverflow,

              smfDiscoveredAddrForwardingLastAddr,
```

```
                smfNeighborRSSA,
                smfNeighborNextHopInterface
        }
        STATUS  current
        DESCRIPTION
           "Set of SMF state objects implemented
            in this module."
     ::= { smfMIBGroups 3 }

     smfPerfObjectsGroup  OBJECT-GROUP
        OBJECTS {
                smfIpv4MultiPktsRecvTotal,
                smfIpv4MultiPktsForwardedTotal,
                smfIpv4DuplMultiPktsDetectedTotal,
                smfIpv4DroppedMultiPktsTTLExceededTotal,
                smfIpv4TTLLargerThanPreviousTotal,

                smfIpv6MultiPktsRecvTotal,
                smfIpv6MultiPktsForwardedTotal,
                smfIpv6DuplMultiPktsDetectedTotal,
                smfIpv6DroppedMultiPktsTTLExceededTotal,
                smfIpv6TTLLargerThanPreviousTotal,
                smfIpv6HAVAssistsReqdTotal,
                smfIpv6DpdHeaderInsertionsTotal,

                smfIpv4MultiPktsRecvPerIf,
                smfIpv4MultiPktsForwardedPerIf,
                smfIpv4DuplMultiPktsDetectedPerIf,
                smfIpv4DroppedMultiPktsTTLExceededPerIf,
                smfIpv4TTLLargerThanPreviousPerIf,

                smfIpv6MultiPktsRecvPerIf,
                smfIpv6MultiPktsForwardedPerIf,
                smfIpv6DuplMultiPktsDetectedPerIf,
                smfIpv6DroppedMultiPktsTTLExceededPerIf,
                smfIpv6TTLLargerThanPreviousPerIf,
                smfIpv6HAVAssistsReqdPerIf,
                smfIpv6DpdHeaderInsertionsPerIf
        }
        STATUS  current
        DESCRIPTION
           "Set of SMF performance objects implemented
            in this module by total and per interface."
     ::= { smfMIBGroups 4 }

     smfNotifObjectsGroup  OBJECT-GROUP
        OBJECTS {
                smfDpdMemoryOverflowThreshold,
```

```
              smfDpdMemoryOverflowWindow,
              smfIpv4DuplMultiPktsDetectedTotalThreshold,
              smfIpv4DuplMultiPktsDetectedTotalWindow,
              smfIpv6DuplMultiPktsDetectedTotalThreshold,
              smfIpv6DuplMultiPktsDetectedTotalWindow
      }
      STATUS  current
      DESCRIPTION
         "Set of SMF notification control
          objects implemented in this module."
   ::= { smfMIBGroups 5 }

   smfNotificationsGroup  NOTIFICATION-GROUP
      NOTIFICATIONS {
              smfAdminStatusChange,
              smfConfiguredOpModeChange,
              smfConfiguredRssaChange,
              smfIfAdminStatusChange,
              smfDpdMemoryOverflowEvent,
              smfIpv4DuplMultiPktsDetectedTotalEvents,
              smfIpv6DuplMultiPktsDetectedTotalEvents
      }
      STATUS  current
      DESCRIPTION
         "Set of SMF notifications implemented
          in this module."
   ::= { smfMIBGroups 6 }


