Internet Engineering Task Force
Internet-Draft
Intended status: Standards Track
Expires: August 26, 2013

K. Korte
J. Schoenwaelder
A. Sehgal
Jacobs University
T. Tsou
Huawei Technologies (USA)
C. Zhou
Huawei Technologies

February 22, 2013

Definition of Managed Objects for the IPv6 Routing Protocol for Low Power and Lossy Networks (RPL) draft-sehgal-roll-rpl-mib-06

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 the IPv6 Routing Protocol for Low Power and Lossy Networks (RPL).

Status of This Memo

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

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at http://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any 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 August 26, 2013.

Copyright Notice

Table of Contents

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 the IPv6 Routing Protocol for Low Power and Lossy Networks (RPL) [RFC6550]. It also provides management access to the Trickle [RFC6206] parameters as they are used by RPL.

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 a group of scalars and tables.

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

  -rplMib(1.3.6.1.2.1.XXXX)
    +-rplNotifications(0)
    +-rplObjects(1)
       +-rplDefaults(1)
       |  +- rwn RplDISMode            rplDefaultDISMode(1)
       |  +- rwn Unsigned32            rplDefaultDISMessages(2)
       |  +- rwn Unsigned32            rplDefaultDISTimeout(3)
       |  +- rwn RplDAODelay           rplDefaultDAODelay(4)
       |  +- rwn TruthValue            rplDefaultDAOAckEnabled(5)
       |  +- rwn RplDodagPreference    rplDefaultPreference(6)
       |  +- rwn RplMinHopRankIncrease rplDefaultMinHopRankIncrease(7)
       |  +- rwn Unsigned32            rplDefaultMaxRankIncrease(8)
       |  +- rwn RplModeOfOperation    rplDefaultModeOfOperation(9)
```

```
|  +- rwn Unsigned32            rplDefaultIntervalDoublings(10)
|  +- rwn Unsigned32            rplDefaultIntervalMin(11)
|  +- rwn Unsigned32            rplDefaultRedundancyConstant(12)
+-rplActive(2)
|  +- rwn RplInstanceID   rplActiveInstance(1)
|  +- rwn InetAddressIPv6 rplActiveDodag(2)
|  +- rwn Unsigned32      rplActiveDodagTriggerSequence(3)
+-rplOCPTable(3)
|  +-rplOCPEntry(1) [rplOCPCodepoint]
|     +- --- RplObjectiveCodePoint rplOCPCodepoint(1)
|     +- rwn TruthValue            rplOCPEnabled(2)
+-rplInstanceTable(4)
|  +-rplInstanceEntry(1) [rplInstanceID]
|     +- --- RplInstanceID         rplInstanceID(1)
|     +- r-n RplDISMode            rplInstanceDISMode(2)
|     +- r-n Unsigned32            rplInstanceDISMessages(3)
|     +- r-n Unsigned32            rplInstanceDISTimeout(4)
|     +- r-n RplModeOfOperation    rplInstanceModeOfOperation(5)
+-rplDodagTable(5)
|  +-rplDodagEntry(1) [rplInstanceID,rplDodagIndex]
|     +- --- Unsigned32            rplDodagIndex(1)
|     +- --- InetAddressIPv6       rplDodagRoot(2)
|     +- r-n RplDodagVersionNumber rplDodagVersion(3)
|     +- r-n RplRank               rplDodagRank(4)
|     +- r-n Enumeration           rplDodagState(5)
|     +- r-n RplObjectiveCodePoint rplDodagOCP(6)
|     +- r-n RplDAODelay           rplDodagDAODelay(7)
|     +- r-n TruthValue            rplDodagDAOAckEnabled(8)
|     +- r-n RplDodagPreference    rplDodagPreference(9)
|     +- r-n RplMinHopRankIncrease rplDodagMinHopRankIncrease(10)
|     +- r-n Unsigned32            rplDodagMaxRankIncrease(11)
|     +- r-n Unsigned32            rplDodagIntervalDoublings(12)
|     +- r-n Unsigned32            rplDodagIntervalMin(13)
|     +- r-n Unsigned32            rplDodagRedundancyConstant(14)
|     +- r-n RplPathControlSize    rplDodagPathControlSize(15)
+-rplDodagParentTable(6)
|  +-rplDodagParentEntry(1) [rplInstanceID,rplDodagIndex,
|     |                       rplDodagParentID]
|     +- --- InetAddressIPv6 rplDodagParentID(1)
|     +- r-n InterfaceIndex  rplDodagParentIf(2)
+-rplDodagChildTable(7)
|  +-rplDodagChildEntry(1) [rplInstanceID,rplDodagIndex,
|     |                     rplDodagChildID]
|     +- --- InetAddressIPv6 rplDodagChildID(1)
|     +- r-n InterfaceIndex  rplDodagChildIf(2)
+-rplStats(8)
|  +- r-n Counter32 rplMemOverflows(1)
|  +- r-n Counter32 rplParseErrors(2)
```

