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 defines objects for managing IPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs).

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols. In particular it defines objects for managing IPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs) [RFC4944].

2. The Internet-Standard Management Framework

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

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

3. Conventions

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

4. Overview

The LOWPAN-MIB module is primarily a collection of counters that reflect how 6LoWPAN datagrams are processed by the 6LoWPAN layer. The objects are defined twice, once to report the global statistics as seen by the 6LoWPAN layer and once to report per interface 6LoWPAN layer statistics. The per interface statistics are optional to implement. The object identifier registration tree has the following structure:

```
---- lowpanMIB(1.3.6.1.2.1.XXXX)
   +---- lowpanNotifications(0)
   +---- lowpanObjects(1)
       |   +----- lowpanStats(1)
       |       |   +--r- lowpanReasmTimeout(1) Unsigned32
       |       |   +--r- lowpanInReceives(2) Counter32
       |       |   +--r- lowpanInHdrErrors(3) Counter32
       |       |   +--r- lowpanInMeshReceives(4) Counter32
       |       |   +--r- lowpanInMeshForwds(5) Counter32
       |       |   +--r- lowpanInMeshDelivers(6) Counter32
```
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|    +-r- lowpanInReasmReqds(7)        Counter32
|    +-r- lowpanInReasmFails(8)         Counter32
|    +-r- lowpanInReasmOKs(9)           Counter32
|    +-r- lowpanInCompReqds(10)         Counter32
|    +-r- lowpanInCompFails(11)         Counter32
|    +-r- lowpanInCompOKs(12)           Counter32
|    +-r- lowpanInDiscards(13)          Counter32
|    +-r- lowpanInDelivers(14)          Counter32
|    +-r- lowpanInCompReqds(15)         Counter32
|    +-r- lowpanInCompFails(16)         Counter32
|    +-r- lowpanInCompOKs(17)           Counter32
|    +-r- lowpanInDiscards(18)          Counter32
|    +-r- lowpanOutRequests(19)         Counter32
|    +-r- lowpanOutCompReqds(20)        Counter32
|    +-r- lowpanOutCompFails(21)        Counter32
|    +-r- lowpanOutCompOKs(22)          Counter32
|    +-r- lowpanOutMeshHopLimitExceeds(23) Counter32
|    +-r- lowpanOutCompRequests(24)     Counter32
|    +-r- lowpanOutCompFails(25)        Counter32
|    +-r- lowpanOutCompOKs(26)          Counter32
|    +-r- lowpanOutFragReqds(27)        Counter32
|    +-r- lowpanOutFragFails(28)        Counter32
|    +-r- lowpanOutFragOKs(29)          Counter32
|    +-r- lowpanOutTransmits(30)        Counter32
|    +---- lowpanIfStatsTable(2)
|    |    +---- lowpanIfStatsEntry(1) [ifIndex]
|    |    |    +---- lowpanIfReasmTimeout(1)        Unsigned32
|    |    |    +---- lowpanIfInReceives(2)         Counter32
|    |    |    +---- lowpanIfInHdrErrors(3)        Counter32
|    |    |    +---- lowpanIfInMeshReceives(4)     Counter32
|    |    |    +---- lowpanIfInMeshForwds(5)       Counter32
|    |    |    +---- lowpanIfInMeshDelivers(6)     Counter32
|    |    |    +---- lowpanIfInReasmReqds(7)       Counter32
|    |    |    +---- lowpanIfInReasmFails(8)       Counter32
|    |    |    +---- lowpanIfInReasmOKs(9)         Counter32
|    |    |    +---- lowpanIfCompReqds(10)         Counter32
|    |    |    +---- lowpanIfCompFails(11)         Counter32
|    |    |    +---- lowpanIfCompOKs(12)           Counter32
|    |    |    +---- lowpanIfDiscards(13)          Counter32
|    |    |    +---- lowpanIfDelivers(14)         Counter32
|    |    |    +---- lowpanIfOutRequests(15)      Counter32
|    |    |    +---- lowpanIfOutCompReqds(16)      Counter32
|    |    |    +---- lowpanIfOutCompFails(17)      Counter32
|    |    |    +---- lowpanIfOutCompOKs(18)        Counter32
|    |    |    +---- lowpanIfOutFragReqds(19)      Counter32
|    |    |    +---- lowpanIfOutFragFails(20)      Counter32
|    |    |    +---- lowpanIfOutFragOKs(21)        Counter32
|    |    |    +---- lowpanIfOutMeshHopLimitExceeds(23) Counter32

