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Definition of Managed Objects for the Manet Simplified Multicast
Framework Relay Set Process
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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 module also reports state information, performance information, and notifications. In addition to configuration, the additional state and performance information is useful to operators troubleshooting multicast forwarding problems.

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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 module also reports state information, performance information, 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 Duplicate Packet Detection (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 Minimum CDS (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 module 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 1 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.

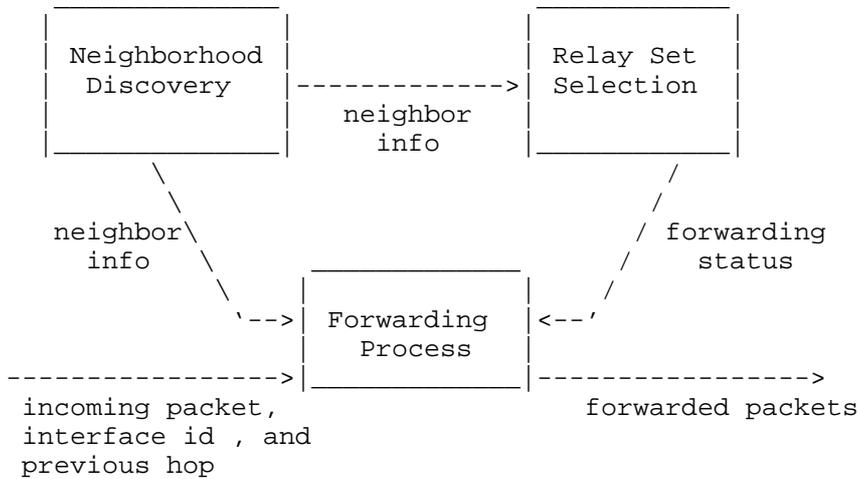


Figure 1: SMF Router Architecture

4.2. Terms

The following definitions apply throughout this document:

- o Configuration Objects - switches, tables, objects which are initialized to default settings or set through the management interfaces such as defined by this MIB module.
- o Tunable Configuration Objects - objects whose values affect timing or attempt bounds on the SMF Relay Set (RS) process.
- o State Objects - automatically generated values which define the current operating state of the SMF RS process in the router.
- o 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:

- o smfMIBNotifications - defines the notifications associated with the SMF process.

- o smfMIBObjects - defines the objects forming the basis for the SMF-MIB module. 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 process and the resulting multicast performance.
 - * State Group - Contains information describing the current state of the SMF process such as the Neighbor Table.
 - * Performance Group - Contains objects which help to characterize the performance of the SMF process, typically counters for statistical computations.
- o smfMIBConformance - defines two, i.e., minimal and full, conformance implementations for the SMF-MIB module.

5.1. Textual Conventions

The textual conventions defined within the SMF-MIB module are:

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

The textual conventions defined for the SMF-MIB module and maintained by IANA are:

- o The IANAsmfOpModeIdTC represents an index that identifies a specific SMF operational mode. This textual convention is maintained by IANA in the IANA-SMF-MIB.
- o The IANAsmfRssaIdTC represents an index that identifies, through reference, a specific RSSA available for operation on the device. This textual convention is maintained by IANA also in the IANA-SMF-MIB.

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 a separate MIB module.

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 are:

- o Operational Mode - determines where topology information is derived from, e.g., 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 the SMF Type Message TLV MAY be included in the NHDP exchanges.
- o SMF Address Block TLV - if NHDP mode is selected, then the SMF Address Block TLV SHOULD be included in the NHDP exchanges.
- o SMF Address Forwarding Table - a table identifying configured multicast addresses to be forwarded by the SMF process.

5.4. The State Group

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

- o Node RSSA State - identifies whether the node is currently in or out of the Relay Set.
- o Neighbors Table - a table containing current one-hop 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 module and their intended purpose and 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 on 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 `smfCapabilitiesIndex` - the index identifying the combination of SMF mode and SMF RSSA available on this device.
- o `smfCfgAddrForwardingIndex` - the index to configured multicast addresses lists which are forwarded by the SMF process.
- o `smfCfgIfIndex` - the `IfIndex` of the interface on the local router on which SMF is configured.
- o `smfStateNeighborIpAddressType`, `smfStateNeighborIpAddress`, and `smfStateNeighborPrefixLen` - the interface index set of specific one-hop neighbor nodes to this local router.

These tables and their associated indexing are:

- o smfCapabilitiesTable - identifies the resident set of (SMF Operational Modes, SMF RSSA algorithms) available on this router. This table has 'INDEX { smfCapabilitiesIndex }'.
- o smfCfgAddrForwardingTable - contains information on multicast addresses which are to be forwarded by the SMF process on this device. This table has 'INDEX { smfCfgAddrForwardingIndex }'.
- o smfCfgInterfaceTable - describes the SMF interfaces on this device that are participating in the SMF packet forwarding process. This table has 'INDEX { smfCfgIfIndex }'.
- o smfStateNeighborTable - describes the current neighbor nodes, their addresses and the SMF RSSA and the interface on which they can be reached. This table has 'INDEX { smfStateNeighborIpAddrType, smfStateNeighborIpAddr, smfStateNeighborPrefixLen }'.
- o smfPerfIpv4InterfacePerfTable - contains the IPv4 related SMF statistics per each SMF interface on this device. This table has 'INDEX { smfCfgIfIndex }'.
- o smfPerfIpv6InterfacePerfTable - contains the IPv6 related SMF statistics per each SMF interface on this device. This table has 'INDEX { smfCfgIfIndex }'.

6. Relationship to Other MIB Modules

6.1. Relationship to the SNMPv2-MIB

The 'system' group in the SNMPv2-MIB module [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 module does not duplicate those objects.

6.2. Relationship to the IP-MIB

It is an expectation that SMF devices will implement the standard IP-MIB module [RFC4293]. Exactly how to integrate SMF packet handling and management into the standard IP-MIB module management are part of the experiment.

The SMF-MIB module counters within the smfPerformanceGroup count packets handled by the system and interface local SMF process (as discussed above). Not all IP (unicast and multicast) packets on a

device interface are handled by the SMF process. So the counters are tracking different packet streams in the IP-MIB and SMF-MIB modules.

6.3. Relationship to the IPMCAST-MIB

The `smfCfgAddrForwardingTable` is essentially a filter table (if populated) that identifies addresses/packets to be forwarded via the local SMF flooding process. The RFC 5132 IP Multicast MIB module [RFC5132] manages objects related to standard IP multicast, which could be running in parallel to SMF on the device.

RFC 5132 manages traditional IP-based multicast (based upon multicast routing mechanisms). The SMF-MIB module provides management for a MANET subnet-based flooding mechanism which, may be used for multicast transport (through SMF broadcast) depending upon the MANET dynamics and other factors regarding the MANET subnet. Further, they may co-exist in certain MANET deployments using the `smfCfgAddrForwardingTable` to hand certain IP multicast addresses to the SMF process and other IP multicast packets to be forwarded by other IP routed-based multicast mechanisms. SMF and the associated SMF-MIB module are experimental and these are some of the experiments to be had with SMF and the SMF-MIB module.

6.4. MIB modules required for IMPORTS

The textual conventions imported for use in the SMF-MIB module 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].

6.5. Relationship to the Future RSSA-MIB Modules

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

7. SMF-MIB Definitions

```
SMF-MIB DEFINITIONS ::= BEGIN

IMPORTS

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

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

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

    InterfaceIndexOrZero, ifName
        FROM IF-MIB -- [RFC2863]

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

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

    IANAsmfOpModeIdTC
        FROM IANA-SMF-MIB

    IANAsmfRssaIdTC
        FROM IANA-SMF-MIB

;

smfMIB MODULE-IDENTITY
    LAST-UPDATED "201407301300Z" -- July 30, 2014
    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 6621,
May 2012.

Copyright (C) The IETF Trust (2014). This version of this MIB module is part of RFC xxxx; see the RFC itself for full legal notices."

-- Revision History

REVISION "201407301300Z" -- July 30, 2014

DESCRIPTION

"The first version of this MIB module,
published as RFC xxxx.
"

-- RFC-Editor assigns xxxx

::= { experimental xxxx } -- 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 this interface is performing SMF functions, and 'disabled' indicates that it is not. Similarly for the status of the device: 'enabled' indicates that the device has enabled the SMF functions on the device and 'disabled' means that the device and all interfaces have disabled all SMF functions."

