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June 27, 2016

A YANG model for Multicast Protocol for Low power and lossy Networks
(MPL)
draft-vanderstok-roll-mpl-yang-01

Abstract

This document defines a YANG data model for management of Multicast Protocol for Low power and lossy Networks (MPL) implementations. The data model includes configuration data and state data.

Note

Discussion and suggestions for improvement are requested, and should be sent to roll@ietf.org.

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Table of Contents

1.	Introduction	2
1.1.	Terminology	2
1.1.1.	Tree Diagrams	3
2.	MPL model	3
3.	yang-mpl modules	5
3.1.	yang-mpl-domain module	5
3.2.	yang-mpl-ops module	8
3.3.	yang-mpl-seeds module	11
3.4.	yang-mpl-statistics module	15
4.	IANA Considerations	19
5.	Acknowledgements	19
6.	Changelog	19
7.	References	19
7.1.	Normative References	19
7.2.	Informative References	20
	Author's Address	20

1. Introduction

This document defines a YANG [RFC6020] data model for management of Multicast Protocol for Low power and lossy Networks (MPL) [RFC7731] implementations. The data model covers configuration of per-interface MPL parameters. It also provides information about which Multicast addresses are operationally used, and the seeds for which packets are forwarded

1.1. Terminology

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 [RFC2119].

The following terms are defined in [RFC6241] and are not redefined here:

- o client
- o configuration data
- o server

- o state data

The following terms are defined in [RFC6020] and are not redefined here:

- o data model
- o data node

The terminology for describing YANG data models is found in [RFC6020].

Terms like domain, seed, I, k, c are defined in [RFC7731].

1.1.1. Tree Diagrams

A simplified graphical representation of the data model is used in the YANG modules specified in this document. The meaning of the symbols in these diagrams is as follows:

Brackets "[" and "]" enclose list keys.

Abbreviations before data node names: "rw" means configuration data (read-write) and "ro" state data (read-only).

Symbols after data node names: "?" means an optional node, "!" means a presence container, and "*" denotes a list and leaf-list.

Parentheses enclose choice and case nodes, and case nodes are also marked with a colon (":").

Ellipsis ("...") stands for contents of subtrees that are not shown.

2. MPL model

This document defines the YANG module "ietf-yang-mpl", which specifies a data model for MPL servers. The model consists of the following parts: (1) a "mpl-domain" part that describes the MPL-domains and associated Multicast addresses and the interfaces on which the Multicast addresses are enabled, (2) a "mpl-op" part that describes the parameters settings per seed, (3) a "mpl-seeds" part that describes the MPL buffer contents and the Trickle timer values, and (4) a "mpl-statistics" part that describes the number of lost and correctly forwarded messages. The data model, divided in four modules, has the following structure for MPL configuration per node:

```

module: ietf-yang-mpl-domain
  +--rw (single)?
    +--:(mpl-domain)
      |
      | +--rw mpl-domain
      | |
      | | +--rw domains* [domainID]
      | | |
      | | | +--rw domainID      uint16
      | | | +--rw MCList*      inet:ipv6-address
      | | +--rw addresses* [MCaddress]
      | | |
      | | | +--rw MCaddress     inet:ipv6-address
      | | | +--rw interfaces*  string
      |
      +--:(mpl-single)
        +--rw mpl-single
          +--rw MCaddresses*  inet:ipv6-address

module: ietf-yang-mpl-ops
  +--rw mpl-ops
    +--rw SE_LIFETIME?          uint16
    +--rw PROACTIVE_FORWARDING? boolean
    +--rw SEED_SET_ENTRY_LIFETIME? uint64
    +--rw mpl-parameter* [domainID]
      +--rw domainID          uint16
      +--rw DATA_MESSAGE_IMIN?  uint16
      +--rw DATA_MESSAGE_IMAX?  uint16
      +--rw DATA_MESSAGE_K?     uint16
      +--rw DATA_MESSAGE_TIMER_EXPIRATIONS? uint16
      +--rw CONTROL_MESSAGE_IMIN? uint16
      +--rw CONTROL_MESSAGE_IMAX? uint16
      +--rw CONTROL_MESSAGE_K?   uint16
      +--rw CONTROL_MESSAGE_TIMER_EXPIRATIONS? uint16

module: ietf-yang-mpl-seeds
  +--ro mpl-seeds* [seedID domainID]
    +--ro seedID          uint64
    +--ro domainID       uint16
    +--ro local?         boolean
    +--ro generate-seqno? uint8
    +--ro life-time?     uint64
    +--ro min-seqno?     uint8
    +--ro data-number?   uint8
    +--ro control-number? uint8
    +--ro buffered-messages* [seqno]
      +--ro seqno      uint8
      +--ro I?         uint8
      +--ro c?         uint8
      +--ro e?         uint8
      +--ro t?         uint8

module: ietf-yang-mpl-statistics