```
|  +- r-n Counter32 rplUnknownMsgTypes(3)
|  +- r-n Counter32 rplSecurityPolicyViolations(4)
|  +- r-n Counter32 rplIntegrityCheckFailures(5)
|  +- r-n Counter32 rplReplayProtectionFailures(6)
|  +- r-n Counter32 rplValidParentFailures(7)
|  +- r-n Counter32 rplNoInstanceIDs(8)
|  +- r-n Counter32 rplTriggeredLocalRepairs(9)
|  +- r-n Counter32 rplTriggeredGlobalRepairs(10)
|  +- r-n Counter32 rplNoParentSecs(11)
|  +- r-n Counter32 rplActiveNoParentSecs(12)
|  +- r-n Counter32 rplOBitSetDownwards(13)
|  +- r-n Counter32 rplOBitClearedUpwards(14)
|  +- r-n Counter32 rplFBitSet(15)
|  +- r-n Counter32 rplRBitSet(16)
|  +- r-n Counter32 rplTrickleTimerResets(17)
+-rplMsgStatsTable(9)
   +-rplMsgStatsEntry(1) [rplMsgStatsType]
      +- --- RplMessageType rplMsgStatsType(1)
      +- r-n Counter32      rplMsgStatsInMsgs(2)
      +- r-n Counter32      rplMsgStatsOutMsgs(3)
```

5. Relationship to Other MIB Modules

The MIB module IMPORTS definitions from SNMPv2-SMI [RFC2578], SNMPv2-TC [RFC2579], SNMPv2-CONF [RFC2580], IF-MIB [RFC2863] and the INET-ADDRESS-MIB [RFC4001].

The IPv6 routing table SHOULD be exposed via the inetCidrRouteTable defined in the IP-FORWARD-MIB [RFC4292]. Since an RPL node can participate in multiple RPL instances, the inetCidrRoutePolicy object SHOULD carry the OID of the rplInstanceID instance, including the value of rplInstanceID.

The prefixes used by DODAGs SHOULD be exported via the ipAddressPrefixTable of the IP-MIB [RFC4293]. The value of ipAddressPrefixOrigin should be routeradv(5).

6. Definitions

```
RPL-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE, Unsigned32, Counter32, mib-2
        FROM SNMPv2-SMI                                 -- RFC 2578
    TEXTUAL-CONVENTION, TruthValue
        FROM SNMPv2-TC                                  -- RFC 2579
    OBJECT-GROUP, MODULE-COMPLIANCE
        FROM SNMPv2-CONF                                -- RFC 2580
```

```
    InterfaceIndex
        FROM IF-MIB                                    -- RFC 2863
    InetAddressIPv6
        FROM INET-ADDRESS-MIB;                         -- RFC 4001

rplMib MODULE-IDENTITY
    LAST-UPDATED "201302200000Z"
    ORGANIZATION
        "Jacobs University Bremen"
    CONTACT-INFO
        "Kevin Dominik Korte
         Jacobs University Bremen
         Email: k.korte@jacobs-university.de

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

         Juergen Schoenwaelder
         Jacobs University Bremen
         Email: j.schoenwaelder@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
         routing protocol for low power and lossy networks (RPL).

         Copyright (c) 2013 IETF Trust and the persons identified as
         authors of the code.  All rights reserved.

         Redistribution and use in source and binary forms, with or
         without modification, is permitted pursuant to, and subject
         to the license terms contained in, the Simplified BSD
         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 "201302200000Z"
    DESCRIPTION
        "Initial version, published as RFC XXXX."
    -- RFC Ed.: replace XXXX with actual RFC number & remove this note
```

```
    ::= { mib-2 XXXX }

RplMessageType ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "The type of an RPL control message as defined in Section
         6 of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32 (0..255)

RplInstanceID ::=  TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "A global or local RPLInstanceID as defined in Section 5.1
         of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32 (0..255)

RplDodagVersionNumber ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "The version number of a DODAG as defined in Section 6.3 of
         RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32 (0..255)

RplRank ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "The rank of a node within a DODAG as defined in Section 6.3
         of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32 (0..65535)

RplObjectiveCodePoint ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "The Objective Code Point of a DODAG as defined in
         Section 6.7.6 of RFC 6550."
```

```
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32 (0..65535)

RplDISMode ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
        "Determines whether a DIS message is send upon boot-up
         or not as defined in Section 18.2.1.1 of RFC 6550:

         silent(1)  do not send DIS messages
         send(2)    send DIS messages"
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      INTEGER {
                    silent(1),
                    send(2)
                }

RplModeOfOperation ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
        "The mode of operation of an RPL instance as defined in
         Section 6.3.1 of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      INTEGER {
                    noDownwardRoutes(0),
                    nonStoringMode(1),
                    storingWithoutMulticastSupport(2),
                    storingWithMulticastSupport(3)
                }

RplDAODelay ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "The delay time used for aggregation before a DAO message
         is send."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32

RplDodagPreference ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "The preference of a DODAG compared to another DODAG of the
```