```
SYNTAX INTEGER {
    enabled (1),
    disabled (2)
}
```

--

-- 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 Capabilities Table

--

```
smfCapabilitiesTable OBJECT-TYPE
```

SYNTAX SEQUENCE OF SmfCapabilitiesEntry
 MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION
 "The smfCapabilitiesTable identifies the resident set of SMF Operational Modes and RSSA combinations that can run on this forwarder."

REFERENCE
 "See Section 7.2. 'Reduced Relay Set Forwarding', Section 8.1.1. 'SMF Message TLV Type', and the Appendices A, B and C in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."
 ::= { smfCapabilitiesGroup 1 }

smfCapabilitiesEntry OBJECT-TYPE

SYNTAX SmfCapabilitiesEntry
 MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION
 "Information about a particular operational mode and RSSA combination."
 "

INDEX { smfCapabilitiesIndex }
 ::= { smfCapabilitiesTable 1 }

SmfCapabilitiesEntry ::= SEQUENCE {
 smfCapabilitiesIndex Integer32,
 smfCapabilitiesOpModeID IANAsmfOpModeIdTC,
 smfCapabilitiesRssaID IANAsmfRssaIdTC
 }

smfCapabilitiesIndex OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)
 MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION
 "The index for this entry; a unique value, greater than zero, for each combination of a particular operational mode and RSSA algorithm available on this device. It is recommended that values are assigned contiguously starting from 1.

Rows in this table are automatically populated by the entity's management system on initialization.

By default, the agent should support at least the Classical Flooding 'CF' algorithm. All compliant SMF forwarders must support Classical Flooding. Hence, the first entry in this table MUST exist and MUST be defined as:

```
smfCapabilitiesIndex i '1'
smfCapabilitiesOpModeID i 'cfOnly(1)'
smfCapabilitiesRssaID i 'cF(1)'
```

The value for each combination MUST remain constant at least from one re-initialization of the entity's management system to the next re-initialization."

```
::= { smfCapabilitiesEntry 1 }
```

```
smfCapabilitiesOpModeID      OBJECT-TYPE
SYNTAX      IANAsmfOpModeIdTC
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "This object identifies
    the particular operational mode for this device."
 ::= { smfCapabilitiesEntry 2 }
```

```
smfCapabilitiesRssaID      OBJECT-TYPE
SYNTAX      IANAsmfRssaIdTC
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "This object identifies
    the particular RSSA algorithm in this MIB
    module. Example RSSAs are found in the
    appendix of RFC 6621."
REFERENCE
    "See, e.g., Section 8.1.1. 'SMF Message TLV Type',
    and the Appendices A, B and C in
    RFC 6621 - Simplified Multicast Forwarding
    (SMF), Macker, J., May 2012."
 ::= { smfCapabilitiesEntry 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 }

smfCfgAdminStatus 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.

        Prior to SMF functions being performed over
        specific interfaces, this object must first
        be 'enabled'. If this object is 'disabled',
        then no SMF functions are being performed on
        the device and all smfCfgIfAdminStatus objects
        MUST also be set to 'disabled'. When this
        object is changed from 'enabled' to 'disabled'
        by the manager, then all smfCfgIfAdminStatus
        objects MUST also be automatically set to
        'disabled' by the agent.

        The default value for this object SHOULD be
        'enabled'.

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

smfCfgSmfSysUpTime OBJECT-TYPE
    SYNTAX      TimeTicks
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The time (in hundredths of a second) since the
        system SMF process was last re-initialized.
        The SMF process is re-initialized when the
        value of the 'smfCfgAdminStatus' object
        transitions to 'enabled' from either a prior
        value of 'disabled' or upon initialization
        of this device."
```

```
::= { smfConfigurationGroup 2 }

smfCfgRouterIDAddrType OBJECT-TYPE
    SYNTAX      InetAddressType { ipv4(1), ipv6(2) }
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The address type of the address used for
        SMF ID of this router as specified
        in the 'smfCfgRouterID' next.

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

        This object is persistent and when written
        the entity SHOULD save the change to
        non-volatile storage."
    DEFVAL { ipv4 }
::= { smfConfigurationGroup 3 }

smfCfgRouterID 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 'smfCfgRouterID'.

        The smfCfgRouterID 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 smfCfgRouterID 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
        "See, e.g.,
```

Appendix Section A.1. 'E-CDS Relay Set Selection Overview' and

Appendix Section C.1. 'MPR-CDS Relay Set Selection Overview'

in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

```
::= { smfConfigurationGroup 4 }
```

smfCfgOperationalMode OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The SMF RSS node operational mode and RSSA algorithm combination active on this local forwarder. This object is defined to be equal to the smfCapabilitiesIndex which identifies the specific active operational mode and RSSA.

The default value for this object is '1' which corresponds to:

```
smfCapabilitiesOpModeID i 'cfOnly(1)'
```

```
smfCapabilitiesRssaID i 'cF(1)'
```

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

REFERENCE

"See Section 7.2. 'Reduced Relay Set Forwarding', and the Appendices A, B and C in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

DEFVAL { 1 }

```
::= { smfConfigurationGroup 5 }
```

smfCfgRssaMember 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(2)' 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

"See Section 7. 'Relay Set Selection' in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

```
DEFVAL { potential }
 ::= { smfConfigurationGroup 6 }
```

```
smfCfgIpv4Dpd 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

"See Section 6.2. 'IPv4 Duplicate Packet Detection' in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

DEFVAL { hashBased }

::= { smfConfigurationGroup 7 }

smfCfgIpv6Dpd 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 'smfCfgIpv4Dpd'.

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

"See Section 6.1. 'IPv6 Duplicate Packet Detection' in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

DEFVAL { hashBased }

::= { smfConfigurationGroup 8 }

smfCfgMaxPktLifetime 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
    "See Section 6. 'SMF Duplicate Packet
    Detection' in RFC 6621 - Simplified
    Multicast Forwarding (SMF), Macker, J.,
    May 2012."
DEFVAL { 60 }
 ::= { smfConfigurationGroup 9 }

smfCfgDpdEntryMaxLifetime 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
    MaxLifetime 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
    "See Section 6. 'SMF Duplicate Packet
    Detection' in RFC 6621 - Simplified
    Multicast Forwarding (SMF), Macker, J.,
    May 2012."
DEFVAL { 600 }
 ::= { smfConfigurationGroup 10 }

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

```
smfCfgNhdpRssaMesgTLVIncluded 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
        "See Section 8.1.1. 'SMF Message TLV Type' in
        RFC 6621 - Simplified Multicast Forwarding
        (SMF), Macker, J., May 2012."
    DEFVAL { true }
 ::= { smfConfigurationGroup 11 }
```

```
smfCfgNhdpRssaAddrBlockTLVIncluded 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 smfCfgNhdpRssaAddrBlockTLVIncluded 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
        "See Section 8.1.2. 'SMF Address Block TLV
```

```

        Type' in RFC 6621 - Simplified Multicast
        Forwarding (SMF), Macker, J., May 2012."
    DEFVAL { true }
 ::= { smfConfigurationGroup 12 }

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

smfCfgAddrForwardingTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF SmfCfgAddrForwardingEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The smfCfgAddrForwardingTable is essentially a filter
        table (if populated) that identifies addresses/packets
        to be forwarded via the local SMF flooding process.
        The RFC 5132 IP Multicast MIB module manages objects
        related to standard IP multicast, which could be running
        in parallel to SMF on the device.

        RFC 5132 manages traditional IP-based multicast (based
        upon multicast routing mechanisms). The SMF-MIB module
        provides management for a MANET subnet-based flooding
        mechanism which, may be used for multicast transport
        (through SMF broadcast) depending upon the MANET dynamics
        and other factors regarding the MANET subnet. Further,
        they may co-exist in certain MANET deployments
        using the smfCfgAddrForwardingTable to hand certain IP
        multicast addresses to the SMF process and other IP
        multicast packets to be forwarded by other IP
        routed-based multicast mechanisms. SMF and the
        associated SMF-MIB module are experimental and these
        are some of the experiments to be had with SMF and
        the SMF-MIB module.

        This is the (conceptual) table containing information on
        multicast addresses which are to be forwarded by the SMF
        process. This table represents an IP filters table for
        forwarding (or not) packets based upon their IP
        multicast address.

        The SMF process can be configured to forward only those
        multicast addresses found within the
        smfCfgAddrForwardingTable. As such, addresses which are
        to be forwarded by the SMF process MUST be found within

```

the address ranges configured within this table, unless this table is empty.