The counters defined in the LOWPAN-MIB module provide information about the 6LoWPAN datagrams received and transmitted and how they are processed in the 6LoWPAN layer. For link-layers that use the 6LoWPAN dispatch byte as defined in [RFC4944] (e.g., IEEE 802.15.4), a 6LoWPAN datagram is a datagram with a dispatch byte matching the bit patterns 01xxxxxx, 10xxxxxx, or 11xxxxxx. Datagrams with a dispatch byte matching the bit pattern 00xxxxxx (NALP - not a LoWPAN frame) are not considered to be 6LoWPAN datagram by this specification. Other radio technologies may use different mechanisms to identify 6LoWPAN datagrams (e.g., the BLUETOOTH Low Energy Logical Link Control and Adaptation Protocol uses Channel Identifiers [I-D.ietf-6lo-btle]).

The following diagram illustrates the conceptual relationships between the counters.

```plaintext
+- r- lowpanIfOutMeshNoRoutes(24)  Counter32
+- r- lowpanIfOutMeshRequests(25)  Counter32
+- r- lowpanIfOutMeshForwds(26)    Counter32
+- r- lowpanIfOutMeshTransmits(27) Counter32
+- r- lowpanIfOutDiscards(28)      Counter32
+- r- lowpanIfOutTransmits(29)     Counter32

+--- lowpanConformance(2)
    +--- lowpanGroups(1)
    |    +--- lowpanStatsGroup(1)
    |    +--- lowpanStatsMeshGroup(2)
    |    +--- lowpanIfStatsGroup(3)
    |    +--- lowpanIfStatsMeshGroup(4)
    +--- lowpanCompliances(2)
        +--- lowpanCompliance(1)
```

The fragmentation related counters have been modeled after the fragmentation related counters of the IP-MIB [RFC4293]. The discard counters have been placed at the end of the input and output chains but they can be bumped any time if a datagram is discarded for a reason not covered by the other counters.

The compression related counters provide insights into compression requests and in particular also compression related failures. Note that the diagram is conceptual in the sense that compression happens after reassembly for incoming 6LoWPAN datagrams and compression happens before fragmentation for outgoing 6LoWPAN datagrams. Implementations may choose to implement things slightly differently. For example, implementations may decompress FRAG1 fragments as soon as they are received, not waiting for reassembly to complete.

The mesh header processing related counters do not have an explicit
discard counter. Implementations that do not support mesh forwarding MUST count the number of received 6LoWPAN datagrams with a MESH header (lowpanInMeshReceives) but they MUST NOT increment the lowpanInMeshReceives and lowpanInMeshDelivers counters if these 6LoWPAN datagrams are dropped.

5. Relationship to Other MIB Modules

The MIB module IMPORTS definitions from SNMPv2-SMI [RFC2578], SNMPv2-CONF [RFC2580], and IF-MIB [RFC2863].

6. Definitions

LOWPAN-MIB DEFINITIONS ::= BEGIN

IMPORTS
MODULE-IDENTITY, OBJECT-TYPE, Unsigned32, Counter32, mib-2
FROM SNMPv2-SMI -- RFC 2578
OBJECT-GROUP, MODULE-COMPLIANCE
FROM SNMPv2-CONF -- RFC 2580
ifIndex FROM IF-MIB; -- RFC 2863

lowpanMIB MODULE-IDENTITY
LAST-UPDATED "201404080000Z"
ORGANIZATION "Jacobs University Bremen"
CONTACT-INFO
"Juergen Schoenwaelder
Jacobs University Bremen
Email: j.schoenwaelder@jacobs-university.de

Anuj Sehgal
Jacobs University Bremen
Email: s.anuj@jacobs-university.de

Tina Tsou
Huawei Technologies
Email: tina.tsou.zouting@huawei.com

Cathy Zhou
Huawei Technologies
Email: cathyzhou@huawei.com"

