Definition of Managed Objects for the Mobile Ad Hoc Network (MANET)
Simplified Multicast Framework Relay Set Process

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.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for examination, experimental implementation, and evaluation.

This document defines an Experimental Protocol for the Internet community. This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Not all documents approved by the IESG are a candidate for any level of Internet Standard; see Section 2 of RFC 5741.

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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", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

4. Overview

SMF provides methods for implementing DPD-based multicast forwarding with the optional use of CDS-based relay sets. The CDS provides a complete connected coverage of the nodes comprising the MANET. The MCDS is the smallest set of MANET nodes (comprising a connected cluster) that 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 that 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 acquired from the MANET Neighborhood Discovery Protocol (NHDP), from the specific MANET routing protocol running on the node, or from Layer 2 information passed up to the higher layer protocol processes.

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

Figure 1: SMF Router Architecture

The asterisks (*) mark the primitives and relationships needed by relay set algorithms requiring previous-hop packet-forwarding knowledge.
4.2. Terms

The following definitions apply throughout this document:

Configuration Objects: switches, tables, and objects that are initialized to default settings or set through the management interfaces such as defined by this MIB module.

Tunable Configuration Objects: objects whose values affect timing or attempt bounds on the SMF Relay Set (RS) process.

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

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

5. Structure of the MIB Module

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

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

- 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 that help to characterize the performance of the SMF process, typically counters for statistical computations.

- 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:

- 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:

- The IANAsmfOpModeIdTC represents an index that identifies a specific SMF operational mode. This Textual Convention is maintained by IANA in the IANA-SMF-MIB.

- 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 that the device can advertise is as follows:

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

- 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:

- Operational Mode - determines from where topology information is derived, e.g., NHDP, CDS-aware unicast routing, or Cross-layer from Layer 2.

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

- Duplicate Packet detection for IPv4 - Identification-based or Hash-based DPD (I-DPD or H-DPD, respectively).

- 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, for example,

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 primarily reports counters that relate to SMF RSSA performance. The SMF performance counters consist 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 that record data related to:

- configuration and operation of packet forwarding on the local router,
- configuration and operation of local MANET interfaces on the router, and
- configuration and operation of various RSSAs for packet forwarding.

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

- smfCapabilitiesIndex - the index identifying the combination of SMF mode and SMF RSSA available on this device.
- smfCfgAddrForwardingIndex - the index to configured multicast address lists that are forwarded by the SMF process.
- smfCfgIfIndex - the IfIndex of the interface on the local router on which SMF is configured.
- smfStateNeighborIpAddrType, smfStateNeighborIpAddr, and smfStateNeighborPrefixLen - the interface index set of specific one-hop neighbor nodes to this local router.

These tables and their associated indexing are defined in the SMF-MIB module:

- smfCapabilitiesTable - identifies the resident set of (SMF Operational Modes, SMF RSSA algorithms) available on this router. This table has ‘INDEX { smfCapabilitiesIndex }’.
- smfCfgAddrForwardingTable - contains information on multicast addresses that are to be forwarded by the SMF process on this device. This table has ‘INDEX { smfCfgAddrForwardingIndex }’.
- 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 IP Multicast MIB module in RFC 5132 [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 coexist 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 multicast mechanisms that are IP route based. 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 objects imported for use in the SMF-MIB module are as follows. The MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE, Counter32, Integer32, TimeTicks and experimental macros are imported from RFC 2578 [RFC2578]. The TEXTUAL-CONVENTION, RowStatus, and TruthValue macros are imported from RFC 2579 [RFC2579]. The MODULE-COMPLIANCE, OBJECT-GROUP, and NOTIFICATION-GROUP macros are imported from RFC 2580 [RFC2580]. The InterfaceIndexOrZero and ifName textual conventions are 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 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 -- RFC 2578

TEXTUAL-CONVENTION, RowStatus, TruthValue
FROM SNMPv2-TC -- RFC 2579
MODULE-COMPLIANCE, OBJECT-GROUP,
NOTIFICATION-GROUP
FROM SNMPv2-CONF -- RFC 2580

InterfaceIndexOrZero, ifName
FROM IF-MIB -- RFC 2863

SnmpAdminString
FROM SNMP-FRAMEWORK-MIB -- RFC 3411

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

IANAsmfOpModeIdTC,
IANAsmfRssaIdTC
FROM IANA-SMF-MIB
;

smfMIB MODULE-IDENTITY
LAST-UPDATED "201410100000Z" -- October 10, 2014
ORGANIZATION "IETF MANET Working Group"
CONTACT-INFO
"WG EMail: manet@ietf.org

WG Chairs: sratliff@cisco.com
jmacker@nrl.navy.mil

Editors: Robert G. Cole
US Army CERDEC
6010 Frankford Road
Aberdeen Proving Ground, MD 21005
USA
Phone: +1 443 395-8744
EMail: robert.g.cole@us.army.mil

Joseph Macker
Naval Research Laboratory
Washington, D.C. 20375
USA
EMail: macker@itd.nrl.navy.mil

Brian Adamson
Naval Research Laboratory
Washington, D.C. 20375
USA
EMail: adamson@itd.nrl.navy.mil"
DESCRIPTION

“This MIB module contains managed object definitions for
the MANET SMF RSSA process defined in:

Macker, J., Ed., Simplified Multicast Forwarding, RFC 6621,
May 2012.

