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

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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   time. It is inappropriate to use Internet-Drafts as reference
   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on April 21, 2013.

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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 MIB module is organized into groups of scalars and tables.

```
   # LOWPAN-MIB registration tree (generated by smidump 0.4.8)

 --lowpanMIB(1.3.6.1.2.1.XXXX)
   +--lowpanNotifications(0)
   +--lowpanObjects(1)
   |  +--lowpanGeneral(1)
   |  |  +-- rwn Unsigned32 lowpanReasmTimeout(1)
   |  +--lowpanStats(2)
   |     +-- r-n Counter32 lowpanStatsInReceives(1)
   |     +-- r-n Counter32 lowpanStatsInHdrErrors(2)
   |     +-- r-n Counter32 lowpanStatsReasmReqds(3)
   |     +-- r-n Counter32 lowpanStatsReasmOKs(4)
   |     +-- r-n Counter32 lowpanStatsReasmFails(5)
   |     +-- r-n Counter32 lowpanStatsInDiscards(6)
   |     +-- r-n Counter32 lowpanStatsInDelivers(7)
   |     +-- r-n Counter32 lowpanStatsOutRequests(8)
   |     +-- r-n Counter32 lowpanStatsOutDiscards(9)
   |     +-- r-n Counter32 lowpanStatsOutFragReqds(10)
   |     +-- r-n Counter32 lowpanStatsOutFragOKs(11)
   |     +-- r-n Counter32 lowpanStatsOutFragFails(12)
   |     +-- r-n Counter32 lowpanStatsOutFragCreates(13)
   |     +-- r-n Counter32 lowpanStatsOutTransmits(14)
   +--lowpanConformance(2)
     +--lowpanGroups(1)
     |  +--lowpanGeneralGroup(1)
     |  +--lowpanStatsGroup(2)
     +--lowpanCompliances(2)
        +--lowpanFullCompliance(1)
        +--lowpanReadOnlyCompliance(2)
```

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    "201210180000Z"
    ORGANIZATION
```

              "Jacobs University Bremen"
         CONTACT-INFO
             "Juergen Schoenwaelder
              Jacobs University Bremen
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              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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              authors of the code. All rights reserved.

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              License set forth in Section 4.c of the IETF Trust's
              Legal Provisions Relating to IETF Documents
              (http://trustee.ietf.org/license-info)."

         REVISION "201210180000Z"
         DESCRIPTION
             "Initial version, published as RFC XXXX."
         -- RFC Ed.: replace XXXX with actual RFC number & remove this note

         ::= { mib-2 XXXX }

   -- object definitions

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

   lowpanGeneral OBJECT IDENTIFIER ::= { lowpanObjects 1 }
   lowpanStats   OBJECT IDENTIFIER ::= { lowpanObjects 2 }

```
   lowpanReasmTimeout OBJECT-TYPE
       SYNTAX     Unsigned32
       UNITS      "seconds"
       MAX-ACCESS read-write
       STATUS     current
       DESCRIPTION
           "The maximum number of seconds that received fragments are
            held while they are awaiting reassembly at this entity."
       ::= { lowpanGeneral 1 }

   lowpanStatsInReceives OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The total number of datagrams received, including those
            received in error."
       ::= { lowpanStats 1 }

   lowpanStatsInHdrErrors OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The number of received datagrams discarded due to errors
            in their headers, including unknown dispatch values,
            errors discovered during any decompression attempts, etc."
       ::= { lowpanStats 2 }

   lowpanStatsReasmReqds OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The number of received datagrams that needed to be
            reassembled."
       ::= { lowpanStats 3 }

   lowpanStatsReasmOKs OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The number of received datagrams successfully reassembled."
       ::= { lowpanStats 4 }

   lowpanStatsReasmFails OBJECT-TYPE
       SYNTAX     Counter32
```

```
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The number of failures detected by the re-assembly algorithm
            (e.g., timeouts)."
       ::= { lowpanStats 5 }

  lowpanStatsInDiscards OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The number of received 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 while
            awaiting re-assembly."
       ::= { lowpanStats 6 }

  lowpanStatsInDelivers OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The total number of datagrams successfully delivered to the
            IPv6 layer."
       ::= { lowpanStats 7 }

  lowpanStatsOutRequests OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The total number of datagrams supplied by the IPv6 layer."
       ::= { lowpanStats 8 }

  lowpanStatsOutDiscards OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The number of datagrams for which no problem was
            encountered to prevent their transmission to their
            destination, but were discarded (e.g., for lack of
            buffer space).."
       ::= { lowpanStats 9 }

  lowpanStatsOutFragReqds OBJECT-TYPE
```

```
      SYNTAX      Counter32
      MAX-ACCESS read-only
      STATUS      current
      DESCRIPTION
          "The number of datagrams that would require fragmentation
           in order to be transmitted."
      ::= { lowpanStats 10 }

   lowpanStatsOutFragOKs OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS read-only
      STATUS      current
      DESCRIPTION
          "The number of IP datagrams that have been successfully
           fragmented."
      ::= { lowpanStats 11 }

   lowpanStatsOutFragFails OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS read-only
      STATUS      current
      DESCRIPTION
          "The number of IP datagrams that have been discarded because
           they needed to be fragmented but could not be."
      ::= { lowpanStats 12 }

   lowpanStatsOutFragCreates OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS read-only
      STATUS      current
      DESCRIPTION
          "The number of datagram fragments that have been
           generated as a result of fragmentation."
      ::= { lowpanStats 13 }

   lowpanStatsOutTransmits OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS read-only
      STATUS      current
      DESCRIPTION
          "The total number of datagram fragments that this entity
           supplied to the lower layers for transmission."
      ::= { lowpanStats 14 }