DESCRIPTION
"The MIB module for monitoring nodes implementing the IPv6 over Low-Power Wireless Personal Area Networks (6LoWPAN) protocol."
lowpanReasmTimeout OBJECT-TYPE
SYNTAX   Unsigned32
UNITS     "seconds"
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
   "The maximum number of seconds that received fragments are
   held while they are awaiting reassembly at this entity."
::= { lowpanStats 1 }

lowpanInReceives OBJECT-TYPE
SYNTAX    Counter32
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
   "The total number of 6LoWPAN datagrams received, including
   those received in error."
::= { lowpanStats 2 }

lowpanInHdrErrors OBJECT-TYPE
SYNTAX    Counter32
MAX-ACCESS read-only
STATUS    current

DESCRIPTION
"The number of received 6LoWPAN datagrams discarded due to
errors in their headers, including unknown dispatch values."
::= { lowpanStats 3 }

lowpanInMeshReceives OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of received 6LoWPAN datagrams with a MESH
header."
::= { lowpanStats 4 }

lowpanInMeshForwds OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of received 6LoWPAN datagrams requiring MESH
forwarding."
::= { lowpanStats 5 }

lowpanInMeshDelivers OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of received 6LoWPAN datagrams with a MESH header
delivered to the local system."
::= { lowpanStats 6 }

lowpanInReasmReqds OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of received 6LoWPAN fragments that needed to
be reassembled. This includes both FRAG1 and FRAGN 6LoWPAN
datagrams."
::= { lowpanStats 7 }

lowpanInReasmFails OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of failures detected by the re-assembly
algorithm (e.g., timeouts). Note that this is not necessarily a count of discarded 6LoWPAN fragments since implementations can lose track of the number of fragments by combining them as received.

\[\text{lowpanInReasmOKs OBJECT-TYPE}\]
\[\text{SYNTAX Counter32}\]
\[\text{MAX-ACCESS read-only}\]
\[\text{STATUS current}\]
\[\text{DESCRIPTION} \]
"The number of IPv6 packets successfully reassembled."

\[\text{::=} \{ \text{lowpanStats 9} \} \]

\[\text{lowpanInCompReqds OBJECT-TYPE}\]
\[\text{SYNTAX Counter32}\]
\[\text{MAX-ACCESS read-only}\]
\[\text{STATUS current}\]
\[\text{DESCRIPTION} \]
"The number of 6LoWPAN datagrams requiring header decompression."

\[\text{::=} \{ \text{lowpanStats 10} \} \]

\[\text{lowpanInCompFails OBJECT-TYPE}\]
\[\text{SYNTAX Counter32}\]
\[\text{MAX-ACCESS read-only}\]
\[\text{STATUS current}\]
\[\text{DESCRIPTION} \]
"The number of 6LoWPAN datagrams where header decompression failed (e.g., because the necessary context information was not available)."

\[\text{::=} \{ \text{lowpanStats 11} \} \]

\[\text{lowpanInCompOKs OBJECT-TYPE}\]
\[\text{SYNTAX Counter32}\]
\[\text{MAX-ACCESS read-only}\]
\[\text{STATUS current}\]
\[\text{DESCRIPTION} \]
"The number of 6LoWPAN datagrams where header decompression was successful."

\[\text{::=} \{ \text{lowpanStats 12} \} \]

\[\text{lowpanInDiscards OBJECT-TYPE}\]
\[\text{SYNTAX Counter32}\]
\[\text{MAX-ACCESS read-only}\]
\[\text{STATUS current}\]
\[\text{DESCRIPTION} \]
"The number of received 6LoWPAN datagrams for which no..."
problems were encountered to prevent their continued processing, but were discarded (e.g., for lack of buffer space). Note that this counter does not include any datagrams discarded due to a reassembly failure or a compression failure."

```c
::= { lowpanStats 13 }
```

`lowpanInDelivers` OBJECT-TYPE

```c
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
    "The total number of IPv6 packets successfully delivered to the IPv6 layer."
```

```c
::= { lowpanStats 14 }
```

`lowpanOutRequests` OBJECT-TYPE

```c
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
    "The total number of IPv6 packets supplied by the IPv6 layer."
```

```c
::= { lowpanStats 15 }
```

`lowpanOutCompReqds` OBJECT-TYPE

```c
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
    "The total number of IPv6 packets for which header compression was attempted."
```

```c
::= { lowpanStats 16 }
```

`lowpanOutCompFails` OBJECT-TYPE

```c
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
    "The total number of IPv6 packets for which header compression failed."
```

```c
::= { lowpanStats 17 }
```