```
          same instance as defined in Section 6.3 of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32 (0..7)

RplMinHopRankIncrease ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "The minimal increase of a rank within a single hop as
         defined in Section 6.7.6 of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32 (0..131071)

RplPathControlSize ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "The Path Control Size within a DODAG as defined in
         Section 6.7.6 of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    SYNTAX      Unsigned32 (0..7)

-- object definitions

rplNotifications OBJECT IDENTIFIER ::= { rplMib 0 }
rplObjects       OBJECT IDENTIFIER ::= { rplMib 1 }
rplConformance   OBJECT IDENTIFIER ::= { rplMib 2 }

rplDefaults OBJECT IDENTIFIER ::= { rplObjects 1 }

rplDefaultDISMode OBJECT-TYPE
    SYNTAX      RplDISMode
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "Determines whether a DIS message is send upon boot-up.
         Changes to this value may not persist across restarts."
    ::= { rplDefaults 1 }

rplDefaultDISMessages OBJECT-TYPE
    SYNTAX      Unsigned32 (1..255)
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The number of DIS messages that are sent as an initial
```

```
         probe for nearby DODAGs if the DIS mode is 'send'. The
         value of this object is ignored if the DIS mode is
         'silent'. Changes to this value may not persist across
         restarts."
    DEFVAL      { 1 }
    ::= { rplDefaults 2 }

rplDefaultDISTimeout OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    UNITS       "seconds"
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The number of seconds after which a node in DIS mode 'send'
         in the absence of DIO messages may decide to root a
         floating DODAG. Changes to this value may not persist
         across restarts."
    DEFVAL      { 60 }
    ::= { rplDefaults 3 }

rplDefaultDAODelay OBJECT-TYPE
    SYNTAX      RplDAODelay
    UNITS       "milliseconds"
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The default delay for aggregations before a DAO is send.
         Changes to this value may not persist across restarts."
    DEFVAL      { 1000 }
    ::= { rplDefaults 4 }

rplDefaultDAOAckEnabled OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "Indicates whether DAO Acknowledgements are sent on this
         RPL instance. Changes to this value may not persist
         across restarts."
    DEFVAL      { false }
    ::= { rplDefaults 5 }

rplDefaultPreference OBJECT-TYPE
    SYNTAX      RplDodagPreference
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The default preference of this DODAG compared to other
```

```
         DODAGs within the same instance. Changes to this value
         may not persist across restarts."
    DEFVAL      { 0 }
    ::= { rplDefaults 6 }

rplDefaultMinHopRankIncrease OBJECT-TYPE
    SYNTAX      RplMinHopRankIncrease
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The default minimum increase of the rank in a single hop.
         Changes to this value may not persist across restarts."
    DEFVAL      { 256 }
    ::= { rplDefaults 7 }

rplDefaultMaxRankIncrease OBJECT-TYPE
    SYNTAX      Unsigned32 (0..65535)
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The default maximum allowable increase in rank in support
         of local repair.  If DAGMaxRankIncrease is 0 then this
         mechanism is disabled. Changes to this value may not
         persist across restarts."
    DEFVAL      { 65535 }
    ::= { rplDefaults 8 }

rplDefaultModeOfOperation OBJECT-TYPE
    SYNTAX      RplModeOfOperation
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The mode of operation of the RPL instance. Changes to this
         value may not persist across restarts."
    DEFVAL      { storingWithoutMulticastSupport }
    ::= { rplDefaults 9 }

rplDefaultIntervalDoublings OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The default Imax parameter of the DIO trickle timer. Changes
         to this value may not persist across restarts."
    REFERENCE
        "RFC 6206: The Trickle Algorithm"
    DEFVAL      { 20 }
    ::= { rplDefaults 10 }
```

```
rplDefaultIntervalMin OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The default Imin parameter of the DIO trickle timer. Changes
         to this value may not persist across restarts."
    REFERENCE
        "RFC 6206: The Trickle Algorithm"
    DEFVAL      { 3 }
    ::= { rplDefaults 11 }

rplDefaultRedundancyConstant OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The default k parameter of the DIO trickle timer. Changes to
         this value may not persist across restarts."
    REFERENCE
        "RFC 6206: The Trickle Algorithm"
    DEFVAL      { 10 }
    ::= { rplDefaults 12 }

rplActive OBJECT IDENTIFIER ::= { rplObjects 2 }

rplActiveInstance OBJECT-TYPE
    SYNTAX       RplInstanceID
    MAX-ACCESS   read-write
    STATUS       current
    DESCRIPTION
        "The currently active RPL Instance. Changes to this value
         may not persist across restarts."
    ::= { rplActive 1 }

rplActiveDodag OBJECT-TYPE
    SYNTAX      InetAddressIPv6
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "The currently active RPL DODAG in the active RPL Instance.
         Changes to this value may not persist across restarts."
    ::= { rplActive 2 }

rplActiveDodagTriggerSequence OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    MAX-ACCESS  read-write
    STATUS      current
```