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Relating to IETF Documents
(http://trustee.ietf.org/license-info)."

-- Revision History
REVISION "201410100000Z" -- October 10, 2014
DESCRIPTION

"The first version of this MIB module,
published as RFC 7367.
"

::= { experimental 126 }

--

-- TEXTUAL CONVENTIONS
--

SmfStatus ::= TEXTUAL-CONVENTION
STATUS current
DESCRIPTION

"An indication of the operability of an 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’,
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   IANA smfOpModeIdTC,
   smfCapabilitiesRssaID     IANA smfRssaIdTC
}

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
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      IANA smfOpModeIdTC
 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
"For example, see Section 8.1.1 'SMF Message TLV Type',
and the Appendices A, B, and C in
RFC 6621 - 'Simplified Multicast Forwarding',
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)' means 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 the 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 }
The SMF-MIB                  October 2014

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. An 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
"For example, see Appendix A.1 ‘E-CDS Relay Set Selection Overview’ and Appendix C.1 ‘MPR-CDS Relay Set Selection Overview’ in RFC 6621 - ‘Simplified Multicast Forwarding’, Macker, J., Ed., 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 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


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 to 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

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 router’s 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

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’,
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’,
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',
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 or not the associated NHDP messages include the RSSA Message TLV. 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',
smfCfgNhdpRssaAddrBlockTLVIncluded OBJECT-TYPE
SYNTAX      TruthValue
MAX-ACCESS  read-write
STATUS      current

DESCRIPTION
"Indicates whether or not the associated NHDP
messages include the RSSA Address Block TLV.
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 that 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’,

DEFVAL { true }
::= { smfConfigurationGroup 12 }
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 that may be used for multicast transport (through SMF broadcast) depending upon the MANET dynamics and other factors regarding the MANET subnet. Further, they may coexist 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 multicast mechanisms that are IP route based. 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 that 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 that 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

::= { 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 a 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 that, 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 that, 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 the 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

::= { smfConfigurationGroup 14 }
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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. Kastenholtz, 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.

If this object is not equal to ‘enabled’, all associated entries in the ‘smfPerfIpv4InterfacePerfTable’ and the ‘smfPerfIpv6InterfacePerfTable’ MUST be deleted.

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 value of the ‘smfCfgIfAdminStatus’ object transitions to ‘enabled’ from either a prior value of ‘disabled’ or upon initialization of this interface or this device."
::= { 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, 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.

::= { 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."
::= { 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 has 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

::= { 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 8 'SMF Neighborhood Discovery' and Section 8.1. 'SMF Relay Algorithm TLV Types' in RFC 6621 - 'Simplified Multicast Forwarding', Macker, J., Ed., 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              IANAasmfRssaIdTC,
        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 }

smfStateNeighborIpAddr  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.
::= { 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 that 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 in RFC 4293.
-- Exactly how to integrate SMF packet handling and
-- management into the standard IP-MIB module management
-- is 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 has 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 has 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 has 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


::= { 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 Time to Live (TTL) exceeded.

There is the potential for a counter discontinuity in this object if the system SMF process has 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


::= { smfPerfGobalGroup 4 }

smfPerfIpv4TTLLargeThanPreviousTotal OBJECT-TYPE
SYNTAX Counter32
UNITS "Packets"
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"A counter of the total number of IPv4 packets received that 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 has 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

::= { 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 has 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 has 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 has 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',

::= { 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 has 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',

::= { smfPerfGobalGroup 9 }
smfPerfIpv6TTL LargerThanPreviousTotal OBJECT-TYPE
SYNTAX Counter32
UNITS "Packets"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"A counter of the total number of IPv6 packets received that 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 has 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
::= { smfPerfGobalGroup 10 }

smfPerfIpv6HAVAssistsReqdT otal OBJECT-TYPE
SYNTAX Counter32
UNITS "Packets"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"A counter of the total number of IPv6 packets received that required the Hash Assist Value (HAV) for DPD.

