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Definition of Managed Objects for
IPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs)

Abstract

This document 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).

Status of This Memo

This is an Internet Standards Track document.

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1. Introduction

This document 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].

While a MIB module provides a direct binding for accessing data via the Simple Network Management Protocol (SNMP) [RFC3410], supporting SNMP may not always be affordable on constrained devices. Other protocols to access data modeled in MIB modules are possible and proposals have been made recently to provide bindings to the Constrained Application Protocol (CoAP) [RFC7252].

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 document 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 [BCP 14](#), [RFC 2119](#) [[RFC2119](#)].

4. Overview

The left part of Figure 1 provides an overview of the IETF protocols designed for constrained devices. The right part lists the MIB modules providing monitoring and troubleshooting support ([[RFC4113](#)], [[RFC4292](#)], [[RFC4293](#)], and [[RFC2863](#)]). The LOWPAN-MIB defined in this document fills a hole by providing monitoring and troubleshooting support for the 6LoWPAN layer.

Protocol Layer	MIB Modules
+-----+	+-----+
CoAP [RFC7252]	UDP-MIB [RFC4113]
+-----+	+-----+
UDP [RFC0768]	IP-MIB [RFC4293]
+-----+	IP-FORWARD-MIB [RFC4292]
IPv6 [RFC2460]	+-----+
ICMPv6 [RFC4443]	LOWPAN-MIB [RFC7388]
+-----+	+-----+
6LoWPAN [RFC4944]	IF-MIB [RFC2863]
+-----+	+-----+
IEEE 802.15.4, ...	
+-----+	

Figure 1: Protocol Layers and MIB Modules

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(1.3.6.1.2.1.226)
+---- 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
|   |   +--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- lowpanOutRequests(15)         Counter32
|   |   +--r- lowpanOutCompReqds(16)        Counter32
|   |   +--r- lowpanOutCompFails(17)        Counter32
|   |   +--r- lowpanOutCompOKs(18)         Counter32
|   |   +--r- lowpanOutFragReqds(19)        Counter32
|   |   +--r- lowpanOutFragFails(20)        Counter32
|   |   +--r- lowpanOutFragOKs(21)         Counter32
|   |   +--r- lowpanOutFragCreates(22)      Counter32
|   |   +--r- lowpanOutMeshHopLimitExceeds(23) Counter32
|   |   +--r- lowpanOutMeshNoRoutes(24)     Counter32
|   |   +--r- lowpanOutMeshRequests(25)     Counter32
|   |   +--r- lowpanOutMeshForwds(26)      Counter32
|   |   +--r- lowpanOutMeshTransmits(27)    Counter32
|   |   +--r- lowpanOutDiscards(28)         Counter32
|   |   +--r- lowpanOutTransmits(29)        Counter32
|   +---- lowpanIfStatsTable(2)
|   |   +---- lowpanIfStatsEntry(1) [ifIndex]
|   |   |   +--r- lowpanIfReasmTimeout(1)   Unsigned32
|   |   |   +--r- lowpanIfInReceives(2)     Counter32
|   |   |   +--r- lowpanIfInHdrErrors(3)     Counter32
|   |   |   +--r- lowpanIfInMeshReceives(4)  Counter32
|   |   |   +--r- lowpanIfInMeshForwds(5)    Counter32
|   |   |   +--r- lowpanIfInMeshDelivers(6)  Counter32
|   |   |   +--r- lowpanIfInReasmReqds(7)    Counter32
|   |   |   +--r- lowpanIfInReasmFails(8)    Counter32
|   |   |   +--r- lowpanIfInReasmOKs(9)      Counter32
|   |   |   +--r- lowpanIfInCompReqds(10)    Counter32
|   |   |   +--r- lowpanIfInCompFails(11)    Counter32
|   |   |   +--r- lowpanIfInCompOKs(12)     Counter32
|   |   |   +--r- lowpanIfInDiscards(13)     Counter32

```