Each row is associated with a range of multicast addresses, and ranges for different rows must be disjoint. Different rows MAY share a common smfCfgAddrForwardingGroupName to administratively associate different rows.

The objects in this table are persistent and when written the entity SHOULD save the change to non-volatile storage."

REFERENCE

"See Section 9.1. 'Forwarded Multicast Groups' in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

::= { smfConfigurationGroup 13 }

smfCfgAddrForwardingEntry OBJECT-TYPE

SYNTAX SmfCfgAddrForwardingEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry (conceptual row) containing the information on a particular multicast scope."

INDEX { smfCfgAddrForwardingIndex }

::= { smfCfgAddrForwardingTable 1 }

SmfCfgAddrForwardingEntry ::= SEQUENCE {

smfCfgAddrForwardingIndex Integer32,

smfCfgAddrForwardingGroupName SnmpAdminString,

smfCfgAddrForwardingAddrType InetAddressType,

smfCfgAddrForwardingAddress InetAddress,

smfCfgAddrForwardingAddrPrefixLength

InetAddressPrefixLength,

smfCfgAddrForwardingStatus RowStatus

}

smfCfgAddrForwardingIndex OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object identifies an unique entry for a forwarding group. The index for this entry is a unique value, greater than zero, for each row.

It is recommended that values are assigned contiguously starting from 1.

The value for each row index MUST remain constant from one re-initialization of the entity's management system to the next re-initialization."

```
::= { smfCfgAddrForwardingEntry 1 }
```

smfCfgAddrForwardingGroupName OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"This object identifies a group name for a set of row entries in order to administratively associate a set of address ranges.

If there is no group name or this object is otherwise not applicable, then this object contains a zero-length string.

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

smfCfgAddrForwardingAddrType OBJECT-TYPE
SYNTAX InetAddressType { ipv4(1), ipv6(2) }
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The type of the addresses in the multicast forwarding ranges identified by this table.

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

This object is persistent and when written the entity SHOULD save the change to non-volatile storage."
::= { smfCfgAddrForwardingEntry 3 }

smfCfgAddrForwardingAddress OBJECT-TYPE
SYNTAX InetAddress (SIZE(4|16))
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The multicast group address which, when combined with smfCfgAddrForwardingAddrPrefixLength, gives the group prefix for this forwarding range."

The InetAddressType is given by smfCfgAddrForwardingAddrType.

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

Legal values correspond to the subset of address families for which multicast address allocation is supported.

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

```
::= { smfCfgAddrForwardingEntry 4 }
```

smfCfgAddrForwardingAddrPrefixLength OBJECT-TYPE

SYNTAX InetAddressPrefixLength

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The length in bits of the mask which, when combined with smfCfgAddrForwardingAddress, gives the group prefix for this forwarding range.

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

```
::= { smfCfgAddrForwardingEntry 5 }
```

smfCfgAddrForwardingStatus 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."

```
::= { smfCfgAddrForwardingEntry 6 }
```

```
--  
-- SMF Interfaces Configuration Table  
--
```

smfCfgInterfaceTable OBJECT-TYPE

SYNTAX SEQUENCE OF SmfCfgInterfaceEntry

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 module (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 automatically supports and runs SMF as part of the device's initialization process.

The manager creates a row in this table 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.

As the smfCfgInterfaceTable sparsely augments the IfTable. Hence,

- + an entry cannot exist in smfCfgInterfaceTable without a corresponding entry in the ifTable.
- + if an entry in the ifTable is removed, the corresponding entry (if it exists) in the smfCfgInterfaceTable MUST be removed.
- + the smfCfgIfStatus can have a value of 'enabled' or 'disabled' independent of the current value of the ifAdminStatus of the corresponding entry in the ifTable.

The values of the objects smfCfgAdminStatus and smfCfgIfAdminStatus reflect the up-down status of the SMF process running on the device and on the specific interfaces respectively. Hence,

- + the value of the smfCfgAdminStatus can be 'enabled' or 'disabled' reflecting the current running status of the SMF process on the device.
- + the value of the smfCfgIfAdminStatus can be 'enabled' or 'disabled' if the value of the smfCfgAdminStatus is set to 'enabled'.
- + if the value of the smfCfgAdminStatus is 'disabled', then the corresponding smfCfgIfAdminStatus objects MUST be set to 'disabled' in the smfCfgInterfaceTable.
- + once the value of the smfCfgAdminStatus changes from 'disabled' to 'enabled', it is up to the management system to make the corresponding changes to the smfCfgIfAdminStatus values back to 'enabled'.

"

REFERENCE

"RFC 2863 - The Interfaces Group MIB, McCloghrie, K., and F. Kastenholz, June 2000."

```
::= { smfConfigurationGroup 14 }
```

smfCfgInterfaceEntry OBJECT-TYPE

```
SYNTAX      SmfCfgInterfaceEntry
```

```
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 smfCfgIfRowStatus object."

```
INDEX { smfCfgIfIndex }
```

```
::= { smfCfgInterfaceTable 1 }
```

SmfCfgInterfaceEntry ::=

```
SEQUENCE {
    smfCfgIfIndex      InterfaceIndexOrZero,
    smfCfgIfAdminStatus SmfStatus,
    smfCfgIfSmfUpTime  TimeTicks,
    smfCfgIfRowStatus  RowStatus
}
```

```
smfCfgIfIndex 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.
        If the manager attempts to create a row
        for which the ifIndex does not exist on the
        local device, then the agent SHOULD issue
        a return value of 'inconsistentValue' and
        the operation SHOULD fail."
    REFERENCE
        "RFC 2863 - The Interfaces Group MIB, McCloghrie,
        K., and F. Kastenholz, June 2000."
    ::= { smfCfgInterfaceEntry 1 }

smfCfgIfAdminStatus 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
        currently external to the SMF forwarding process.

        When the value of the smfCfgAdminStatus is
        'disabled', then the corresponding smfCfgIfAdminStatus
        objects MUST be set to 'disabled' in the
        smfCfgInterfaceTable.

        The default value for this object is 'enabled(1)'.

        This object SHOULD be persistent and when
        written the device SHOULD save the change to
        non-volatile storage."
    DEFVAL { enabled }
    ::= { smfCfgInterfaceEntry 2 }

smfCfgIfSmfUpTime OBJECT-TYPE
    SYNTAX      TimeTicks
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The time (in hundredths of a second) since
```

```
    this interface SMF process was last
    re-initialized. The interface SMF process
    is re-initialized when the corresponding
    'smfCfgIfRowStatus' object transits to
    the 'active' state."
 ::= { smfCfgInterfaceEntry 3 }

smfCfgIfRowStatus OBJECT-TYPE
    SYNTAX      RowStatus
    MAX-ACCESS  read-create
    STATUS      current
    DESCRIPTION
        "This object permits management of this 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' 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 these objects in order
        for the row to transit to the 'active' state; the default
        value for these objects is used. For objects that do not
        have DEFVAL clauses, then the network manager MUST
        specify the value of these objects prior to this row
        transitioning to the 'active' state.

        When this object transitions to 'active', 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 smfCfgIfRowStatus of 'active'
        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', all associated
        entries in the smfPerfIpv4InterfacePerfTable and the
        smfPerfIpv6InterfacePerfTable MUST be deleted."
 ::= { smfCfgInterfaceEntry 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 }

smfStateNodeRsStatusIncluded 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

"See Section 7. 'Relay Set Selection' in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

::= { smfStateGroup 1 }

smfStateDpdMemoryOverflow OBJECT-TYPE

SYNTAX Counter32

UNITS "DPD Records"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of DPD records that had to be flushed to prevent memory overruns for caching of these records. The number of records to be flushed upon a buffer overflow is an implementation specific decision."

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled. In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgSmfSysUpTime object also be monitored."