   -- conformance definitions

   lowpanGroups      OBJECT IDENTIFIER ::= { lowpanConformance 1 }
   lowpanCompliances OBJECT IDENTIFIER ::= { lowpanConformance 2 }
```

    lowpanFullCompliance MODULE-COMPLIANCE
        STATUS   current
        DESCRIPTION
            "Compliance statement for implementations supporting
             read/write access, according to the object definitions."
        MODULE   -- this module
        MANDATORY-GROUPS {
            lowpanGeneralGroup,
            lowpanStatsGroup
        }
        ::= { lowpanCompliances 1 }

    lowpanReadOnlyCompliance MODULE-COMPLIANCE
        STATUS   current
        DESCRIPTION
            "Compliance statement for implementations supporting
             only readonly access."
        MODULE   -- this module
        MANDATORY-GROUPS {
            lowpanGeneralGroup,
            lowpanStatsGroup
        }

        OBJECT lowpanReasmTimeout
        MIN-ACCESS   read-only
        DESCRIPTION
            "Write access is not required."

        ::= { lowpanCompliances 2 }

    lowpanGeneralGroup OBJECT-GROUP
        OBJECTS {
            lowpanReasmTimeout
        }
        STATUS   current
        DESCRIPTION
            "A collection of objects providing general information about
             the 6LoWPAN implementation."
        ::= { lowpanGroups 1 }

    lowpanStatsGroup OBJECT-GROUP
        OBJECTS {
            lowpanStatsInReceives,
            lowpanStatsInHdrErrors,
            lowpanStatsReasmReqds,
            lowpanStatsReasmOKs,
            lowpanStatsReasmFails,
            lowpanStatsInDiscards,

```
        lowpanStatsInDelivers,
        lowpanStatsOutRequests,
        lowpanStatsOutDiscards,
        lowpanStatsOutFragReqds,
        lowpanStatsOutFragOKs,
        lowpanStatsOutFragFails,
        lowpanStatsOutFragCreates,
        lowpanStatsOutTransmits
    }
    STATUS      current
    DESCRIPTION
        "A collection of objects providing statistics about
         the 6LoWPAN implementation."
    ::= { lowpanGroups 2 }

  END
```

7. Security Considerations

   There are a number of management objects defined in this MIB module
   with a MAX-ACCESS clause of read-write and/or read-create. Such
   objects may be considered sensitive or vulnerable in some network
   environments. The support for SET operations in a non-secure
   environment without proper protection can have a negative effect on
   network operations. These are the tables and objects and their
   sensitivity/vulnerability:

   o lowpanReasmTimeout: This object controls how long received
      fragments are kept in memory awaiting reassembly. An attacker
      might set this object to a very small value in order to prevent
      successful reassembly of fragmented IPv6 packets. An attacker
      might as well set this object to a very large value in order to
      reserve memory for a long time as part of a denial of service
      attack.

   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].

10. References

10.1. Normative References

[RFC2119]   Bradner, S., "Key words for use in
                                  RFCs to Indicate Requirement Levels",
                                  BCP 14, RFC 2119, March 1997.

[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.

   [RFC2580]   McCloghrie, K., Perkins, D., and J.
                                    Schoenwaelder, "Conformance Statements
                                    for SMIv2", STD 58, RFC 2580,
                                    April 1999.

   [RFC4944]   Montenegro, G., Kushalnagar, N., Hui,
                                    J., and D. Culler, "Transmission of
                                    IPv6 Packets over IEEE 802.15.4
                                    Networks", RFC 4944, September 2007.

10.2. Informative References

   [RFC3410]   Case, J., Mundy, R., Partain, D., and
                                    B. Stewart, "Introduction and
                                    Applicability Statements for Internet-
                                    Standard Management Framework",
                                    RFC 3410, December 2002.

   [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-00 (work
                                    in progress), October 2012.

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": {
            "lowpanGeneral": {
                "lowpanReasmTimeout": 120
            },
            "lowpanStats": {
                "lowpanStatsInReceives": 42,
                "lowpanStatsInHdrErrors": 0,
                "lowpanStatsReasmReqds": 22,
                "lowpanStatsReasmOKs": 20,
                "lowpanStatsReasmFails": 2,
                "lowpanStatsInDiscards": 1,
                "lowpanStatsInDelivers": 12,
                "lowpanStatsOutRequests": 12,
                "lowpanStatsOutDiscards": 0,
                "lowpanStatsOutFragReqds": 5,
                "lowpanStatsOutFragOKs": 5,
                "lowpanStatsOutFragFails": 0,
                "lowpanStatsOutFragCreates": 8,
                "lowpanStatsOutTransmits": 15
            }
        }
    }
```

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