There is the potential for a counter discontinuity in this object if the system SMF process has 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
::= { 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 received that the device inserted the DPD header option.

There is the potential for a counter discontinuity in this object if the system SMF process has 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
::= { 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 has 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 has 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 has 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 has 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 that 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 has 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,
   smfPerfIpv6Dup1MultiPktsDetectedPerIf       Counter32,
   smfPerfIpv6DroppedMultiPktsTTLExceededPerIf Counter32,
   smfPerfIpv6TTLLargerThanPreviousPerIf       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 has 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."

::= { smfPerfIpxInterfacePerfEntry 1 }

smfPerfIpxMultiPktsForwardedPerIf 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 has 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."

::= { smfPerfIpxInterfacePerfEntry 2 }

smfPerfIpxDupIPktsDetectedPerIf 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 has 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 has 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 that 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 has 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 that required the
HAV assist for DPD.

There is the potential for a counter discontinuity
in this object if the system SMF process has 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 that the device inserted the
DPD header option.

There is the potential for a counter discontinuity
in this object if the system SMF process has 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 originator of
         smfCfgAdminStatus -- The new status of the
      }
STATUS current
DESCRIPTION
"smfCfgAdminStatusChange is a notification sent when
the 'smfCfgAdminStatus' object changes."
::= { smfMIBNotifObjects 1 }

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

smfNotifDpdMemoryOverflowEvent NOTIFICATION-TYPE
OBJECTS { smfCfgRouterIDAddrType, -- The originator of
smfNotifDpdMemoryOverflowEvents is sent when the number of memory overflow events exceeds 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,
  smfCfgRouterIDAaddrType,
  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
::= { smfMIBGroups 3 }

smfPerfObjectsGroup OBJECT-GROUP
  OBJECTS {
    smfPerfIpv4MultiPktsRecvTotal,
    smfPerfIpv4MultiPktsForwardedTotal,
    smfPerfIpv4DuplMultiPktsDetectedTotal,
    smfPerfIpv4DroppedMultiPktsTTLExceededTotal,
    smfPerfIpv4TTLLargerThanPreviousTotal,
    
    smfPerfIpv6MultiPktsRecvTotal,
    smfPerfIpv6MultiPktsForwardedTotal,
    smfPerfIpv6DuplMultiPktsDetectedTotal,
    smfPerfIpv6DroppedMultiPktsTTLExceededTotal,
    smfPerfIpv6TTLLargerThanPreviousTotal,
    smfPerfIpv6HAVAssistsReqdTotal,
    smfPerfIpv6DpdHeaderInsertionsTotal,
    
    smfPerfIpv4MultiPktsRecvPerIf,
    smfPerfIpv4MultiPktsForwardedPerIf,
    smfPerfIpv4DuplMultiPktsDetectedPerIf,
    smfPerfIpv4DroppedMultiPktsTTLExceededPerIf,
    smfPerfIpv4TTLLargerThanPreviousPerIf,
    smfPerfIpv4HAVAssistsReqdPerIf,
    smfPerfIpv4DpdHeaderInsertionsPerIf,
    
    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 Independent submission [RFC5742]). The category of RFC MUST be Standards Track. The specific RSSAs 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 Independent submission [RFC5742]). The category of RFC MUST be Experimental. The RSSA algorithms MUST be documented in sufficient detail so that interoperability between independent implementations is possible.

This MIB module references [RFC3626], [RFC5614], [RFC6621], and [RFC7181].

IANA-SMF-MIB DEFINITIONS ::= BEGIN

IMPORTS
MODULE-IDENTITY, mib-2
FROM SNMPv2-SMI -- RFC 2578
TEXTUAL-CONVENTION
FROM SNMPv2-TC; -- RFC 2579

ianaSmfMIB MODULE-IDENTITY
LAST-UPDATED "201410100000Z" -- October 10, 2014
ORGANIZATION "IANA"
CONTACT-INFO "Internet Assigned Numbers Authority
Postal: ICANN
12025 Waterfront Drive, Suite 300
Los Angeles, CA 90094-2536
United States
Tel: +1 310 301 5800
EMail: 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 "201410100000Z" -- October 10, 2014
DESCRIPTION

"Initial version of this MIB as published in RFC 7367.

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::= { mib-2 225 }

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 Connected Dominating Set (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 updated periodically by the IANA, in the IANA-maintained registries. (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


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

IANAsmfRssaIdTC ::= TEXTUAL-CONVENTION
STATUS current
DESCRIPTION
"An index that identifies through reference to specific RSSAs. Several are currently defined in the Appendices A, B, and C of RFC 6621.

Examples of RSSAs already identified within this Textual Convention (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 (RFC 3626, RFC 7181). Since each router picks its neighboring relays independently, sMPR forwarders depend upon previous hop information (e.g., source Media Access Control (MAC) address) to operate correctly.