`lowpanOutCompOKs` OBJECT-TYPE

```c
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
```
"The total number of IPv6 packets for which header compression was successful."
::= { lowpanStats 18 }

lowpanOutFragReqds OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of IPv6 packets that required fragmentation in order to be transmitted."
::= { lowpanStats 19 }

lowpanOutFragFails OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of IPv6 packets that have been discarded because fragmentation failed."
::= { lowpanStats 20 }

lowpanOutFragOKs OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of IPv6 packets that have been successfully fragmented."
::= { lowpanStats 21 }

lowpanOutFragCreates OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of 6LoWPAN fragments that have been generated as a result of fragmentation. This includes both FRAG1 and FRAGN 6LoWPAN datagrams."
::= { lowpanStats 22 }

lowpanOutMeshHopLimitExceeds OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of 6LoWPAN datagrams with a MESH header that were dropped because the hop limit has been exceeded."
lowpanOutMeshNoRoutes OBJECT-TYPE
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
"The number of 6LoWPAN datagrams with a MESH header that
were dropped because there was no forwarding information
available."

lowpanOutMeshRequests OBJECT-TYPE
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
"The number of 6LoWPAN datagrams requiring MESH header
encapsulation."

lowpanOutMeshForwds OBJECT-TYPE
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
"The number of 6LoWPAN datagrams with a MESH header for
which suitable forwarding information was available."

lowpanOutMeshTransmits OBJECT-TYPE
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
"The number of 6LoWPAN datagrams with a MESH header
created."

lowpanOutDiscards OBJECT-TYPE
SYNTAX       Counter32
MAX-ACCESS   read-only
STATUS       current
DESCRIPTION
"The number of IPv6 packets for which no problem was
encountered to prevent their transmission to their
destination, but were discarded (e.g., for lack of
buffer space)."
lowpanOutTransmits OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The total number of 6LoWPAN datagram that this entity
supplied to the lower layers for transmission."
 ::= { lowpanStats 28 }

lowpanIfStatsTable OBJECT-TYPE
SYNTAX SEQUENCE OF LowpanIfStatsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"A table providing per interface statistics."
 ::= { lowpanObjects 2 }

lowpanIfStatsEntry OBJECT-TYPE
SYNTAX LowpanIfStatsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"An entry providing statistics for a specific interface."
INDEX { ifIndex }
 ::= { lowpanIfStatsTable 1 }

LowpanIfStatsEntry ::= SEQUENCE {
  lowpanIfReasmTimeout       Unsigned32,
  lowpanIfInReceives         Counter32,
  lowpanIfInHdrErrors        Counter32,
  lowpanIfInMeshReceives     Counter32,
  lowpanIfInMeshForwds       Counter32,
  lowpanIfInMeshDelivers     Counter32,
  lowpanIfInReasmReqds       Counter32,
  lowpanIfInReasmFails       Counter32,
  lowpanIfInReasmOKs         Counter32,
  lowpanIfInCompReqds        Counter32,
  lowpanIfInCompFails        Counter32,
  lowpanIfInCompOKs          Counter32,
  lowpanIfOutRequests        Counter32,
  lowpanIfOutCompReqds       Counter32,
  lowpanIfOutCompFails       Counter32,
lowpanIfOutFragFails Counter32,
lowpanIfOutFragOKs Counter32,
lowpanIfOutFragCreates Counter32,
lowpanIfOutMeshHopLimitExceeds Counter32,
lowpanIfOutMeshNoRoutes Counter32,
lowpanIfOutMeshRequests Counter32,
lowpanIfOutMeshForwds Counter32,
lowpanIfOutMeshTransmits Counter32,
lowpanIfOutDiscards Counter32,
lowpanIfOutTransmits Counter32

lowpanIfReasmTimeout OBJECT-TYPE
SYNTAX Unsigned32
UNITS "seconds"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The maximum number of seconds that received fragments are held while they are awaiting reassembly at this interface."
::= { lowpanIfStatsEntry 1 }

lowpanIfInReceives OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The total number of 6LoWPAN datagrams received on this interface, including those received in error."
::= { lowpanIfStatsEntry 2 }

lowpanIfInHdrErrors OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of 6LoWPAN datagrams received on this interface that were discarded due to errors in their headers, including unknown dispatch values."
::= { lowpanIfStatsEntry 3 }