REFERENCE

"See Section 6. 'SMF Duplicate Packet Detection' in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

::= { smfStateGroup 2 }

--

-- SMF Neighbor Table

--

```

smfStateNeighborTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF SmfStateNeighborEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "The SMF StateNeighborTable describes the
        current one-hop neighbor nodes, their address
        and SMF RSSA and the interface on which
        they can be reached."
    REFERENCE
        "See Section 7. 'SMF Neighborhood Discovery' and
        Section 8.1. 'SMF Relay Algorithm TLV
        Types' in RFC 6621 - Simplified Multicast
        Forwarding (SMF), Macker, J., May 2012."
 ::= { smfStateGroup 3 }

smfStateNeighborEntry OBJECT-TYPE
    SYNTAX          SmfStateNeighborEntry
    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 { smfStateNeighborIpAddrType,
            smfStateNeighborIpAddr,
            smfStateNeighborPrefixLen }
 ::= { smfStateNeighborTable 1 }

SmfStateNeighborEntry ::=
    SEQUENCE {
        smfStateNeighborIpAddrType      InetAddressType,
        smfStateNeighborIpAddr          InetAddress,
        smfStateNeighborPrefixLen       InetAddressPrefixLength,
        smfStateNeighborRSSA            IANAsmfRssaIdTC,
        smfStateNeighborNextHopInterface InterfaceIndexOrZero
    }

smfStateNeighborIpAddrType OBJECT-TYPE
    SYNTAX          InetAddressType { ipv4(1), ipv6(2) }
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "The one-hop neighbor IP address type.

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

```

```
::= { smfStateNeighborEntry 1 }

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

        Only IPv4 and IPv6 addresses
        are supported."
 ::= { smfStateNeighborEntry 2 }

smfStateNeighborPrefixLen OBJECT-TYPE
    SYNTAX      InetAddressPrefixLength
    UNITS       "bits"
    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."
 ::= { smfStateNeighborEntry 3 }

smfStateNeighborRSSA OBJECT-TYPE
    SYNTAX      IANAsmfRssaIdTC
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The current RSSA running on the neighbor."
 ::= { smfStateNeighborEntry 4 }

smfStateNeighborNextHopInterface OBJECT-TYPE
    SYNTAX      InterfaceIndexOrZero
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The interface ifIndex over which the
        neighbor is reachable in one-hop."
 ::= { smfStateNeighborEntry 6 }

--
-- 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.
--
-- It is an expectation that SMF devices will
-- implement the standard IP-MIB module RFC4293.
-- Exactly how to integrate SMF packet handling and
-- management into the standard IP-MIB module management
-- are part of the experiment.
--
-- The SMF-MIB module counters within the
-- smfPerformanceGroup count packets handled by the
-- system and interface local SMF process (as discussed
-- above). Not all IP (unicast and multicast) packets
-- on a device interface are handled by the SMF process.
-- So the counters are tracking different packet streams
-- in the IP-MIB and SMF-MIB modules.
--

smfPerformanceGroup OBJECT IDENTIFIER ::= { smfMIBObjects 4 }

smfPerfGobalGroup OBJECT IDENTIFIER ::= { smfPerformanceGroup 1 }

--
-- IPv4 packet counters
--

smfPerfIpv4MultiPktsRecvTotal OBJECT-TYPE
    SYNTAX Counter32
    UNITS "Packets"
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "A counter of the total number of
        multicast IPv4 packets received by the
        device and delivered to the SMF process.

        There is the potential for a counter discontinuity
        in this object if the system SMF process had been
        disabled and later enabled. In order to check for
        the occurrence of such a discontinuity when monitoring
        this counter object, it is recommended that the
        smfCfgSmfSysUpTime object also be monitored."
    ::= { smfPerfGobalGroup 1 }

smfPerfIpv4MultiPktsForwardedTotal OBJECT-TYPE
    SYNTAX Counter32
    UNITS "Packets"

```

```

MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "A counter of the total number of
    multicast IPv4 packets forwarded by the
    device.

    There is the potential for a counter discontinuity
    in this object if the system SMF process had been
    disabled and later enabled. In order to check for
    the occurrence of such a discontinuity when monitoring
    this counter object, it is recommended that the
    smfCfgSmfSysUpTime object also be monitored."
 ::= { smfPerfGobalGroup 2 }

smfPerfIpv4DuplMultiPktsDetectedTotal OBJECT-TYPE
SYNTAX Counter32
UNITS "Packets"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "A counter of the total number of duplicate
    multicast IPv4 packets detected by the
    device.

    There is the potential for a counter discontinuity
    in this object if the system SMF process had been
    disabled and later enabled. In order to check for
    the occurrence of such a discontinuity when monitoring
    this counter object, it is recommended that the
    smfCfgSmfSysUpTime object also be monitored."
REFERENCE
    "See Section 6.2. 'IPv4 Duplicate Packet
    Detection' in RFC 6621 - Simplified Multicast
    Forwarding (SMF), Macker, J., May 2012."
 ::= { smfPerfGobalGroup 3 }

smfPerfIpv4DroppedMultiPktsTTLExceededTotal OBJECT-TYPE
SYNTAX Counter32
UNITS "Packets"
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.

    There is the potential for a counter discontinuity

```

in this object if the system SMF process had been disabled and later enabled. In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgSmfSysUpTime object also be monitored."

REFERENCE

"See Section 5. 'SMF Packet Processing and Forwarding' in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

```
::= { smfPerfGobalGroup 4 }
```

```
smfPerfIpv4TTLLargerThanPreviousTotal OBJECT-TYPE
```

```
SYNTAX Counter32
```

```
UNITS "Packets"
```

```
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.

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled. In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgSmfSysUpTime object also be monitored."

REFERENCE

"See Section 5. 'SMF Packet Processing and Forwarding' in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

```
::= { smfPerfGobalGroup 5 }
```

```
--
```

```
-- IPv6 packet counters
```

```
--
```

```
smfPerfIpv6MultiPktsRecvTotal OBJECT-TYPE
```

```
SYNTAX Counter32
```

```
UNITS "Packets"
```

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

```
STATUS current
```

DESCRIPTION

"A counter of the total number of multicast IPv6 packets received by the device and delivered to the SMF process.

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled. In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgSmfSysUpTime object also be monitored."

```
::= { smfPerfGobalGroup 6 }
```

```
smfPerfIpv6MultiPktsForwardedTotal OBJECT-TYPE
```

```
SYNTAX Counter32
```

```
UNITS "Packets"
```

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

```
STATUS current
```

```
DESCRIPTION
```

```
"A counter of the total number of
multicast IPv6 packets forwarded by the
device.
```

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled. In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgSmfSysUpTime object also be monitored."

```
::= { smfPerfGobalGroup 7 }
```

```
smfPerfIpv6DuplMultiPktsDetectedTotal OBJECT-TYPE
```

```
SYNTAX Counter32
```

```
UNITS "Packets"
```

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

```
STATUS current
```

```
DESCRIPTION
```

```
"A counter of the total number of duplicate
multicast IPv6 packets detected by the
device.
```

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled. In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgSmfSysUpTime object also be monitored."

```
REFERENCE
```

```
"See Section 6.1. 'IPv6 Duplicate Packet
Detection' in RFC 6621 - Simplified Multicast
Forwarding (SMF), Macker, J., May 2012."
```

```
::= { smfPerfGobalGroup 8 }
```

```

smfPerfIpv6DroppedMultiPktsTTLExceededTotal  OBJECT-TYPE
    SYNTAX      Counter32
    UNITS       "Packets"
    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.

        There is the potential for a counter discontinuity
        in this object if the system SMF process had been
        disabled and later enabled.  In order to check for
        the occurrence of such a discontinuity when monitoring
        this counter object, it is recommended that the
        smfCfgSmfSysUpTime object also be monitored."
    REFERENCE
        "See Section 5. 'SMF Packet Processing and
        Forwarding' in RFC 6621 - Simplified
        Multicast Forwarding (SMF), Macker, J.,
        May 2012."
 ::= { smfPerfGobalGroup 9 }

smfPerfIpv6TTLLargerThanPreviousTotal  OBJECT-TYPE
    SYNTAX      Counter32
    UNITS       "Packets"
    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 recieved identical packet.

        There is the potential for a counter discontinuity
        in this object if the system SMF process had been
        disabled and later enabled.  In order to check for
        the occurrence of such a discontinuity when monitoring
        this counter object, it is recommended that the
        smfCfgSmfSysUpTime object also be monitored."
    REFERENCE
        "See Section 5. 'SMF Packet Processing and
        Forwarding' in RFC 6621 - Simplified Multicast
        Forwarding (SMF), Macker, J., May 2012."
 ::= { smfPerfGobalGroup 10 }

smfPerfIpv6HAVAssistsReqdTotal  OBJECT-TYPE
    SYNTAX      Counter32
    UNITS       "Packets"

```

```

MAX-ACCESS read-only
STATUS      current
DESCRIPTION
    "A counter of the total number of IPv6 packets
    received which required the HAV assist for DPD.