```
    DESCRIPTION
        "The DAO Trigger Sequence Number (DTSN) of the active
         DODAG as defined in Section 6.3.1 of RFC 6550. Changes to
         this value may not persist across restarts."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    ::= { rplActive 3 }

rplOCPTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF RplOCPEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The table of all supported Objective Code Points (OCPs)."
    ::= { rplObjects 3 }

rplOCPEntry OBJECT-TYPE
    SYNTAX      RplOCPEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "An entry representing a supported Objective Code Point."
    INDEX { rplOCPCodepoint }
    ::= { rplOCPTable 1 }

RplOCPEntry ::= SEQUENCE {
    rplOCPCodepoint  RplObjectiveCodePoint,
    rplOCPEnabled    TruthValue
}

rplOCPCodepoint OBJECT-TYPE
    SYNTAX      RplObjectiveCodePoint
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "A supported Objective Code Point."
    ::= { rplOCPEntry 1 }

rplOCPEnabled OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
        "Enables the usage of this Objective Code Point. Changes to
         this value may not persist across restarts."
    ::= { rplOCPEntry 2 }

rplInstanceTable OBJECT-TYPE
```

```
    SYNTAX      SEQUENCE OF RplInstanceEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The table represents information about all known
         RPL Instances."
    ::= { rplObjects 4 }

rplInstanceEntry OBJECT-TYPE
    SYNTAX      RplInstanceEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "An entry representing information about a RPL Instance."
    INDEX { rplInstanceID }
    ::= { rplInstanceTable 1 }

RplInstanceEntry ::= SEQUENCE {
    rplInstanceID               RplInstanceID,
    rplInstanceDISMode          RplDISMode,
    rplInstanceDISMessages      Unsigned32,
    rplInstanceDISTimeout       Unsigned32,
    rplInstanceModeOfOperation  RplModeOfOperation
}

rplInstanceID OBJECT-TYPE
    SYNTAX      RplInstanceID
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The InstanceID of this RPL Instance."
    ::= { rplInstanceEntry 1 }

rplInstanceDISMode OBJECT-TYPE
    SYNTAX      RplDISMode
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "Reports whether a DIS message is send for this instance
         upon boot-up."
    ::= { rplInstanceEntry 2 }

rplInstanceDISMessages OBJECT-TYPE
    SYNTAX      Unsigned32 (1..255)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of DIS messages that are sent as an initial
```

```
         probe for nearby DODAGs if the DIS mode is 'send'."
    ::= { rplInstanceEntry 3 }

rplInstanceDISTimeout OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    UNITS       "seconds"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of seconds after which a node in DIS mode 'send'
         in the absence of DIO messages may decide to root a
         floating DODAG."
    ::= { rplInstanceEntry 4 }

rplInstanceModeOfOperation OBJECT-TYPE
    SYNTAX      RplModeOfOperation
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The mode of operation of the RPL instance."
    ::= { rplInstanceEntry 5 }

rplDodagTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF RplDodagEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The table represents information about all locally known
         DODAGs."
    ::= { rplObjects 5 }

rplDodagEntry OBJECT-TYPE
    SYNTAX      RplDodagEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "An entry representing information about a DODAG."
    INDEX { rplInstanceID, rplDodagIndex }
    ::= { rplDodagTable 1 }

RplDodagEntry ::= SEQUENCE {
    rplDodagIndex               Unsigned32,
    rplDodagID                  InetAddressIPv6,
    rplDodagVersion             RplDodagVersionNumber,
    rplDodagRank                RplRank,
    rplDodagState               INTEGER,
    rplDodagOCP                 RplObjectiveCodePoint,
    rplDodagDAODelay            RplDAODelay,
```

```
    rplDodagDAOAckEnabled       TruthValue,
    rplDodagPreference          RplDodagPreference,
    rplDodagMinHopRankIncrease  RplMinHopRankIncrease,
    rplDodagMaxRankIncrease     Unsigned32,
    rplDodagIntervalDoublings   Unsigned32,
    rplDodagIntervalMin         Unsigned32,
    rplDodagRedundancyConstant  Unsigned32,
    rplDodagPathControlSize     RplPathControlSize
}

rplDodagIndex OBJECT-TYPE
    SYNTAX      Unsigned32 (1..4294967295)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The index identifying a DODAG within an RPL instance. This
         index is used to keep the table indexes short. The RPL protocol
         identifies a DODAG within an RPL instance by the DODAGID."
    ::= { rplDodagEntry 1 }

rplDodagID OBJECT-TYPE
    SYNTAX      InetAddressIPv6
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The identifier of a DODAG root (DODAGID) of this RPL
         instance. The root of the DODAG reports its own IPv6
         address as the DODAG root. This is uniquely identifying
         a DODAG within an RPL instance."
    ::= { rplDodagEntry 2 }

rplDodagVersion OBJECT-TYPE
    SYNTAX      RplDodagVersionNumber
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The version of the DODAG in this RPL instance."
    ::= { rplDodagEntry 3 }

rplDodagRank OBJECT-TYPE
    SYNTAX      RplRank
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The rank of the node within the DODAG."
    ::= { rplDodagEntry 4 }

rplDodagState OBJECT-TYPE
```

```
    SYNTAX      INTEGER {
                    other(0),
                    grounded(1),
                    floating(2)
                }
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The status of the DODAG:

         other(0)      An unknown state.