lowpanIfInMeshReceives OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of 6LoWPAN datagrams received on this interface with a MESH header."
lowpanIfInMeshForwds OBJECT-TYPE
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
 "The number of 6LoWPAN datagrams received on this
 interface requiring MESH forwarding."
 ::= { lowpanIfStatsEntry 4 }

lowpanIfInMeshDelivers OBJECT-TYPE
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
 "The number of 6LoWPAN datagrams received on this
 interface with a MESH header delivered to the local
 system."
 ::= { lowpanIfStatsEntry 5 }

lowpanIfInReasmRegds OBJECT-TYPE
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
 "The number of 6LoWPAN fragments received on this
 interface that needed to be reassembled. This
 includes both FRAG1 and FRAGN 6LoWPAN datagrams."
 ::= { lowpanIfStatsEntry 6 }

lowpanIfInReasmFails OBJECT-TYPE
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
 "The number of failures detected by the re-assembly
 algorithm (e.g., timeouts) for datagrams received
 on this interface. Note that this is not necessarily
 a count of discarded 6LoWPAN fragments since
 implementations can lose track of the number
 of fragments by combining them as received."
 ::= { lowpanIfStatsEntry 7 }

lowpanIfInReasmOKs OBJECT-TYPE
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"The number of IPv6 packets successfully reassembled
from fragments received on this interface."
::= { lowpanIfStatsEntry 9 }

lowpanIfInCompReqds OBJECT-TYPE
SYNTAX    Counter32
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
"The number of 6LoWPAN datagrams received on this
interface requiring header decompression."
::= { lowpanIfStatsEntry 10 }

lowpanIfInCompFails OBJECT-TYPE
SYNTAX    Counter32
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
"The number of 6LoWPAN datagrams received on this
interface where header decompression failed (e.g.,
because the necessary context information was
not available)."
::= { lowpanIfStatsEntry 11 }

lowpanIfInCompOKs OBJECT-TYPE
SYNTAX    Counter32
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
"The number of 6LoWPAN datagrams received on this
interface where header decompression was successful."
::= { lowpanIfStatsEntry 12 }

lowpanIfInDiscards OBJECT-TYPE
SYNTAX    Counter32
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
"The number of 6LoWPAN datagrams received on this
interface for which no problems were encountered to
prevent their continued processing, but were discarded
(e.g., for lack of buffer space). Note that this
counter does not include any datagrams discarded due
to a reassembly failure or a compression failure."
::= { lowpanIfStatsEntry 13 }

lowpanIfInDelivers OBJECT-TYPE
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SYNTAX        Counter32  
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
"The total number of IPv6 packets received on this interface that were successfully delivered to the IPv6 layer."
::= { lowpanIfStatsEntry 14 }

lowpanIfOutRequests OBJECT-TYPE  
SYNTAX        Counter32  
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
"The total number of IPv6 packets supplied by the IPv6 layer to be sent over this interface."
::= { lowpanIfStatsEntry 15 }

lowpanIfOutCompReqds OBJECT-TYPE  
SYNTAX        Counter32  
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
"The total number of IPv6 packets to be sent over this interface for which header compression was attempted."
::= { lowpanIfStatsEntry 16 }

lowpanIfOutCompFails OBJECT-TYPE  
SYNTAX        Counter32  
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
"The total number of IPv6 packets to be sent over this interface for which header compression failed."
::= { lowpanIfStatsEntry 17 }

lowpanIfOutCompOKs OBJECT-TYPE  
SYNTAX        Counter32  
MAX-ACCESS    read-only
STATUS        current
DESCRIPTION
"The total number of IPv6 packets to be sent over this interface for which header compression was successful."
::= { lowpanIfStatsEntry 18 }

lowpanIfOutFragReqds OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of IPv6 packets to be sent over this interface that required fragmentation in order to be transmitted."
::= { lowpanIfStatsEntry 19 }

lowpanIfOutFragFails OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of IPv6 packets to be sent over this interface that have been discarded because fragmentation failed."
::= { lowpanIfStatsEntry 20 }

lowpanIfOutFragOKs OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of IPv6 packets to be sent over this interface that have been successfully fragmented."
::= { lowpanIfStatsEntry 21 }

