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Definition of Managed Objects for IPv6 over Low-Power Wireless Personal
Area Networks (6LoWPANs)
[draft-schoenw-6lo-lowpan-mib-01](#)

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).

Status of This Memo

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols. In 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

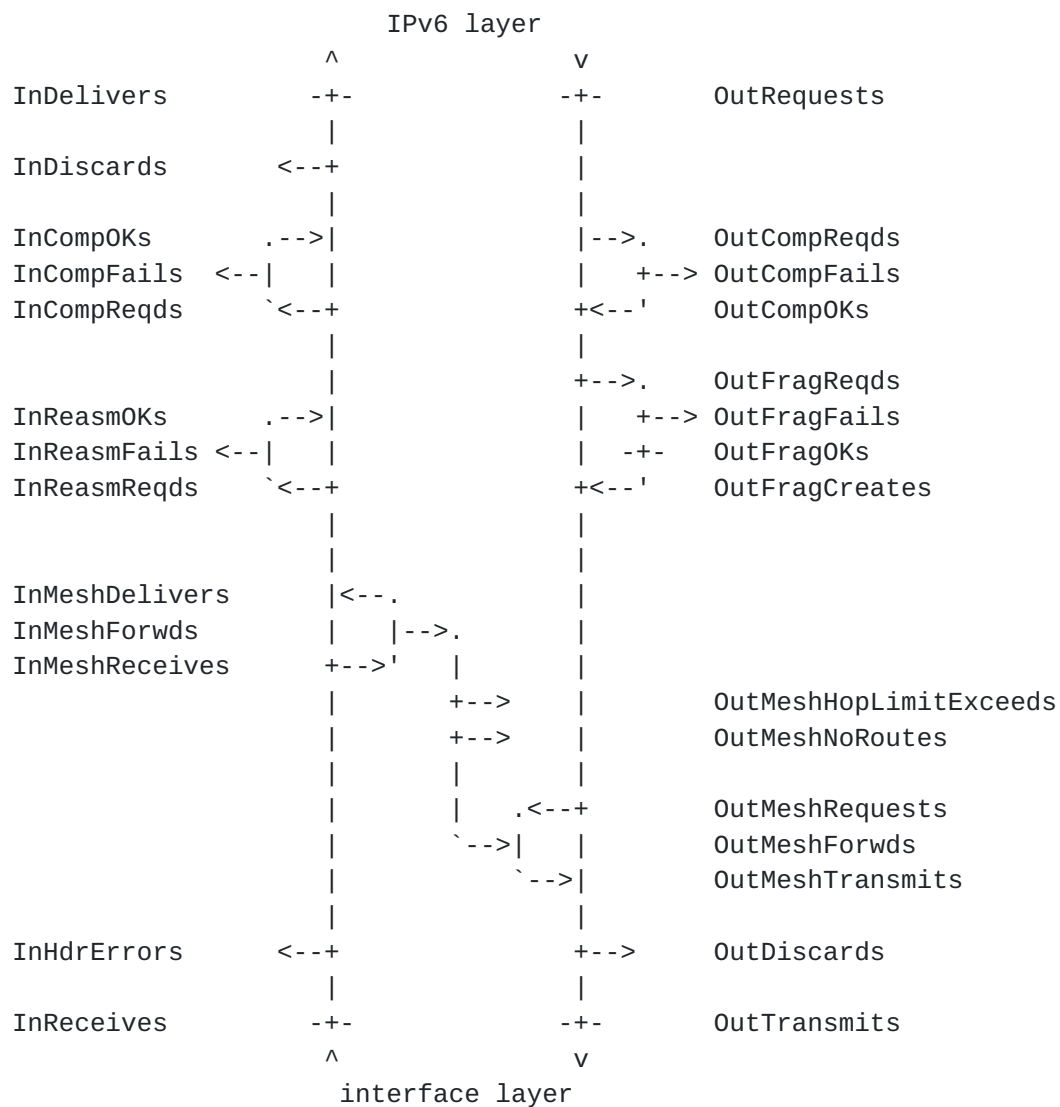
The LOWPAN-MIB module is primarily a collection of counters that reflect how 6LoWPAN datagrams are processed by the 6LoWPAN layer. The object identifier registration tree has the following structure:


```
--lowpanMIB(1.3.6.1.2.1.XXXX)
  +--lowpanNotifications(0)
  +--lowpanObjects(1)
    | +-- r-n Unsigned32 lowpanReasmTimeout(1)
    | +-- r-n Counter32 lowpanInReceives(2)
    | +-- r-n Counter32 lowpanInHdrErrors(3)
    | +-- r-n Counter32 lowpanInMeshReceives(4)
    | +-- r-n Counter32 lowpanInMeshForwds(5)
    | +-- r-n Counter32 lowpanInMeshDelivers(6)
    | +-- r-n Counter32 lowpanInReasmReqds(7)
    | +-- r-n Counter32 lowpanInReasmFails(8)
    | +-- r-n Counter32 lowpanInReasmOKs(9)
    | +-- r-n Counter32 lowpanInCompReqds(10)
    | +-- r-n Counter32 lowpanInCompFails(11)
    | +-- r-n Counter32 lowpanInCompOKs(12)
    | +-- r-n Counter32 lowpanInDiscards(13)
    | +-- r-n Counter32 lowpanInDelivers(14)
    | +-- r-n Counter32 lowpanOutRequests(15)
    | +-- r-n Counter32 lowpanOutCompReqds(16)
    | +-- r-n Counter32 lowpanOutCompFails(17)
    | +-- r-n Counter32 lowpanOutCompOKs(18)
    | +-- r-n Counter32 lowpanOutFragReqds(19)
    | +-- r-n Counter32 lowpanOutFragFails(20)
    | +-- r-n Counter32 lowpanOutFragOKs(21)
    | +-- r-n Counter32 lowpanOutFragCreates(22)
    | +-- r-n Counter32 lowpanOutMeshHopLimitExceeds(23)
    | +-- r-n Counter32 lowpanOutMeshNoRoutes(24)
    | +-- r-n Counter32 lowpanOutMeshRequests(25)
    | +-- r-n Counter32 lowpanOutMeshForwds(26)
    | +-- r-n Counter32 lowpanOutMeshTransmits(27)
    | +-- r-n Counter32 lowpanOutDiscards(28)
    | +-- r-n Counter32 lowpanOutTransmits(29)
  +--lowpanConformance(2)
    +--lowpanGroups(1)
      | +--lowpanCoreGroup(1)
      | +--lowpanMeshGroup(2)
    +--lowpanCompliances(2)
      +--lowpanCompliance(1)
```