    There is the potential for a counter discontinuity
    in this object if the system SMF process had been
    disabled and later enabled.  In order to check for
    the occurrence of such a discontinuity when monitoring
    this counter object, it is recommended that the
    smfCfgSmfSysUpTime object also be monitored."
REFERENCE
    "See Section 6.1.1. 'IPv6 SMF_DPD Option Header'
    in RFC 6621 - Simplified Multicast Forwarding
    (SMF), Macker, J., May 2012."
 ::= { smfPerfGobalGroup 11 }

smfPerfIpv6DpdHeaderInsertionsTotal OBJECT-TYPE
SYNTAX      Counter32
UNITS       "Packets"
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.

    There is the potential for a counter discontinuity
    in this object if the system SMF process had been
    disabled and later enabled.  In order to check for
    the occurrence of such a discontinuity when monitoring
    this counter object, it is recommended that the
    smfCfgSmfSysUpTime object also be monitored."
REFERENCE
    "See Section 6.1.2. 'IPv6 Identification-Based
    DPD' in RFC 6621 - Simplified Multicast
    Forwarding (SMF), Macker, J., May 2012."
 ::= { smfPerfGobalGroup 12 }

--
-- Per SMF Interface Performance Table
--

smfPerfInterfaceGroup OBJECT IDENTIFIER ::= { smfPerformanceGroup 2 }

smfPerfIpv4InterfacePerfTable OBJECT-TYPE

```

```

SYNTAX          SEQUENCE OF SmfPerfIpv4InterfacePerfEntry
MAX-ACCESS      not-accessible
STATUS          current
DESCRIPTION
    "The SMF Interface Performance Table
    describes the SMF counters per
    interface."
 ::= { smfPerfInterfaceGroup 1 }

smfPerfIpv4InterfacePerfEntry OBJECT-TYPE
SYNTAX          SmfPerfIpv4InterfacePerfEntry
MAX-ACCESS      not-accessible
STATUS          current
DESCRIPTION
    "The SMF Interface Performance entry
    describes the statistics for a particular
    node interface."
INDEX { smfCfgIfIndex }
 ::= { smfPerfIpv4InterfacePerfTable 1 }

SmfPerfIpv4InterfacePerfEntry ::=
SEQUENCE {
    smfPerfIpv4MultiPktsRecvPerIf          Counter32,
    smfPerfIpv4MultiPktsForwardedPerIf     Counter32,
    smfPerfIpv4DuplMultiPktsDetectedPerIf  Counter32,
    smfPerfIpv4DroppedMultiPktsTTLExceededPerIf Counter32,
    smfPerfIpv4TTLLargerThanPreviousPerIf  Counter32
}

smfPerfIpv4MultiPktsRecvPerIf OBJECT-TYPE
SYNTAX          Counter32
UNITS           "Packets"
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION
    "A counter of the number of multicast IP
    packets received by the SMF process on
    this device on this interface.

    There is the potential for a counter discontinuity
    in this object if the system SMF process had been
    disabled and later enabled on this interface.
    In order to check for the occurrence of such a
    discontinuity when monitoring this counter object,
    it is recommended that the smfCfgIfSmfUpTime
    object also be monitored."
 ::= { smfPerfIpv4InterfacePerfEntry 1 }

```

```
smfPerfIpv4MultiPktsForwardedPerIf  OBJECT-TYPE
    SYNTAX      Counter32
    UNITS        "Packets"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "A counter of the number of
        multicast IP packets forwarded by the
        SMF process on this device
        on this interface.

        There is the potential for a counter discontinuity
        in this object if the system SMF process had been
        disabled and later enabled on this interface.
        In order to check for the occurrence of such a
        discontinuity when monitoring this counter object,
        it is recommended that the smfCfgIfSmfUpTime
        object also be monitored."
 ::= { smfPerfIpv4InterfacePerfEntry 2 }

smfPerfIpv4DuplMultiPktsDetectedPerIf  OBJECT-TYPE
    SYNTAX      Counter32
    UNITS        "Packets"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "A counter of the number of duplicate
        multicast IP packets detected by the
        SMF process on this device
        on this interface.

        There is the potential for a counter discontinuity
        in this object if the system SMF process had been
        disabled and later enabled on this interface.
        In order to check for the occurrence of such a
        discontinuity when monitoring this counter object,
        it is recommended that the smfCfgIfSmfUpTime
        object also be monitored."
 ::= { smfPerfIpv4InterfacePerfEntry 3 }

smfPerfIpv4DroppedMultiPktsTTLExceededPerIf  OBJECT-TYPE
    SYNTAX      Counter32
    UNITS        "Packets"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "A counter of the total number of dropped
        multicast IPv4 packets by the SMF process
```

on this device on this interface
due to TTL exceeded.

There is the potential for a counter discontinuity
in this object if the system SMF process had been
disabled and later enabled on this interface.

In order to check for the occurrence of such a
discontinuity when monitoring this counter object,
it is recommended that the smfCfgIfSmfUpTime
object also be monitored."

```
::= { smfPerfIpv4InterfacePerfEntry 4 }
```

```
smfPerfIpv4TTLLargerThanPreviousPerIf OBJECT-TYPE
```

```
SYNTAX Counter32
```

```
UNITS "Packets"
```

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

```
STATUS current
```

```
DESCRIPTION
```

```
"A counter of the total number of IPv4 packets  
received by the SMF process on this device  
on this interface which have a TTL larger than  
that of a previously received identical packet.
```

There is the potential for a counter discontinuity
in this object if the system SMF process had been
disabled and later enabled on this interface.

In order to check for the occurrence of such a
discontinuity when monitoring this counter object,
it is recommended that the smfCfgIfSmfUpTime
object also be monitored."

```
::= { smfPerfIpv4InterfacePerfEntry 5 }
```

```
smfPerfIpv6InterfacePerfTable OBJECT-TYPE
```

```
SYNTAX SEQUENCE OF SmfPerfIpv6InterfacePerfEntry
```

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

```
STATUS current
```

```
DESCRIPTION
```

```
"The SMF Interface Performance Table  
describes the SMF counters per  
interface."
```

```
::= { smfPerfInterfaceGroup 2 }
```

```
smfPerfIpv6InterfacePerfEntry OBJECT-TYPE
```

```
SYNTAX SmfPerfIpv6InterfacePerfEntry
```

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

```
STATUS current
```

```
DESCRIPTION
```

"The SMF Interface Performance entry describes the counters for a particular node interface."

```

INDEX { smfCfgIfIndex }
 ::= { smfPerfIpv6InterfacePerfTable 1 }

SmfPerfIpv6InterfacePerfEntry ::=
SEQUENCE {
    smfPerfIpv6MultiPktsRecvPerIf          Counter32,
    smfPerfIpv6MultiPktsForwardedPerIf    Counter32,
    smfPerfIpv6DuplMultiPktsDetectedPerIf Counter32,
    smfPerfIpv6DroppedMultiPktsTTLExceededPerIf Counter32,
    smfPerfIpv6TTLargerThanPreviousPerIf  Counter32,
    smfPerfIpv6HAVAssistsReqdPerIf        Counter32,
    smfPerfIpv6DpdHeaderInsertionsPerIf   Counter32
}

smfPerfIpv6MultiPktsRecvPerIf OBJECT-TYPE
SYNTAX      Counter32
UNITS       "Packets"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "A counter of the number of
    multicast IP packets received by the
    SMF process on this device
    on this interface.

    There is the potential for a counter discontinuity
    in this object if the system SMF process had been
    disabled and later enabled on this interface.
    In order to check for the occurrence of such a
    discontinuity when monitoring this counter object,
    it is recommended that the smfCfgIfSmfUpTime
    object also be monitored."
 ::= { smfPerfIpv6InterfacePerfEntry 1 }

smfPerfIpv6MultiPktsForwardedPerIf OBJECT-TYPE
SYNTAX      Counter32
UNITS       "Packets"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "A counter of the number of
    multicast IP packets forwarded by the
    SMF process on this device
    on this interface."

```

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled on this interface.

In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgIfSmfUpTime object also be monitored."

```
::= { smfPerfIpv6InterfacePerfEntry 2 }
```

```
smfPerfIpv6DuplMultiPktsDetectedPerIf OBJECT-TYPE
```

```
SYNTAX Counter32
```

```
UNITS "Packets"
```

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

```
STATUS current
```

```
DESCRIPTION
```

```
"A counter of the number of duplicate
multicast IP packets detected by the
SMF process on this device
on this interface.
```

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled on this interface.

In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgIfSmfUpTime object also be monitored."