lowpanIfOutFragCreates OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of 6LoWPAN fragments that have been generated on this interface as a result of fragmentation. This includes both FRAG1 and FRAGN 6LoWPAN datagrams."
::= { lowpanIfStatsEntry 22 }

lowpanIfOutMeshHopLimitExceeds OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of 6LoWPAN datagrams to be sent on this interface with a MESH header that were dropped because the hop limit has been exceeded."
::= { lowpanIfStatsEntry 23 }
lowpanIfOutMeshNoRoutes OBJECT-TYPE
SYNTAX          Counter32
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION     "The number of 6LoWPAN datagrams to be sent on this
interface with a MESH header that were dropped
because there was no forwarding information available."
::= { lowpanIfStatsEntry 24 }

lowpanIfOutMeshRequests OBJECT-TYPE
SYNTAX          Counter32
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION     "The number of 6LoWPAN datagrams to be sent on this
interface requiring MESH header encapsulation."
::= { lowpanIfStatsEntry 25 }

lowpanIfOutMeshForwds OBJECT-TYPE
SYNTAX          Counter32
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION     "The number of 6LoWPAN datagrams to be sent on this
interface with a MESH header for which suitable
forwarding information was available."
::= { lowpanIfStatsEntry 26 }

lowpanIfOutMeshTransmits OBJECT-TYPE
SYNTAX          Counter32
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION     "The number of 6LoWPAN datagrams to be sent on this
interface with a MESH header created."
::= { lowpanIfStatsEntry 27 }

lowpanIfOutDiscards OBJECT-TYPE
SYNTAX          Counter32
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION     "The number of IPv6 packets to be sent over this
interface for which no problem was encountered to
prevent their transmission to their destination, but
were discarded (e.g., for lack of buffer space)."
::= { lowpanIfStatsEntry 28 }
lowpanIfOutTransmits OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The total number of 6LoWPAN datagrams to be sent on
this interface that this entity supplied to the lower
layers for transmission."
 ::= { lowpanIfStatsEntry 29 }

-- conformance definitions

lowpanGroups OBJECT IDENTIFIER ::= { lowpanConformance 1 }
lownpanCompliances OBJECT IDENTIFIER ::= { lowpanConformance 2 }
lownpanCompliance MODULE-COMPLIANCE
STATUS current
DESCRIPTION "Compliance statement for systems that implement 6LoWPAN."
MODULE -- this module
MANDATORY-GROUPS {
  lowpanStatsGroup
}
GROUP lowpanStatsMeshGroup
DESCRIPTION "This group is mandatory for implementations that process
or forward 6LoWPAN datagrams with mesh headers."
GROUP lowpanIfStatsGroup
DESCRIPTION "This group is mandatory for implementations that expose
per interface statistics."
GROUP lowpanIfStatsMeshGroup
DESCRIPTION "This group is mandatory for implementations that expose
per interface statistics and that process or forward
6LoWPAN datagrams with mesh headers."
 ::= { lowpanCompliances 1 }

lowpanStatsGroup OBJECT-GROUP
OBJECTS {
  lowpanReasmTimeout,
  lowpanInReceives,
  lowpanInHdrErrors,
  lowpanInMeshReceives,
  lowpanInReasmReqds,
  lowpanInReasmFails,
  lowpanInReasmOKs,
  lowpanInCompReqds,
lowpanInCompFails,
lowpanInCompOKs,
lowpanInDiscards,
lowpanInDelivers,
lowpanOutRequests,
lowpanOutCompReqds,
lowpanOutCompFails,
lowpanOutCompOKs,
lowpanOutFragReqds,
lowpanOutFragFails,
lowpanOutFragOKs,
lowpanOutFragCreates,
lowpanOutDiscards,
lowpanOutTransmits
}

STATUS current
DESCRIPTION
"A collection of objects providing information and
statistics about the processing of 6LoWPAN datagrams,
excluding counters covering the processing of datagrams
with a mesh header."
::= { lowpanGroups 1 }

lowpanStatsMeshGroup OBJECT-GROUP
OBJECTS {
  lowpanInMeshForwds,
  lowpanInMeshDelivers,
  lowpanOutMeshHopLimitExceeds,
  lowpanOutMeshNoRoutes,
  lowpanOutMeshRequests,
  lowpanOutMeshForwds,
  lowpanOutMeshTransmits
}