```

|      +--r- lowpanIfInDelivers(14)          Counter32
|      +--r- lowpanIfOutRequests(15)         Counter32
|      +--r- lowpanIfOutCompReqds(16)        Counter32
|      +--r- lowpanIfOutCompFails(17)        Counter32
|      +--r- lowpanIfOutCompOKs(18)          Counter32
|      +--r- lowpanIfOutFragReqds(19)         Counter32
|      +--r- lowpanIfOutFragFails(20)        Counter32
|      +--r- lowpanIfOutFragOKs(21)          Counter32
|      +--r- lowpanIfOutFragCreates(22)       Counter32
|      +--r- lowpanIfOutMeshHopLimitExceeds(23) Counter32
|      +--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)

```

Figure 2: Object Identifier Registration Tree

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 datagrams 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 [IPV6-BTLE]).

The Case Diagram [CASE] in Figure 3 illustrates the conceptual relationships between the counters. Implementations may choose to implement the processing of 6LoWPAN datagrams in a different order.

The generic InDiscards and OutDiscards counters can be incremented anytime 6LoWPAN datagrams are discarded due to reasons not covered by the other more specific counters. For example, an implementation

discarding 6LoWPAN datagrams while all buffers are used for ongoing packet reassemblies will increment the relevant InDiscards counters for each discarded 6LoWPAN datagram.

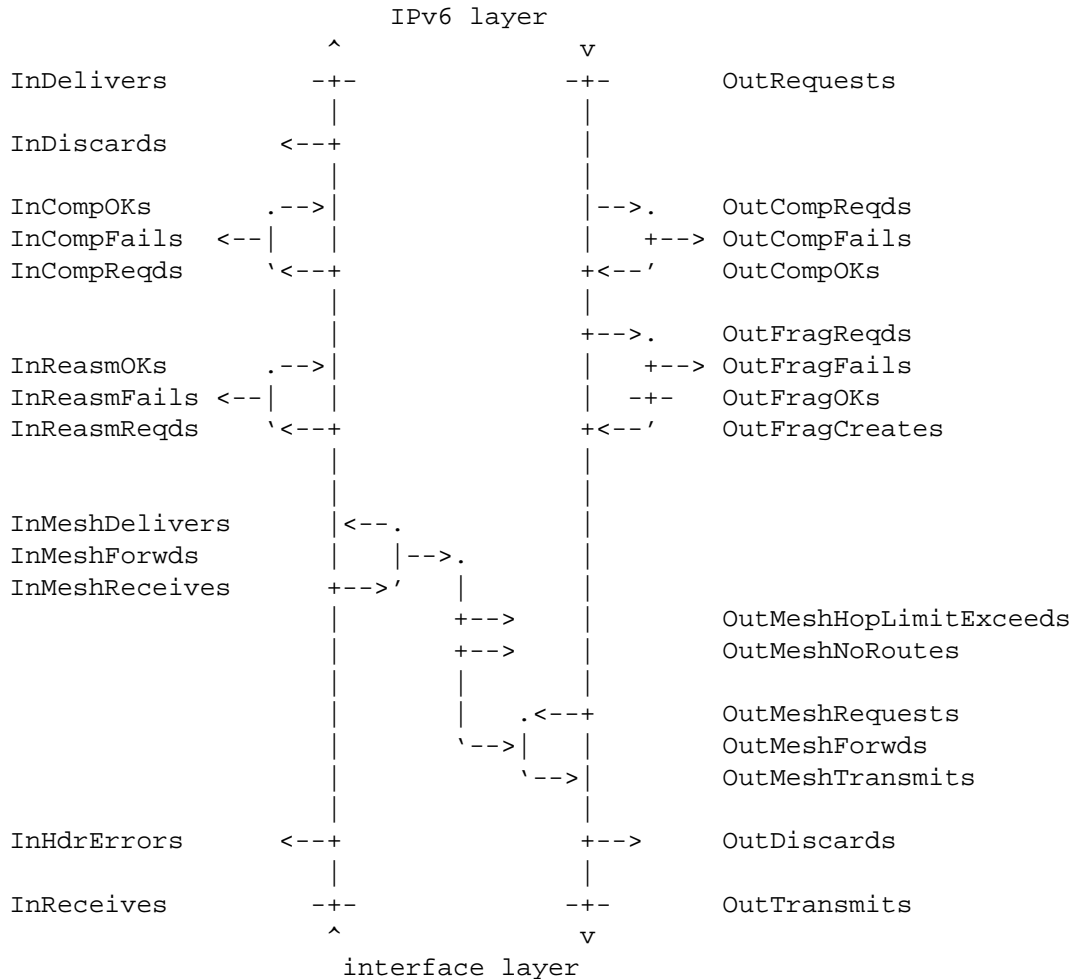


Figure 3: Conceptual Relationship between LOWPAN-MIB Counters

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, 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 counters related to MESH header processing 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      "201410100000Z"  -- October 10, 2014
```

```
    ORGANIZATION
```

```
        "IETF IPv6 over Networks of Resource-constrained Nodes
         Working Group"
```

```
    CONTACT-INFO
```

```
        "WG Email: 6lo@ietf.org
```

```
        WG Web:  http://tools.ietf.org/wg/6lo/
```

```
        Juergen Schoenwaelder
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        Email: j.schoenwaelder@jacobs-university.de
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        Tina Tsou
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        Huawei Technologies
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```
        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.

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REVISION "201410100000Z" -- October 10, 2014

DESCRIPTION

"Initial version, published as [RFC 7388](#)."

::= { mib-2 226 }

-- object definitions

lowpanNotifications OBJECT IDENTIFIER ::= { lowpanMIB 0 }
lowpanObjects OBJECT IDENTIFIER ::= { lowpanMIB 1 }
lowpanConformance OBJECT IDENTIFIER ::= { lowpanMIB 2 }

lowpanStats OBJECT IDENTIFIER ::= { lowpanObjects 1 }

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."

::= { lowpanStats 8 }

lowpanInReasmOKs OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of IPv6 packets successfully reassembled."

::= { lowpanStats 9 }

lowpanInCompReqds OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of 6LoWPAN datagrams requiring header decompression."

::= { lowpanStats 10 }

lowpanInCompFails OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of 6LoWPAN datagrams where header decompression failed (e.g., because the necessary context information was not available)."

::= { lowpanStats 11 }