```
::= { smfPerfIpv6InterfacePerfEntry 3 }
```

```
smfPerfIpv6DroppedMultiPktsTTLExceededPerIf OBJECT-TYPE
```

```
SYNTAX Counter32
```

```
UNITS "Packets"
```

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

```
STATUS current
```

```
DESCRIPTION
```

```
"A counter of the number of dropped
multicast IP packets by the
SMF process on this device
on this interface due to TTL
exceeded.
```

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled on this interface.

In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgIfSmfUpTime object also be monitored."

```
::= { smfPerfIpv6InterfacePerfEntry 4 }

smfPerfIpv6TTLlargerThanPreviousPerIf OBJECT-TYPE
    SYNTAX      Counter32
    UNITS       "Packets"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "A counter of the total number of IPv6 packets
        received which have a TTL larger than that
        of a previously received identical packet
        by the SMF process on this device on this
        interface.

        There is the potential for a counter discontinuity
        in this object if the system SMF process had been
        disabled and later enabled on this interface.
        In order to check for the occurrence of such a
        discontinuity when monitoring this counter object,
        it is recommended that the smfCfgIfSmfUpTime
        object also be monitored."
::= { smfPerfIpv6InterfacePerfEntry 5 }

smfPerfIpv6HAVAssistsReqdPerIf OBJECT-TYPE
    SYNTAX      Counter32
    UNITS       "Packets"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "A counter of the total number of IPv6 packets
        received by the SMF process on this device
        on this interface which required the
        HAV assist for DPD.

        There is the potential for a counter discontinuity
        in this object if the system SMF process had been
        disabled and later enabled on this interface.
        In order to check for the occurrence of such a
        discontinuity when monitoring this counter object,
        it is recommended that the smfCfgIfSmfUpTime
        object also be monitored."
::= { smfPerfIpv6InterfacePerfEntry 6 }

smfPerfIpv6DpdHeaderInsertionsPerIf OBJECT-TYPE
    SYNTAX      Counter32
    UNITS       "Packets"
    MAX-ACCESS  read-only
    STATUS      current
```

DESCRIPTION

"A counter of the total number of IPv6 packets received by the SMF process on this device on this interface which the device inserted the DPD header option.

There is the potential for a counter discontinuity in this object if the system SMF process had been disabled and later enabled on this interface. In order to check for the occurrence of such a discontinuity when monitoring this counter object, it is recommended that the smfCfgIfSmfUpTime object also be monitored."

```
::= { smfPerfIpv6InterfacePerfEntry 7 }
```

```
--
```

```
-- Notifications
```

```
--
```

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

```
-- smfMIBNotifObjects
```

```
smfNotifAdminStatusChange NOTIFICATION-TYPE
```

```
  OBJECTS { smfCfgRouterIDAddrType, -- The originator of
            smfCfgRouterID,         -- the notification.
            smfCfgAdminStatus       -- The originator of
            }                       -- the notification.
            -- The new status of the
            -- SMF process.
```

```
  STATUS current
```

```
  DESCRIPTION
```

```
    "smfCfgAdminStatusChange is a notification sent when a
     the 'smfCfgAdminStatus' object changes."
```

```
 ::= { smfMIBNotifObjects 1 }
```

```
smfNotifConfiguredOpModeChange NOTIFICATION-TYPE
```

```
  OBJECTS { smfCfgRouterIDAddrType, -- The originator of
            smfCfgRouterID,         -- the notification.
            smfCfgOperationalMode   -- The originator of
            }                       -- the notification.
            -- The new Operations
            -- Mode of the SMF
```

```

-- process.
    }
STATUS      current
DESCRIPTION
    "smfNotifConfiguredOpModeChange is a notification
    sent when the 'smfCfgOperationalMode' object
    changes."
 ::= { smfMIBNotifObjects 2 }

smfNotifIfAdminStatusChange NOTIFICATION-TYPE
OBJECTS { smfCfgRouterIDAddrType, -- The originator of
          smfCfgRouterID,         -- the notification.
          ifName,                 -- The originator of
          smfCfgIfAdminStatus     -- the notification.
          }
STATUS      current
DESCRIPTION
    "smfCfgIfAdminStatusChange is a notification sent when a
    the 'smfCfgIfAdminStatus' object changes."
 ::= { smfMIBNotifObjects 3 }

smfNotifDpdMemoryOverflowEvent NOTIFICATION-TYPE
OBJECTS { smfCfgRouterIDAddrType, -- The originator of
          smfCfgRouterID,         -- the notification.
          smfStateDpdMemoryOverflow -- The counter of
          }
STATUS      current
DESCRIPTION
    "smfNotifDpdMemoryOverflowEvents is sent when the
    number of memory overflow events exceeds the
    the 'smfNotifDpdMemoryOverflowThreshold' within the
    previous number of seconds defined by the
    'smfNotifDpdMemoryOverflowWindow'."
 ::= { smfMIBNotifObjects 4 }

-- smfMIBNotifControl
smfNotifDpdMemoryOverflowThreshold OBJECT-TYPE
SYNTAX      Integer32 (0..255)
UNITS       "Events"

```

```

MAX-ACCESS    read-write
STATUS        current
DESCRIPTION
    "A threshold value for the
    'smfNotifDpdmemoryOverflowEvents' object.
    If the number of occurrences exceeds
    this threshold within the previous
    number of seconds
    'smfNotifDpdMemoryOverflowWindow',
    then the 'smfNotifDpdMemoryOverflowEvent'
    notification is sent.

    The default value for this object is
    '1'."
DEFVAL { 1 }
 ::= { smfMIBNotifControl 1 }

```

```

smfNotifDpdMemoryOverflowWindow OBJECT-TYPE
    SYNTAX      TimeTicks
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "A time window value for the
        'smfNotifDpdmemoryOverflowEvents' object.
        If the number of occurrences exceeds
        the 'smfNotifDpdMemoryOverflowThreshold'
        within the previous number of seconds
        'smfNotifDpdMemoryOverflowWindow',
        then the 'smfNotifDpdMemoryOverflowEvent'
        notification is sent.

        The default value for this object is
        '1'."
    DEFVAL { 1 }
    ::= { smfMIBNotifControl 2 }

```

```

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

smfConfigObjectsGroup OBJECT-GROUP
OBJECTS {
    smfCfgAdminStatus,
    smfCfgSmfSysUpTime,
    smfCfgRouterIDAddrType,
    smfCfgRouterID,
    smfCfgOperationalMode,
    smfCfgRssaMember,
    smfCfgIpv4Dpd,
    smfCfgIpv6Dpd,
    smfCfgMaxPktLifetime,
    smfCfgDpdEntryMaxLifetime,

```

```
        smfCfgNhdpRssaMesgTLVIncluded,
        smfCfgNhdpRssaAddrBlockTLVIncluded,

        smfCfgAddrForwardingGroupName,
        smfCfgAddrForwardingAddrType,
        smfCfgAddrForwardingAddress,
        smfCfgAddrForwardingAddrPrefixLength,
        smfCfgAddrForwardingStatus,

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

smfStateObjectsGroup OBJECT-GROUP
    OBJECTS {
        smfStateNodeRsStatusIncluded,
        smfStateDpdMemoryOverflow,

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

smfPerfObjectsGroup OBJECT-GROUP
    OBJECTS {
        smfPerfIpv4MultiPktsRecvTotal,
        smfPerfIpv4MultiPktsForwardedTotal,
        smfPerfIpv4DuplMultiPktsDetectedTotal,
        smfPerfIpv4DroppedMultiPktsTTLExceededTotal,
        smfPerfIpv4TTLLargerThanPreviousTotal,

        smfPerfIpv6MultiPktsRecvTotal,
        smfPerfIpv6MultiPktsForwardedTotal,
        smfPerfIpv6DuplMultiPktsDetectedTotal,
        smfPerfIpv6DroppedMultiPktsTTLExceededTotal,
        smfPerfIpv6TTLLargerThanPreviousTotal,
        smfPerfIpv6HAVAssistsReqdTotal,
        smfPerfIpv6DpdHeaderInsertionsTotal,
```