         grounded(1)   The DODAG is grounded.

         floating(2)   The DODAG is floating (not grounded)."
    ::= { rplDodagEntry 5 }

rplDodagOCP OBJECT-TYPE
    SYNTAX      RplObjectiveCodePoint
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The Objective Code Point of this DODAG."
    ::= { rplDodagEntry 6 }

rplDodagDAODelay OBJECT-TYPE
    SYNTAX      RplDAODelay
    UNITS       "milliseconds"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The delay for aggregations before a DAO is send."
    ::= { rplDodagEntry 7 }

rplDodagDAOAckEnabled OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "Indicates whether DAO Acknowledgements are sent on this
         DODAG."
    ::= { rplDodagEntry 8 }

rplDodagPreference OBJECT-TYPE
    SYNTAX      RplDodagPreference
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
```

```
        "How preferred this DODAG is compared to other DODAGs
         within the same instance."
    ::= { rplDodagEntry 9 }

rplDodagMinHopRankIncrease OBJECT-TYPE
    SYNTAX      RplMinHopRankIncrease
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The minimum increase of the rank in a single hop."
    ::= { rplDodagEntry 10 }

rplDodagMaxRankIncrease OBJECT-TYPE
    SYNTAX      Unsigned32 (0..65535)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
         "The maximum allowable increase in rank in support of local
          repair.  If DAGMaxRankIncrease is 0 then this mechanism is
          disabled."
    ::= { rplDodagEntry 11 }

rplDodagIntervalDoublings OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The Imax parameter of the DIO trickle timer."
    REFERENCE
        "RFC 6206: The Trickle Algorithm"
    ::= { rplDodagEntry 12 }

rplDodagIntervalMin OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The Imin parameter of the DIO trickle timer."
    REFERENCE
        "RFC 6206: The Trickle Algorithm"
    ::= { rplDodagEntry 13 }

rplDodagRedundancyConstant OBJECT-TYPE
    SYNTAX      Unsigned32 (0..255)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The k parameter of the DIO trickle timer."
```

```
    REFERENCE
        "RFC 6206: The Trickle Algorithm"
    ::= { rplDodagEntry 14 }

rplDodagPathControlSize OBJECT-TYPE
    SYNTAX      RplPathControlSize
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The Path Control Size of this DODAG."
    ::= { rplDodagEntry 15 }

rplDodagParentTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF RplDodagParentEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The list of parents of a DODAG."
    ::= { rplObjects 6 }

rplDodagParentEntry OBJECT-TYPE
    SYNTAX      RplDodagParentEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "Information about a known DODAG parent."
    INDEX { rplInstanceID, rplDodagIndex, rplDodagParentID }
    ::= { rplDodagParentTable 1 }

RplDodagParentEntry ::= SEQUENCE {
    rplDodagParentID     InetAddressIPv6,
    rplDodagParentIf     InterfaceIndex
}

rplDodagParentID OBJECT-TYPE
    SYNTAX      InetAddressIPv6
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The address of a parent associated with this DODAG."
    ::= { rplDodagParentEntry 1 }

rplDodagParentIf OBJECT-TYPE
    SYNTAX      InterfaceIndex
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The interface over which the parent can be reached."
```

```
    ::= { rplDodagParentEntry 2 }

rplDodagChildTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF RplDodagChildEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The list of children of a DODAG."
    ::= { rplObjects 7 }

rplDodagChildEntry OBJECT-TYPE
    SYNTAX      RplDodagChildEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "Information about a known DODAG child."
    INDEX { rplInstanceID, rplDodagIndex, rplDodagChildID }
    ::= { rplDodagChildTable 1 }

RplDodagChildEntry ::= SEQUENCE {
    rplDodagChildID     InetAddressIPv6,
    rplDodagChildIf     InterfaceIndex
}

rplDodagChildID OBJECT-TYPE
    SYNTAX      InetAddressIPv6
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The address of an RPL child associated with this DODAG."
    ::= { rplDodagChildEntry 1 }

rplDodagChildIf OBJECT-TYPE
    SYNTAX      InterfaceIndex
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The interface over which the child can be reached."
    ::= { rplDodagChildEntry 2 }

rplStats OBJECT IDENTIFIER ::= { rplObjects 8 }

rplMemOverflows OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of memory allocation failures (e.g., routing table
```