```
lowpanInCompOKs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of 6LoWPAN datagrams where header decompression
        was successful."
    ::= { lowpanStats 12 }

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

lowpanInDelivers OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The total number of IPv6 packets successfully delivered
        to the IPv6 layer."
    ::= { lowpanStats 14 }

lowpanOutRequests OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The total number of IPv6 packets supplied by the IPv6
        layer."
    ::= { lowpanStats 15 }

lowpanOutCompReqds OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The total number of IPv6 packets for which header
        compression was attempted."
    ::= { lowpanStats 16 }
```

lowpanOutCompFails OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The total number of IPv6 packets for which header
compression failed."

::= { lowpanStats 17 }

lowpanOutCompOKs OBJECT-TYPE

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 was exceeded."
 ::= { lowpanStats 23 }

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."
 ::= { lowpanStats 24 }

lowpanOutMeshRequests OBJECT-TYPE
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The number of 6LoWPAN datagrams requiring MESH header
    encapsulation."
 ::= { lowpanStats 25 }

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."
 ::= { lowpanStats 26 }

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

DESCRIPTION

"The number of 6LoWPAN datagrams with a MESH header created."

::= { lowpanStats 27 }

lowpanOutDiscards OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of IPv6 packets that were discarded (e.g., for lack of buffer space) even though no problem was encountered to prevent their transmission to their destination."

::= { lowpanStats 28 }

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 29 }

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,
    lowpanIfInDiscards          Counter32,
    lowpanIfInDelivers          Counter32,
    lowpanIfOutRequests         Counter32,
    lowpanIfOutCompReqds        Counter32,
    lowpanIfOutCompFails        Counter32,
    lowpanIfOutCompOKs          Counter32,
    lowpanIfOutFragReqds        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."
    ::= { lowpanIfStatsEntry 4 }

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 5 }

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 6 }

lowpanIfInReasmReqds 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 7 }

lowpanIfInReasmFails OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
```



```
STATUS          current
DESCRIPTION
    "The number of failures detected by the reassembly
    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 8 }

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 that were discarded (e.g., for lack of buffer space) even though no problems were encountered to prevent their continued processing. Note that this counter does not include any datagrams discarded due to a reassembly failure or a compression failure."

::= { lowpanIfStatsEntry 13 }

lowpanIfInDelivers OBJECT-TYPE

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 was 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 that were discarded (e.g., for lack of buffer
        space) even though no problem was encountered to
        prevent their transmission to their destination."
    ::= { 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 }
lowpanCompliances     OBJECT IDENTIFIER ::= { lowpanConformance 2 }

lowpanCompliance 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 a MESH header."
    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 a MESH header."

::= { 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 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 header."
    ::= { 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 MESH header."
    ::= { lowpanGroups 4 }
```

END

7. Security Considerations

There are no management objects defined in this MIB module that have a MAX-ACCESS clause of read-write and/or read-create. So, if this MIB module is implemented correctly, then there is no risk that an intruder can alter or create any management objects of this MIB module via direct SNMP SET operations.

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.

The read-only counters provide insights into the amount of 6LoWPAN traffic a node is receiving or transmitting. This might provide information regarding 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

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

Descriptor	OBJECT IDENTIFIER value
-----	-----
lowpanMIB	{ mib-2 226 }

9. References

9.1. Normative References

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9.2. Informative References

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Acknowledgements

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