```
        smfPerfIpv4MultiPktsRecvPerIf,
        smfPerfIpv4MultiPktsForwardedPerIf,
        smfPerfIpv4DuplMultiPktsDetectedPerIf,
        smfPerfIpv4DroppedMultiPktsTTLExceededPerIf,
        smfPerfIpv4TTLLargerThanPreviousPerIf,

        smfPerfIpv6MultiPktsRecvPerIf,
        smfPerfIpv6MultiPktsForwardedPerIf,
        smfPerfIpv6DuplMultiPktsDetectedPerIf,
        smfPerfIpv6DroppedMultiPktsTTLExceededPerIf,
        smfPerfIpv6TTLLargerThanPreviousPerIf,
        smfPerfIpv6HAVAssistsReqdPerIf,
        smfPerfIpv6DpdHeaderInsertionsPerIf
    }
    STATUS current
    DESCRIPTION
        "Set of SMF performance objects implemented
        in this module by total and per interface."
 ::= { smfMIBGroups 4 }

smfNotifObjectsGroup OBJECT-GROUP
    OBJECTS {
        smfNotifDpdMemoryOverflowThreshold,
        smfNotifDpdMemoryOverflowWindow
    }
    STATUS current
    DESCRIPTION
        "Set of SMF notification control
        objects implemented in this module."
 ::= { smfMIBGroups 5 }

smfNotificationsGroup NOTIFICATION-GROUP
    NOTIFICATIONS {
        smfNotifAdminStatusChange,
        smfNotifConfiguredOpModeChange,
        smfNotifIfAdminStatusChange,
        smfNotifDpdMemoryOverflowEvent
    }
    STATUS current
    DESCRIPTION
        "Set of SMF notifications implemented
        in this module."
 ::= { smfMIBGroups 6 }

END
```

8. IANA-SMF-MIB Definitions

This section contains the IANA-SMF-MIB module. This MIB module defines two textual conventions for which IANA SHOULD maintain and keep synchronized with the registry identified below within the IANAsmfOpModeIdTC and the IANAsmfRssaIdTC TEXTUAL-CONVENTIONS.

The IANAsmfOpModeIdTC defines an index that identifies through reference to a specific SMF operations mode. The index is an integer valued named-number enumeration consisting of an integer and label. IANA is to create and maintain this textual convention. Future assignments are made to anyone on a first come, first served basis. There is no substantive review of the request, other than to ensure that it is well-formed and does not duplicate an existing assignment. However, requests must include a minimal amount of clerical information, such as a point of contact (including an email address) and a brief description of the method being identified as a new SMF operations mode.

The IANAsmfRssaIdTC defines an index that identifies through reference to a specific Reduced Set Selection Algorithm (RSSA). The index is an integer valued named-number enumeration consisting of an integer and label. IANA is to create and maintain this textual convention.

Future assignments to the IANAsmfRssaIdTC for the index range 5-127 require an RFC publication (either as an IETF submission or as an RFC Editor Independent submission [RFC3932]). The type of RFC MUST be Standards Track. The specific RSSA algorithms MUST be documented in sufficient detail so that interoperability between independent implementations is possible.

Future assignments to the IANAsmfRssaIdTC for the index range 128-239 are private or local use only, with the type and purpose defined by the local site. No attempt is made to prevent multiple sites from using the same value in different (and incompatible) ways. There is no need for IANA to review such assignments (since IANA will not record these) and assignments are not generally useful for broad interoperability. It is the responsibility of the sites making use of the Private Use range to ensure that no conflicts occur (within the intended scope of use).

Future assignments to the IANAsmfRssaIdTC for the index range 240-255 are to facilitate experimentation. These require an RFC publication (either as an IETF submission or as an RFC Editor Independent submission [RFC3932]). The type of RFC MUST be Experimental. The RSSA algorithms MUST be documented in sufficient detail so that interoperability between independent implementations is possible.

IANA-SMF-MIB DEFINITIONS ::= BEGIN

IMPORTS

MODULE-IDENTITY, mib-2
FROM SNMPv2-SMI
TEXTUAL-CONVENTION
FROM SNMPv2-TC;

ianaSmfMIB MODULE-IDENTITY

LAST-UPDATED "201407301300Z" -- July 30, 2014
ORGANIZATION "IANA"
CONTACT-INFO "Internet Assigned Numbers Authority

Postal: ICANN
4676 Admiralty Way, Suite 330
Marina del Rey, CA 90292

Tel: +1 310 823 9358
E-Mail: iana@iana.org"

DESCRIPTION "This MIB module defines the
IANAsmfOpModeIdTC and IANAsmfRssaIdTC
Textual Conventions, and thus the
enumerated values of the
smfCapabilitiesOpModeID and
smfCapabilitiesRssaID objects defined
in the SMF-MIB."
REVISION "201407301300Z" -- July 30, 2014
DESCRIPTION "Initial version of this MIB as published in
RFC KKKK."
 ::= { mib-2 kkkk }

IANAsmfOpModeIdTC ::= 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 currently
identified:

Independent operation 'independent(1)' -
SMF performs its own relay
set selection using information from an associated
MANET NHDP process.

CDS-aware unicast routing operation 'routing(2) '-
a coexistent unicast routing
protocol provides dynamic relay

set state based upon its own control plane
CDS or neighborhood discovery information.

Cross-layer operation 'crossLayer(3)' -
SMF operates using neighborhood
status and triggers from a
cross-layer information base for dynamic relay
set selection and maintenance.

IANA MUST update this textual convention accordingly.

The definition of this textual convention with the
addition of newly assigned values is published
periodically by the IANA, in either the Assigned
Numbers RFC, or some derivative of it specific to
Internet Network Management number assignments. (The
latest arrangements can be obtained by contacting the
IANA.)

Requests for new values SHOULD be made to IANA via
email (iana@iana.org)."

REFERENCE

"See Section 7.2. 'Reduced Relay Set Forwarding',
and the Appendices A, B and C in
RFC 6621 - Simplified Multicast Forwarding
(SMF), Macker, J., May 2012."

SYNTAX INTEGER {
 independent (1),
 routing (2),
 crossLayer (3)
 -- future (4-255)
}

IANAsmfRssaIdTC ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"An index that identifies through reference to a specific
RSSA algorithms. Several are currently defined
in the Appendix A, B and C of RFC 6621.

Examples of RSSA algorithms already identified within
this TC are:

Classical Flooding (cF(1)) - is the standard
flooding algorithm where each node in the next
retransmits the information on each of its interfaces.

Source-Based Multipoint Relay (sMPR(2)) -
 this algorithm is used by Optimized Link State Routing (OLSR) and OLSR version 2 (OLSRv2) protocols for the relay of link state updates and other control information [RFC3626]. Since each router picks its neighboring relays independently, sMPR forwarders depend upon previous hop information (e.g., source MAC address) to operate correctly.

Extended Connected Dominating Set (eCDS(3)) -
 defined in [RFC5614] this algorithm forms a single CDS mesh for the SMF operating region. Its packet-forwarding rules are not dependent upon previous hop knowledge in contrast to sMPR.

Multipoint Relay Connected Dominating Set (mprCDS(4)) -
 This algorithm is an extension to the basic sMPR election algorithm that results in a shared (non-source-specific) SMF CDS. Thus, its forwarding rules are not dependent upon previous hop information, similar to eCDS.

IANA MUST update this textual convention accordingly.

The definition of this textual convention with the addition of newly assigned values is published periodically by the IANA, in either the Assigned Numbers RFC, or some derivative of it specific to Internet Network Management number assignments. (The latest arrangements can be obtained by contacting the IANA.)

Requests for new values SHOULD be made to IANA via email (iana@iana.org)."

REFERENCE

"See, e.g.,

Section 8.1.1. 'SMF Message TLV Type',
 Appendix A. 'Essential Connecting Dominating Set (E-CDS) Algorithm',
 Appendix B. 'Source-Based Multipoint Relay (S-MPR) Algorithm', and
 Appendix C. 'Multipoint Relay Connected Dominating Set (MPR-CDS) Algorithm'

in RFC 6621 - Simplified Multicast Forwarding (SMF), Macker, J., May 2012."

SYNTAX INTEGER {

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

END

9. 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 'smfCfgAdminStatus' - 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 'smfCfgRouterIDAddrType' and 'smfCfgRouterID' - 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 smfCfgRouterID is a logical identification that MUST be configured as unique 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 smfCfgRouterID MUST be unique within the scope of the operating MANET network regardless of the method used for selecting it. If these objects are mis-configured or configured in-consistently across the MANET, then the ability of various RSSA algorithms, e.g., ECDS, may be compromised. This would potentially result in some routers within the MANET not receiving multicast packets destined to them. Hence, intentionally mis-configuring these objects could pose a form of Denial-of-Service (DOS) attack against the MANET.

- o 'smfCfgOpMode' - this writable configuration object defines the operational mode of the SMF process. The operational mode defines how the SMF process receives its data to form its local estimate of the CDS. It is recommended that the value for this object be set consistently across the MANET to ensure proper operation of the multicast packet forwarding. If the value for this object is set inconsistently across the MANET, the result may be that multicast packet delivery will be compromised within the MANET. Hence, intentionally mis-configuring this object could pose a form DOS attack against the MANET.
- o 'smfCfgRssa' - 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 likely fail. Hence, intentionally mis-configuring this object could pose a form DOS attack against the MANET.
- o 'smfCfgRssaMember' - 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 'smfCfgIpv4Dpd' - this writable configuration object sets the duplicate packet detection method, i.e., H-DPD or I-DPD, for forwarding of IPv4 multicast packets. Forwarders may operate with mixed H-DPD and I-DPD modes as long as they consistently perform the appropriate DPD routines outlined [RFC6621]. However, it is RECOMMENDED that a deployment be configured with a common mode for operational consistency.
- o 'smfCfgIpv6Dpd' - this writable configuration object sets the duplicate packet detection method for forwarding of IPv6 multicast packets. Since IPv6 SMF does specifies an option header, the interoperability constraints are not as loose as in the IPv4 version, and forwarders SHOULD not operate with mixed H-DPD and I-DPD modes. Hence the value for this object SHOULD be consistently set within the forwarders comprising the MANET, else inconsistent forwarding may result unnecessary multicast packet dropping.
- o 'smfCfgMaxPktLifetime' - 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. This could serve as a form of DOS attack if this object value is set too small.

- o 'smfCfgDpdEntryMaxLifetime' - 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 MaxLifetime being exceeded, the local SMF devices should purge the oldest records first. If this object value is set too small, then the effectiveness of the SMF DPD algorithms may become greatly diminished causing a higher than necessary packet load on the MANET.
- o 'smfCfgNhdpRssaMesgTLVIncluded' - this writable configuration object indicates whether the associated NHDP messages include the RSSA Message TLV, or not. It is highly RECOMMENDED that this object be set to 'true(1)' when the SMF operation mode is set to independent as this information will inform the local forwarder of the RSSA algorithm implemented in neighboring forwarders and is used to ensure consistent forwarding across the MANET. While it is possible that SMF neighbors MAY be configured differently with respect to the RSSA algorithm and still operate cooperatively, but these cases will vary dependent upon the algorithm types designated and this situation SHOULD be avoided.
- o 'smfCfgNhdpRssaAddrBlockTLVIncluded' - this writable configuration object indicates whether the associated NHDP messages include 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)' as this TLV enables CDS relay algorithm operation and configuration to be shared among 2-hop neighborhoods. Some relay algorithms require 2-hop neighbor configuration in order to correctly select relay sets.
- o 'smfCfgAddrForwardingTable' - the writable configuration objects in this table indicate which multicast IP addresses are to be forwarded by this SMF node. Misconfiguration of rows within this table can limit the ability of this SMF device to properly forward multicast data.
- o 'smfCfgInterfaceTable' - 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 properly 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 'smfStateNeighborTable' - 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 module 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.

10. Applicability Statement

This document describes objects for configuring parameters of the Simplified Multicast Forwarding [RFC6621] process on a Mobile Ad-Hoc Network (MANET) router. This MIB module, denoted SMF-MIB, also reports state and performance information and notifications. This section 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 MANET 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 Relay Set Selection Algorithms (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. The set of interesting configuration objects for the SMF process are listed within this MIB module.
- 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 fixed 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.

Here we provide an example of the simplest of configurations to establish an operational multicast forwarding capability in a MANET. This discussion only identifies the configuration necessary through the SMF-MIB module and assumes that other configuration has occurred. Assume that the MANET is to support only IPv4 addressing and that the MANET nodes are to be configured in the context of the Parking Lot Initialization case above. Then the SMF-MIB module defines ten configuration OIDs and two configuration tables, i.e., the `smfCfgAddrForwardingTable` and the `smfCfgInterfaceTable`. Of the ten

OIDs defined, all but one, i.e., the smfCfgRouterID, have DEFVAL clauses which allow for a functional configuration of the SMF process within the MANET. The smfCfgRouterIDType defaults to 'ipv4' so the smfCfgRouterID can be set as, e.g. (assuming the use of the Net-SNMP toolkit),:

```
snmpset [options] <smfCfgRouterID_OID>.0 a 192.168.1.100
```

If the smfCfgAddrForwardingTable is left empty, then the SMF local forwarder will forward all multicast addresses. So this table does not require configuration if you want to have the MANET forward all multicast addresses.

All that remains is to configure at least one row in the smfCfgInterfaceTable. Assume that the node has a wireless interface with an <ifName>='wlan0' and an <ifIndex>='1'. All of the objects in the rows of the smfCfgInterfaceTable have a DEFVAL clause, hence only the RowStatus object needs to be set. So the SMF process will be activated on the 'wlan0' interface by the following network manager snmpset command:

```
snmpset [options] <smfCfgIfRowStatus>.1 i active(1)
```

At this point, the configured forwarder will begin a Classical Flooding algorithm to forward all multicast addresses IPv4 packets it receives.

To provide a more efficient multicast forwarding within the MANET, the network manager could walk the smfCapabilitiesTable to identify other SMF operational modes, e.g.,:

```
snmpwalk [options] <smfCapabilitiesTable>
```

```
SMF-MIB::smfCapabilitiesIndex.1 = INTEGER: 1
```

```
SMF-MIB::smfCapabilitiesIndex.2 = INTEGER: 2
```

```
SMF-MIB::smfCapabilitiesOpModeID.1 = INTEGER: cfOnly(1)
```

```
SMF-MIB::smfCapabilitiesOpModeID.2 = INTEGER: independent(2)
```

```
SMF-MIB::smfCapabilitiesRssaID.1 = INTEGER: cF(1)
```

```
SMF-MIB::smfCapabilitiesRssaID.2 = INTEGER: eCDS(3)
```

In this example, the forwarding device also supports the Extended Connected Dominating Set (eCDS) RSSA with the forwarder in the 'independent(2)' operational mode. If the network manager were to

then issue an snmpset, e.g.,:

```
snmpset [options] <smfCfgOperationalMode>.0 i 2
```

then the local forwarder would switch if forwarding behavior from Classical Flooding to the more efficient eCDS flooding.

11. IANA Considerations

This document defines two MIB modules:

- o SMF-MIB is defined in Section 7 and is an experimental MIB module.
- o IANA-SMF-MIB is defined in Section 8 and is an IANA MIB module that IANA is requested to maintain.

Thus, there are three actions requested of IANA:

1. IANA is requested to allocate an OBJECT IDENTIFIER value and record it in the SMI Numbers registry in the sub-registry called "SMI Experimental Codes" under the experimental branch (1.3.6.1.3).

Decimal	Name	Description	Reference
xxxx	smfMib	SMF-MIB	[This.I-D]

[RFC Editor Note: Please replace the tag "xxxx" in this document with the value assigned by IANA and remove this note.]

2. IANA is requested to allocate an OBJECT IDENTIFIER value and record it in the SMI Numbers registry in the sub-registry called "SMI Network Management MGMT Codes Internet-standard MIB" under the mib-2 branch (1.3.6.1.2.1).

Decimal	Name	Description	Reference
kkkk	ianaSmfMIB	IANA-SMF-MIB	[This.I-D]

[RFC Editor Note: Please replace the tag "kkkk" in this document with the value assigned by IANA and remove this note.]

3. IANA is requested to maintain a MIB module called ianaSmfMIB and populate it with the initial MIB module defined in Section 8 of this document by creating a new entry in the registry "IANA Maintained MIBs" called "IANA-SMF-MIB".

12. 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.

13. 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 Adrian Farrel, Dan Romascanu, Juergen Schoenwaelder, Stephen Hanna, and Brian Haberman for their careful review of this document and their insightful comments. We also wish to thank the entire MANET WG for many reviews of this document. Further 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, Ryan Morgan and Justin Dean on their software development of the SMF-MIB.

14. References

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14.2. Informative References

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Appendix A.

```

*****
* Note to the RFC Editor (to be removed prior to publication) *
*
* 1) The reference to RFCXXXX throughout this document point *
* to the current draft-ietf-manet-smf-xx.txt. This needs *
* to be replaced with the XXXX RFC number for the SMF *
* publication. *
*
* 2) This document also contains the IANA-SMF-MIB module *
* which is defined by this specification above. IANA should *
* take over the IANA-SMF-MIB and keep it synchronized with *
* the registries identified within the contained *
* IANAsmfOpModeIdTC and IANAsmfRssaIdTC TEXTUAL-CONVENTIONS. *
*
*****

```

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