```
         overflows)."
    ::= { rplStats 1 }

rplParseErrors OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of received malformed messages."
    ::= { rplStats 2 }

rplUnknownMsgTypes OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of received RPL messages that we dropped because
         the message type is not recognized by the implementation."
    ::= { rplStats 3 }

rplSecurityPolicyViolations OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of messages discarded because the described level
         of security for the message type and originator is unknown or
         does not meet locally maintained security policies as defined
         in Section 10.7 of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    ::= { rplStats 4 }

rplIntegrityCheckFailures OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of messages discarded because the integrity
         check failed against the received message authentication
         code (MAC) as defined in Section 10.7 of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    ::= { rplStats 5 }

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

```
    STATUS      current
    DESCRIPTION
        "The number of messages discarded because the received
         message Counter value is non-zero and less than the
         maintained incoming Counter watermark or because the
         received Timestamp Counter value indicates a message
         transmission time that is earlier than the Current time
         less the acceptable packet delay as defined in Section
         10.7 of RFC 6550. This counter is also incremented if the
         temporal consistency check of the message fails as defined
         in Section 10.7.1."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    ::= { rplStats 6 }

rplValidParentFailures OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of times a packet could not be sent to a DODAG
         parent flagged as valid."
    ::= { rplStats 7 }

rplNoInstanceIDs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of times a packet could not be sent because of
         a missing RPLInstanceID."
    ::= { rplStats 8 }

rplTriggeredLocalRepairs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of times a local repair procedure was triggered."
    ::= { rplStats 9 }

rplTriggeredGlobalRepairs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of times a global repair procedure was triggered."
    ::= { rplStats 10 }
```

```
rplNoParentSecs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of seconds without a next hop (DODAG parent)."
    ::= { rplStats 11 }

rplActiveNoParentSecs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of seconds with packets to forward without a
         next hop (DODAG parent)."
    ::= { rplStats 12 }

rplOBitSetDownwards OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "Number of packets received with the 'O' bit set from
         a node with a higher rank as defined in Section 18.3.2
         of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    ::= { rplStats 13 }

rplOBitClearedUpwards OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "Number of packets received with the 'O' bit cleared
         from a node with a lower rank as defined in Section 18.3.2
         of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    ::= { rplStats 14 }

rplFBitSet OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "Number of packets received with the 'F' bit set as
         defined in Section 18.3.2 of RFC 6550."
```

```
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    ::= { rplStats 15 }

rplRBitSet OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "Number of packets received with the 'R' bit set as
         defined in Section 18.3.2 of RFC 6550."
    REFERENCE
        "RFC 6550: RPL: IPv6 Routing Protocol for LLNs"
    ::= { rplStats 16 }

rplTrickleTimerResets OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of trickle timer resets."
    ::= { rplStats 17 }

rplMsgStatsTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF RplMsgStatsEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "Basic RPL message statistics by message type."
    ::= { rplObjects 9 }

rplMsgStatsEntry OBJECT-TYPE
    SYNTAX      RplMsgStatsEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "Statistics for a specific RPL message type."
    INDEX { rplMsgStatsType }
    ::= { rplMsgStatsTable 1 }

RplMsgStatsEntry ::= SEQUENCE {
    rplMsgStatsType    RplMessageType,
    rplMsgStatsInMsgs  Counter32,
    rplMsgStatsOutMsgs Counter32
}

rplMsgStatsType OBJECT-TYPE
    SYNTAX      RplMessageType
```

```
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The RPL message type being counted by this row."
    ::= { rplMsgStatsEntry 1 }

rplMsgStatsInMsgs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of RPL messages received of this type."
    ::= { rplMsgStatsEntry 2 }

rplMsgStatsOutMsgs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of RPL messages sent of this type."
    ::= { rplMsgStatsEntry 3 }

-- conformance definitions

rplGroups      OBJECT IDENTIFIER ::= { rplConformance 1 }
rplCompliances OBJECT IDENTIFIER ::= { rplConformance 2 }

rplFullCompliance MODULE-COMPLIANCE
    STATUS      current
    DESCRIPTION
        "Compliance statement for implementations supporting
         read/write access, according to the object definitions."
    MODULE      -- this module
    MANDATORY-GROUPS {
        rplGeneralGroup,