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-6lowpan-btle](#)]).

The following diagram illustrates the conceptual relationships between the 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 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](#)] and SNMPv2-CONF [[RFC2580](#)].

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](#)

lowpanMIB MODULE-IDENTITY

LAST-UPDATED "201311070000Z"

ORGANIZATION

"Jacobs University Bremen"

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DESCRIPTION

"The MIB module for monitoring nodes implementing the IPv6 over Low-Power Wireless Personal Area Networks (6LoWPAN) protocol.

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REVISION "201311070000Z"

DESCRIPTION

"Initial version, published as RFC XXXX."

-- RFC Ed.: replace XXXX with actual RFC number and remove this note

::= { mib-2 XXXX }

-- object definitions

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

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."

::= { lowpanObjects 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."

::= { lowpanObjects 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."

::= { lowpanObjects 3 }

lowpanInMeshReceives OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

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

::= { lowpanObjects 4 }

lowpanInMeshForwds OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of received 6LoWPAN datagrams requiring MESH forwarding."

::= { lowpanObjects 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."

::= { lowpanObjects 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."

::= { lowpanObjects 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."
 ::= { lowpanObjects 8 }

lowpanInReasmOKs OBJECT-TYPE

SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The number of IPv6 packets successfully reassembled."
 ::= { lowpanObjects 9 }

lowpanInCompReqds OBJECT-TYPE

SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The number of 6LoWPAN datagrams requiring header
 decompression."
 ::= { lowpanObjects 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)."
 ::= { lowpanObjects 11 }

lowpanInCompOKs OBJECT-TYPE

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

lowpanInDiscards OBJECT-TYPE

SYNTAX Counter32
MAX-ACCESS read-only

STATUS current

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."

::= { lowpanObjects 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."

::= { lowpanObjects 14 }

lowpanOutRequests OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The total number of IPv6 packets supplied by the IPv6 layer."

::= { lowpanObjects 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."

::= { lowpanObjects 16 }

lowpanOutCompFails OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

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

::= { lowpanObjects 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."
::= { lowpanObjects 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."
::= { lowpanObjects 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."
::= { lowpanObjects 20 }

lowpanOutFragOKs OBJECT-TYPE

SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of IPv6 packets that have been successfully
fragmented."
::= { lowpanObjects 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."
::= { lowpanObjects 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."
 ::= { lowpanObjects 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."
 ::= { lowpanObjects 24 }

lowpanOutMeshRequests OBJECT-TYPE

SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of 6LoWPAN datagrams requiring MESH header encapsulation."
 ::= { lowpanObjects 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."
 ::= { lowpanObjects 26 }

lowpanOutMeshTransmits OBJECT-TYPE

SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The number of 6LoWPAN datagrams with a MESH header created."
 ::= { lowpanObjects 27 }

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)."
```

```
::= { lowpanObjects 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."
```

```
::= { lowpanObjects 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 {
```

```
        lowpanCoreGroup
```

```
    }
```

```
    GROUP       lowpanMeshGroup
```

```
    DESCRIPTION
```

```
        "This group is mandatory for implementations that process
        or forward 6LoWPAN datagrams with mesh headers."
```

```
::= { lowpanCompliances 1 }
```

```
lowpanCoreGroup 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 headers."
    ::= { lowpanGroups 1 }
```

lowpanMeshGroup 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 }
```

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 [\[RFC4293\]](#).

Juergen Schoenwaelder and Anuj Sehgal were partly funded by Flamingo, a Network of Excellence project (ICT-318488) supported by the European Commission under its Seventh Framework Programme.

10. References

10.1. Normative References

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- [RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, [RFC 2578](#), April 1999.
- [RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Textual Conventions for SMIv2", STD 58, [RFC 2579](#), April 1999.
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- [I-D.ietf-6lowpan-btle] Nieminen, J., Savolainen, T., Isomaki, M., Patil, B., Shelby, Z., and C. Gomez, "Transmission of IPv6 Packets over BLUETOOTH Low Energy", [draft-ietf-6lowpan-btle-12](#) (work in progress), February 2013.

[10.2.](#) Informative References

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- [RFC4293] Routhier, S., "Management Information Base for the Internet Protocol (IP)", [RFC 4293](#), April 2006.
- [RFC6643] Schoenwaelder, J., "Translation of Structure of Management Information Version 2 (SMIv2) MIB Modules to YANG Modules", [RFC 6643](#), July 2012.
- [I-D.lhotka-netmod-yang-json] Lhotka, L., "Modeling JSON Text with

YANG",
[draft-lhotka-netmod-yang-json-02](#) (work
in progress), September 2013.

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": {
    "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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