STATUS current
DESCRIPTION
"A collection of objects providing information and
statistics about the processing of 6LoWPAN datagrams
with a 6LoWPAN mesh header."
::= { lowpanGroups 2 }

lowpanIfStatsGroup OBJECT-GROUP
OBJECTS {
  lowpanIfReasmTimeout,
  lowpanIfInReceives,
  lowpanIfInHdrErrors,
  lowpanIfInMeshReceives,
  lowpanIfInReasmReqds,
  lowpanIfInReasmFails,
lowpanIfInReasmOKs,
lowpanIfInCompReqds,
lowpanIfInCompFails,
lowpanIfInCompOKs,
lowpanIfInDiscards,
lowpanIfInDelivers,
lowpanIfOutRequests,
lowpanIfOutCompReqds,
lowpanIfOutCompFails,
lowpanIfOutCompOKs,
lowpanIfOutFragReqds,
lowpanIfOutFragFails,
lowpanIfOutFragOKs,
lowpanIfOutFragCreates,
lowpanIfOutDiscards,
lowpanIfOutTransmits
}
STATUS      current
DESCRIPTION
"A collection of objects providing per interface
information and statistics about the processing
of 6LoWPAN datagrams, excluding counters covering
the processing of datagrams with a mesh headers."
::= { lowpanGroups 3 }

lowpanIfStatsMeshGroup OBJECT-GROUP
OBJECTS {
    lowpanIfInMeshForwds,
    lowpanIfInMeshDelivers,
    lowpanIfOutMeshHopLimitExceeds,
    lowpanIfOutMeshNoRoutes,
    lowpanIfOutMeshRequests,
    lowpanIfOutMeshForwds,
    lowpanIfOutMeshTransmits
}
STATUS      current
DESCRIPTION
"A collection of objects providing per interface
information and statistics about the processing
of 6LoWPAN datagrams with a 6LoWPAN mesh header."
::= { lowpanGroups 4 }

END
7. Security Considerations

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:

The read-only counters provide insights into the amount of 6LoWPAN traffic a node is receiving or transmitting. This might provide information whether a device is regularly exchanging information with other devices or whether a device is mostly not participating in any communication (e.g., the device might be "easier" to take away unnoticed). The reassembly counters could be used to direct denial of service attacks on the reassembly mechanism.

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

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

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

8. IANA Considerations

IANA is requested to assign a value for "XXXX" under the 'mib-2' subtree and to record the assignment in the SMI Numbers registry. When the assignment has been made, the RFC Editor is asked to replace "XXXX" (here and in the MIB module) with the assigned value and to remove this note.
9. Acknowledgements

This specification borrows heavily from the IP-MIB defined in [RFC4293].

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10. References

10.1. Normative References


10.2. Informative References

Appendix A. JSON Representation

Using the translation algorithm defined in [RFC6643], the SMIv2 module can be translated to YANG. Using the JSON representation of data modeled in YANG defined in [I-D.lhotka-netmod-yang-json], the objects defined in the MIB module can be represented in JSON as shown below. The compact representation without any white space uses 468 octets. (Of course, this number depends on the number of octets needed for the counter values.)
{ "LOWPAN-MIB:LOWPAN-MIB": { "lowpanStats": { "lowpanReasmTimeout": 20, "lowpanInReceives": 42, "lowpanInHdrErrors": 0, "lowpanInMeshReceives": 8, "lowpanInMeshForwds": 0, "lowpanInMeshDelivers": 0, "lowpanInReasmReqds": 22, "lowpanInReasmFails": 2, "lowpanInReasmOKs": 20, "lowpanInCompReqds": 16, "lowpanInCompFails": 2, "lowpanInCompOKs": 14, "lowpanInDiscards": 1, "lowpanInDelivers": 12, "lowpanOutRequests": 12, "lowpanOutCompReqds": 0, "lowpanOutCompFails": 0, "lowpanOutCompOKs": 0, "lowpanOutFragReqds": 5, "lowpanOutFragFails": 0, "lowpanOutFragOKs": 5, "lowpanOutFragCreates": 8, "lowpanOutMeshHopLimitExceeds": 0, "lowpanOutMeshNoRoutes": 0, "lowpanOutMeshRequests": 0, "lowpanOutMeshForwds": 0, "lowpanOutMeshTransmits": 0, "lowpanOutDiscards": 0, "lowpanOutTransmits": 15 } } }

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