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).

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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 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 | rplOCPEnsabled(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] |
| ++ r-n InterfaceIndex | rplDodagParentIf(2) |
| +- rplDodagChildTable(7) |
| ++ rplDodagChildEntry(1) [rplInstanceID,rplDodagIndex, rplDodagChildID] |
| ++ r-n InterfaceIndex | rplDodagChildIf(2) |
| +- rplStats(8) |
| ++ r-n Counter32 | rplMemOverflows(1) |
| ++ r-n Counter32 | rplParseErrors(2) |
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).

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REVISION "201302200000Z"
DESCRIPTION
"Initial version, published as RFC XXXX."
-- RFC Ed.: replace XXXX with actual RFC number & remove this note
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."
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
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 }

rp1OCPTable 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 I\text{max} 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 I\text{min} 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
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.

"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."
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 15 }

rplTrickleTimerResets OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The number of trickle timer resets."
::= { rplStats 16 }

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,
}
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

{ rplGroups 1 }

rplGroups 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

{ rplGroups 2 }
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.

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

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10. References

10.1. Normative References


10.2. Informative References


Appendix A. JSON Representation

Using the translation algorithm defined in [RFC6643], the SMIv2 module can be translated to YANG. Using the JSON representation of data modeled in YANG defined in [I-D.lhotka-netmod-yang-json], the objects defined in the MIB module can be represented in JSON as shown below. The compact representation without any white space uses XXXX octets. (Of course, this number depends on the number of octets needed for the counter values.)

```json
{
    "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,
            "rplActive": false,
            "rplActiveInstance": 0,
            "rplActiveDodag": "2001:db8:bad:cafe::1",
            "rplActiveDodagTriggerSequence": 4
        }
    ]
}
"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
    }
}]
}

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