        rplInstanceGroup,
        rplStatsGroup
    }
    ::= { rplCompliances 1 }

rplReadOnlyCompliance MODULE-COMPLIANCE
    STATUS      current
    DESCRIPTION
        "Compliance statement for implementations supporting
         only readonly access."
    MODULE      -- this module
    MANDATORY-GROUPS {
        rplGeneralGroup,
```

```
        rplInstanceGroup,
        rplStatsGroup
    }

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

    ::= { rplCompliances 2 }

rplGeneralGroup OBJECT-GROUP
    OBJECTS {
        rplDefaultDISMode,
        rplDefaultDISMessages,
        rplDefaultDISTimeout,
        rplDefaultDAODelay,
        rplDefaultDAOAckEnabled,
        rplDefaultPreference,
        rplDefaultMinHopRankIncrease,
        rplDefaultMaxRankIncrease,
        rplDefaultModeOfOperation,
```

```
        rplDefaultIntervalDoublings,
        rplDefaultIntervalMin,
        rplDefaultRedundancyConstant,
        rplActiveInstance,
        rplActiveDodag,
        rplActiveDodagTriggerSequence,
        -- rplOCPCodepoint,
        rplOCPEnabled
    }
    STATUS      current
    DESCRIPTION
        "A collection of objects providing general information about
         the RPL implementation."
    ::= { rplGroups 1 }

rplInstanceGroup OBJECT-GROUP
    OBJECTS {
        -- rplInstanceID,
        rplInstanceDISMode,
        rplInstanceDISMessages,
        rplInstanceDISTimeout,
        rplInstanceModeOfOperation,
        -- rplDodagIndex,
        rplDodagID,
        rplDodagVersion,
        rplDodagRank,
        rplDodagState,
        rplDodagOCP,
        rplDodagDAODelay,
        rplDodagDAOAckEnabled,
        rplDodagPreference,
        rplDodagMinHopRankIncrease,
        rplDodagMaxRankIncrease,
        rplDodagIntervalDoublings,
        rplDodagIntervalMin,
        rplDodagRedundancyConstant,
        rplDodagPathControlSize,
        -- rplDodagParentID,
        rplDodagParentIf,
        -- rplDodagChildID,
        rplDodagChildIf
    }
    STATUS      current
    DESCRIPTION
        "A collection of objects providing insight into RPL
         Instances and RPL DODAGs."
    ::= { rplGroups 2 }
```

```
rplStatsGroup OBJECT-GROUP
    OBJECTS {
        rplMemOverflows,
        rplParseErrors,
        rplUnknownMsgTypes,
        rplSecurityPolicyViolations,
        rplIntegrityCheckFailures,
        rplReplayProtectionFailures,
        rplValidParentFailures,
        rplNoInstanceIDs,
        rplTriggeredLocalRepairs,
        rplTriggeredGlobalRepairs,
        rplNoParentSecs,
        rplActiveNoParentSecs,
        rplOBitSetDownwards,
        rplOBitClearedUpwards,
        rplFBitSet,
        rplRBitSet,
        rplTrickleTimerResets,
        -- rplMsgStatsType,
        rplMsgStatsInMsgs,
        rplMsgStatsOutMsgs
    }
    STATUS      current
    DESCRIPTION
        "A collection of objects providing statistics about the
         RPL implementation."
    ::= { rplGroups 3 }

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:

- The objects below rplDefaults control the operation of RPL. Unauthorized access to these objects can either make RPL inefficient or even fail to converge.

- The objects below rplActive select the currently active RPL DODAG in the currently active RPL Instance. Unauthorized changes may prevent communication or cause loss of efficiency.

- The rplOCPTable controls which objective functions can be used by an RPL implementation. Unauthorized access may prevent certain RPL instances to be established or less it may cause less efficient RPL instances to be used.

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 tables and objects provide detailed information about the structure and operation of RPL instances and the topology of the DODAGs. This information may be exploited to target attacks or to gain insights about the structure of a certain deployment.

The counters of the RPL-MIB are provided primarily to assist in troubleshooting problems in RPL deployments. The counters, however, may also be used to gain insights into certain active attacks on RPL itself.

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.

IANA has allocated a number for RPL in the IANAipRouteProtocol textual convention of the IANA-RTPROTO-MIB.

9. Acknowledgements

The authors like to thank Michael Richardson for providing helpful comments during the development of this specification.

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

[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.

[RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", RFC 2863, June 2000.

[RFC4001] Daniele, M., Haberman, B., Routhier, S., and J. Schoenwaelder, "Textual Conventions for Internet Network Addresses", RFC 4001, February 2005.

[RFC4292] Haberman, B., "IP Forwarding Table MIB", RFC 4292, April 2006.

[RFC4293] Routhier, S., "Management Information Base for the Internet Protocol (IP)", RFC 4293, April 2006.

[RFC6206] Levis, P., Clausen, T., Hui, J., Gnawali, O., and J. Ko, "The Trickle Algorithm", RFC 6206, March 2011.

[RFC6550] Winter, T., Thubert, P., Brandt, A., Hui, J., Kelsey, R., Levis, P., Pister, K., Struik, R., Vasseur, JP., and R. Alexander, "RPL: IPv6 Routing Protocol for Low-Power and Lossy Networks", RFC 6550, March 2012.

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.

[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 XXXX octets. (Of course, this number depends on the number of octets needed for the counter values.)