Essential Connected Dominating Set (eCDS(3)) - defined in RFC 5614, 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 updated periodically by the IANA, in the IANA-maintained registries. (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
"For example, see:

Section 8.1.1. ‘SMF Message TLV Type’ and the Appendices A, B, and C in
RFC 6621 - ‘Simplified Multicast Forwarding’,


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:

- '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.

- '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 interoperating 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 misconfigured or configured inconsistently across the MANET, then the ability of various RSSAs, 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 misconfiguring these objects could pose a form of Denial-of-Service (DoS) attack against the MANET.

- '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 misconfiguring this object could pose a form DoS attack against the MANET.
o ‘smfCfgRssa’ - this writable configuration object sets the specific RSSA for the SMF process. If this object is set inconsistently across the MANET domain, multicast delivery of data will likely fail. Hence, intentionally misconfiguring 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 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 in [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 the forwarding of IPv6 multicast packets. Since IPv6 SMF does specify 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.
RFC 7367                  The SMF-MIB                  October 2014

- `smfCfgNhdpRssaMesgTLVIncluded` - this writable configuration object indicates whether or not the associated NHDP messages include the RSSA Message TLV. 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 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 and still operate cooperatively, but these cases will vary dependent upon the algorithm types designated and this situation SHOULD be avoided.

- `smfCfgNhdpRssaAddrBlockTLVIncluded` - this writable configuration object indicates whether or not the associated NHDP messages include the RSSA Address Block TLV. The smfNhdpRssaAddrBlockTLVIncluded is optional in all cases as it depends on the existence of an address block that 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.

- `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.

- `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:

- `smfNodeRsStatusIncluded` - this readable state object indicates whether or not this SMF node is part of the CDS. Being part of the CDS makes this node a distinguished device. It could be exploited for data ex-filtration, or DoS 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 poses 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 SHOULD provide the security features described by the SNMPv3 framework (see [RFC3410]), and implementations claiming compliance to the SNMPv3 standard MUST include full support for authentication and privacy via the User-based Security Model (USM) [RFC3414] with the AES cipher algorithm [RFC3826]. Implementations MAY also provide support for the Transport Security Model (TSM) [RFC5591] in combination with a secure transport such as SSH [RFC5592] or TLS/DTLS [RFC6353].

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

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 is out of scope for this document.

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 is
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:

- 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 Operations 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.

- 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 that 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.

- 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 that 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 192.0.2.100
```
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, for example:

```
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 Essential
Connected Dominating Set (eCDS) RSSA with the forwarder in the
‘independent(2)’ operational mode. If the network manager were to
then issue an snmpset, for example:

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

then the local forwarder would switch its forwarding behavior from
Classical Flooding to the more efficient eCDS flooding.
11. IANA Considerations

This document defines two MIB modules:

1. SMF-MIB is defined in Section 7 and is an experimental MIB module.

2. IANA-SMF-MIB is defined in Section 8 and is an IANA MIB module that IANA maintains.

Thus, IANA has completed three actions:

IANA has allocated an OBJECT IDENTIFIER value and recorded it in the SMI Numbers registry in the subregistry called "SMI Experimental Codes" under the experimental branch (1.3.6.1.3).

<table>
<thead>
<tr>
<th>Decimal</th>
<th>Name</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>126</td>
<td>smfMib</td>
<td>SMF-MIB</td>
<td>[RFC7367]</td>
</tr>
</tbody>
</table>

IANA has allocated an OBJECT IDENTIFIER value and recorded it in the SMI Numbers registry in the subregistry called "SMI Network Management MGMT Codes Internet-standard MIB" under the mib-2 branch (1.3.6.1.2.1).

<table>
<thead>
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<th>Name</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>225</td>
<td>ianaSmfMIB</td>
<td>IANA-SMF-MIB</td>
<td>[RFC7367]</td>
</tr>
</tbody>
</table>

IANA maintains a MIB module called ianaSmfMIB and has populated 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. References

12.1. Normative References


12.2. Informative References


Cole, et al.                  Experimental                     [Page 64]
Acknowledgements

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Contributors

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Authors’ Addresses

Robert G. Cole
US Army CERDEC
6010 Frankford Road
Aberdeen Proving Ground, Maryland  21005
United States

Phone: +1 443 395 8744
EMail: robert.g.cole@us.army.mil

Joseph Macker
Naval Research Laboratory
Washington, D.C.  20375
United States

EMail: macker@itd.nrl.navy.mil

Brian Adamson
Naval Research Laboratory
Washington, D.C.  20375
United States

EMail: adamson@itd.nrl.navy.mil