   END
```

8. Security Considerations

This section discusses security implications of the choices made in this SMF-MIB module.

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:

o 'smfAdminStatus' - this writable configuration object controls the operational status of the SMF process. If this setting is configured inconsistently across the MANET multicast domain, then delivery of multicast data may be inconsistent across the domain; some nodes may not receive multicast data intended for them.

o 'smfRouterIDAddrType' and 'smfRouterID' - these writable configuration objects define the ID of the SMF process. These objects should be configured with a routable address defined on the local SMF device. The smfRouterID is a logical identification that MUST be consistent across inter-operating SMF neighborhoods and it is RECOMMENDED to be chosen as the numerically largest address contained in a node's 'Neighbor Address List' as defined in NHDP. A smfRouterID MUST be unique within the scope of the operating MANET network regardless of the method used for selecting it.

o 'smfConfiguredOpMode' - this writable configuration objects define the operational mode of the SMF process. The operational mode defines how the SMF process develops its local estimate of the CDS.

o 'smfConfiguredRssa' - this writable configuration object sets the specific Reduced Set Selection Algorithm (RSSA) for the SMF process. If this object is set inconsistently across the MANET domain, multicast delivery of data will fail.

o 'smfRssaMember' - this writable configuration object sets the 'interest' of the local SMF node in participating in the CDS. Setting this object to 'never(3)' on a highly highly connected device could lead to frequent island formation. Setting this object to 'always(2)' could support data ex-filtration from the MANET domain.

o 'smfIpv4Dpd' - this writable configuration object sets the duplicate packet detection method for forwarding of IPv4 multicast packets.

o 'smfIpv6Dpd' - this writable configuration object sets the duplicate packet detection method for forwarding of IPv6 multicast packets.

o 'smfMaxPktLifetime' - this writable configuration object sets the estimate of the network packet traversal time. If set too small, this could lead to poor multicast data delivery ratios throughout the MANET domain.

o 'smfDpdMaxMemorySize' - this writable configuration object sets the memory storage size (in Kilo-Bytes) for the cached DPD records for the combined IPv4 and IPv6 methods. If set too small this could lead to poor performance of the duplicate packet protection algorithms and lead to inefficient resource, e.g., link, utilization within the MANET domain. The local SMF device should protect itself against memory overruns in the event that too large a setting is requested.

o 'smfDpdEntryMaxLifetime' - this writable configuration object sets the maximum lifetime (in seconds) for the cached DPD records for the combined IPv4 and IPv6 methods. If the memory is running low prior to the MaxLifetimes being exceeded, the local SMF devices should purge the oldest records first.

o 'smfNhdpRssaMesgTLVIncluded' - this writable configuration object indicates whether the associated NHDP messages include the the RSSA Message TLV, or not. It is highly RECOMMENDED that this object be set to 'true(1)'.

o 'smfNhdpRssaAddrBlockTLVIncluded' - this writable configuration object indicates whether the associated NHDP messages include the the RSSA Address Block TLV, or not. The smfNhdpRssaAddrBlockTLVIncluded is optional in all cases as it depends on the existence of an address block which may not be present. If this SMF device is configured with NHDP, then this object should be set to 'true(1)'.

o 'smfConfiguredAddrForwardingTable' - the writable configuration objects in this table indicate which multicast IP address are to be forwarded by this SMF node. Misconfiguration of rows within this table can limit the ability of this SMF device to forward multicast data.

o 'smfInterfaceTable' - the writable configuration objects in this table indicate which SMF node interfaces are participating in the SMF packet forwarding process. Misconfiguration of rows within this table can limit the ability of this SMF device to forward multicast data.

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 'smfNodeRsStatusIncluded' - this readable state object indicates that this SMF node is part of the CDS, or not. Being part of the CDS makes this node a distinguished device. It could be exploited for data ex-filtration, or denial of service attacks.

o 'smfDiscoveredAddrForwardingTable' - the readable state objects in this table indicate which, dynamically discovered, multicast IP address are to be forwarded by this SMF node.

o 'smfNeighborTable' - the readable state objects in this table indicate current neighbor nodes to this SMF node. Exposing this information to an attacker could allow the attacker easier access to the larger MANET domain.

The remainder of the objects in the SMF-MIB are performance counter objects. While these give an indication of the activity of the SMF process on this node, it is not expected that exposing these values pose a security risk to the MANET network.

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.

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

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

9. Applicability Statement

This document describes objects for configuring parameters of the Simplified Multicast Forwarding [RFC6621] process on a router. This MIB module, denoted SMF-MIB, also reports state, performance information and notifications. This sections provides some examples of how this MIB module can be used in MANET network deployments. A fuller discussion of MANET network management use cases and challenges will be provided elsewhere.

SMF is designed to allow routers to forward IPv4 and IPv6 packets over the MANET and cover the MANET nodes through the automatic discovery of efficient estimates of the Minimum Connected Dominating Set (MCDS) of nodes within the MANET. The MCDS are estimated using the RSSAs discussed within this document. In the following, three scenarios are listed where this MIB module is useful, i.e.,

- o For a Parking Lot Initial Configuration Situation - it is common for the vehicles comprising the MANET being forward deployed at a remote location, e.g., the site of a natural disaster, to be off-loaded in a parking lot where an initial configuration of the networking devices is performed. The configuration is loaded into the devices from a fixed location Network Operation Center (NOC) at the parking lot and the vehicles are stationary at the parking lot while the configuration changes are made. Standards-based methods for configuration management from the co-located NOC are necessary for this deployment option.

- o For Mobile vehicles with Low Bandwidth Satellite Link to a Fixed NOC - Here the vehicles carrying the MANET routers carry multiple wireless interfaces, one of which is a relatively low-bandwidth on-the-move satellite connection which interconnects a fix NOC to the nodes of the MANET. Standards-based methods for monitoring and fault management from the fixed NOC are necessary for this deployment option.

- o For Fixed NOC and Mobile Local Manager in Larger Vehicles - for larger vehicles, a hierarchical network management arrangement is useful. Centralized network management is performed from a fixed NOC while local management is performed locally from within the vehicles. Standards-based methods for configuration, monitoring and fault management are necessary for this deployment option.

10. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER value recorded in the SMI Numbers registry:

```
     Descriptor        OBJECT IDENTIFIER value
     ----------        -----------------------
     SMF-MIB          { experimental XXXX }
     IANA EDITOR NOTE: please assign XXXX
```

11. Contributors

This MIB document uses the template authored by D. Harrington which is based on contributions from the MIB Doctors, especially Juergen Schoenwaelder, Dave Perkins, C.M.Heard and Randy Presuhn.

12. Acknowledgements

The authors would like to acknowledge the valuable comments from Sean Harnedy in the early phases of the development of this MIB-module. The authors would like to thank James Nguyen for his careful review and comments on this MIB-module and his work on the definitions of the follow on MIB-modules to configure specific RSSA algorithms related to SMF. Further, the authors would like to acknowledge to work of James Nguyen, Brian Little and Ryan Morgan on their software development of the SMF-MIB.

13. References

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[RFC6353] Hardaker, W., "Transport Layer Security (TLS) Transport Model for the Simple Network Management Protocol (SNMP)", RFC 6353, July 2011.

Appendix A. Change Log

This section tracks the revision history in the development of this SMF-MIB. It will be removed from the final version of this document.

These changes were made from draft-ietf-manet-smf-mib-05 to draft-ietf-manet-smf-mib-06.

1. Only minor editorial and formatting changes were made to this document revision. No substantive changes were made to the SMF-MIB module itself.

These changes were made from draft-ietf-manet-smf-mib-04 to draft-ietf-manet-smf-mib-05.

1. Updated the smfInterfaceTable to reflect that fact that we want it to 'sparsely augment' the ifTable.

2. Added a section to the text discussing the SMF Tables and their indexing.

3. Added the section on 'Applicability Statement'.

4. Added/checked for DEFVAL, REFERENCES, UNITS and SIZE clauses within the MIB.

These changes were made from draft-ietf-manet-smf-mib-03 to draft-ietf-manet-smf-mib-04.

1. Removed the bitmap switch in the notifications control group.

2. Moved the notification Objects group up to support reverse-mapping between SNMPv1 traps and SNMPv2 notifications.

3. Removed reference to the notifications state group.

4. Replaced smfIfIndex with smfIfName in notifications.

These changes were made from draft-ietf-manet-smf-mib-02 to draft-ietf-manet-smf-mib-03.

1. Clarified and added discussion of default values for several of the configuration objects within the MIB.

2. Added the security section.

These changes were made from draft-ietf-manet-smf-mib-01 to draft-ietf-manet-smf-mib-02.

1. Added the NotificationGroup to the MIB and updated the ConformanceGroup.

2. Added the definition of an smfRouterID to the MIB. This is later used in the Notifications to indicate the origin of the event to the management station.

3. Removed the Router Priority object as this was used only in the eCDS algorithm and hence should be contained within the future eCDS-MIB.

4. Cleaned up the TEXTUAL CONVENTION for the 'SmfOpMode'.

5. Filled in some of the missing text in various object descriptions.

These changes were made from draft-ietf-manet-smf-mib-00 to draft-ietf-manet-dsmf-mib-01.

1. Editorial changes to the textual material. These included the addition of the paragraphs on TEXTUAL-CONVENTIONS defined and imported into this MIB and relationships to other MIBs.

2. Identified those objects in the SMF-MIB requiring non-volatile storage.

3. Changed the name of the TEXTUAL-CONVENTION 'Status', defined within this MIB to 'SmfStatus'.

Appendix B. Open Issues

This section contains the set of open issues related to the development and design of the SMF-MIB. This section will not be present in the final version of the MIB and will be removed once all the open issues have been resolved.

1. A careful review by the working group.

Appendix C.

```
***************************************************************
* Note to the RFC Editor (to be removed prior to publication) *
*                                                             *
* 1) The reference to RFCXXXX within the DESCRIPTION clauses  *
* of the MIB module point to this draft and are to be         *
* assigned by the RFC Editor.                                 *
*                                                             *
***************************************************************
```

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