```
{
    "RPL-MIB:RPL-MIB": {
        "rplGeneral": {
            "rplDefaultDISMode": "silent",
            "rplDefaultDISMessages": 1,
```

```
            "rplDefaultDISTimeout": 60,
            "rplDefaultDAODelay": 1000,
            "rplDefaultDAOAckEnabled": false,
            "rplDefaultPreference": 0,
            "rplDefaultMinHopRankIncrease": 256,
            "rplDefaultMaxRankIncrease": 65535,
            "rplDefaultModeOfOperation":
               "storingWithoutMulticastSupport",
            "rplDefaultIntervalDoublings": 20,
            "rplDefaultIntervalMin": 3,
            "rplDefaultRedundancyConstant": 10
        },
        "rplActive": {
            "rplActiveInstance": 0,
            "rplActiveDodag": "2001:db8:bad:cafe::1",
            "rplActiveDodagTriggerSequence": 4
        },
        "rplStats": {
            "rplMemOverflows": 0,
            "rplParseErrors": 0,
            "rplUnknownMsgTypes": 1,
            "rplSecurityPolicyViolations": 0,
            "rplIntegrityCheckFailures": 0,
            "rplReplayProtectionFailures": 0,
            "rplValidParentFailures": 1,
            "rplNoInstanceIDs": 0,
            "rplTriggeredLocalRepairs": 3,
            "rplTriggeredGlobalRepairs": 0,
            "rplNoParentSecs": 15,
            "rplActiveNoParentSecs": 0,
            "rplOBitSetDownwards": 0,
            "rplOBitClearedUpwards": 0,
            "rplFBitSet": 0,
            "rplRBitSet": 0,
            "rplTrickleTimerResets": 42
        },
        "rplOCPTable": {
            "rplOCPEntry": [
                {
                    "rplOCPCodepoint": 0,
                    "rplOCPEnabled": true
                }
            ]
        },
        "rplInstanceTable": {
            "rplInstanceEntry": [
                {
                    "rplInstanceID": 0,
```

```
                    "rplInstanceDISMode": "send",
                    "rplInstanceDISMessages": 1,
                    "rplInstanceDISTimeout": 60,
                    "rplInstanceModeOfOperation":
                         "storingWithoutMulticastSupport"
                }
            ]
        },
        "rplDodagTable": {
            "rplDodagEntry": [
                {
                    "rplInstanceID": 0,
                    "rplDodagIndex": 1,
                    "rplDodagID": "2001:db8:bad:cafe::1",
                    "rplDodagVersion": 3,
                    "rplDodagRank": 2,
                    "rplDodagState": "grounded",
                    "rplDodagOCP": 0,
                    "rplDodagDAODelay": 1000,
                    "rplDodagDAOAckEnabled": false,
                    "rplDodagPreference": 0,
                    "rplDodagMinHopRankIncrease": 256,
                    "rplDodagMaxRankIncrease": 0,
                    "rplDodagIntervalDoublings": 20,
                    "rplDodagIntervalMin": 3,
                    "rplDodagRedundancyConstant": 10,
                    "rplDodagPathControlSize": 0
                }
            ]
        },
        "rplDodagParentTable": {
             "rplDodagParentEntry": [
                 {
                     "rplRPLInstanceID": 0,
                     "rplDodagIndex": 1,
                     "rplDodagParentID": "2001:db8:bad:cafe::8",
                     "rplDodagParentIf": 1
                 }
             ]
        },
        "rplDodagChildTable": {
            "rplDodagChildEntry": [
                {
                    "rplRPLInstanceID": 0,
                    "rplDodagIndex": 1,
                    "rplDodagChildID": "2001:db8:bad:cafe::a"
                    "rplDodagChildIf": 1
                },
```

```
                    {
                        "rplRPLInstanceID": 0,
                        "rplDodagIndex": 1,
                        "rplDodagChildID": "2001:db8:bad:cafe::b"
                        "rplDodagChildIf": 2
                    }
                ]
            },
            "rplMsgStatsTable": {
                "rplMsgStatsEntry": [
                    {
                        "rplMsgStatsType": 0,
                        "rplMsgStatsInMsgs": 78,
                        "rplMsgStatsOutMsgs": 23
                    },
                    {
                        "rplMsgStatsType": 1,
                        "rplMsgStatsInMsgs": 11,
                        "rplMsgStatsOutMsgs": 54
                    },
                    {
                        "rplMsgStatsType": 2,
                        "rplMsgStatsInMsgs": 87,
                        "rplMsgStatsOutMsgs": 28
                    },
                    {
                        "rplMsgStatsType": 4,
                        "rplMsgStatsInMsgs": 47,
                        "rplMsgStatsOutMsgs": 38
                    }
                ]
            }
        }
    }
```


Authors' Addresses

Kevin Korte
Jacobs University
Campus Ring 1
Bremen 28759
Germany

EMail: k.korte@jacobs-university.de

Juergen Schoenwaelder
Jacobs University
Campus Ring 1
Bremen 28759
Germany

EMail: j.schoenwaelder@jacobs-university.de

Anuj Sehgal
Jacobs University
Campus Ring 1
Bremen 28759
Germany

EMail: s.anuj@jacobs-university.de

Tina Tsou
Huawei Technologies (USA)
2330 Central Expressway
Santa Clara CA 95050
USA

EMail: tina.tsou.zouting@huawei.com

Cathy Zhou
Huawei Technologies
Bantian, Longgang District
Shenzhen 518129
P.R. China

EMail: cathyzhou@huawei.com