```

```
+--ro mpl-statistics* [seedID domainID]
  +--ro seedID          uint64
  +--ro domainID       uint16
  +--ro c-too-high?    uint64
  +--ro nr-forwarded?  uint64
  +--ro nr-of-messages-received? uint64
  +--ro nr-of-copies-received?  uint64
  +--ro nr-of-messages-forwarded? uint64
  +--ro nr-of-copies-forwarded?  uint64
  +--ro nr-of-refused?   uint64
  +--ro nr-of-missed?   uint64
  +--ro nr-of-notreceived? uint64
  +--ro nr-of-inconsistent-data? uint64
  +--ro nr-of-consistent-data?  uint64
  +--ro nr-of-consistent-control? uint64
  +--ro nr-of-inconsistent-control? uint64
```

3. yang-mpl modules

This section describes four yang modules. The model is based on the MPL specification published in [RFC7731] and the specification of [RFC6206]. The identification of the interfaces follows the specification of ietf-interfaces of [RFC7223].

The data model allows to set values to the parameters of the MPL algorithm. This approach requires an active manager process to set the values without use of DHCP as described in: [RFC7774].

The names of the four modules are: yang-mpl-domain, yang-mpl-ops, yang-mpl-seeds, and yang-mpl-statistics, described in subsections with the same name.

3.1. yang-mpl-domain module

This modules describes (1) the MPL domains and the associated multicast addresses, and (2) the interfaces and the multicast addresses for which they are enabled.

The model features a choice such that for constrained devices with only one "single" interface and only one "single" domain, the model specifies a list of MC addresses for which the single interface is enabled.

<CODE BEGINS>

```
module ietf-yang-mpl-domain {
```

```
yang-version 1;

namespace
  "urn:ietf:params:xml:ns:yang:ietf-yang-mpl-domain";

prefix mpl;

import ietf-inet-types{
  prefix inet;
}

organization
  "IETF ROLL (Routing Over Low power and lossy networks) Working Group";

contact
  "WG Web:   http://tools.ietf.org/wg/roll/
  WG List:  mailto:roll@ietf.org

  WG Chair: Peter van der Stok
             mailto:consultancy@vanderstok.org

  WG Chair: Ines Robles
             mailto:maria.ines.robles@ericsson.com

  Editor:   Peter van der Stok
             mailto:consultancy@vanderstok.org";

description
  "This module contains information about the state of the MPL domain.

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revision "2016-05-18" {
  description "Initial revision.";
  reference
    "I-D:draft-vanderstok-roll-mpl-yang: A YANG model for Multicast Prot
    ocol for Low power and lossy Networks (MPL)";
}
```

```

choice single {
  description
  "A choice between single domain/interface and multiple
  domains and interfaces.";
  container mpl-domain {
    description
    "The entries describe the MPL domains, the associated
    Multicast addresses and interfaces.";

    list domains {
      key domainID;
      description
      "The entries describe a given domain identified with domainID and t
      he associated Multicast addresses.";

      leaf domainID {
        type uint16;
        description
        "Entry uniquely identifies the domain in the
        forwarder.";
      }

      leaf-list Mclist{
        type inet:ipv6-address;
        description
        "List of associated IPv6 Addresses.";
      }
    } // domains list

    list addresses {
      key MCaddress;
      description
      "The entries describe the interfaces enabled with the specified M
      C address.";

      leaf MCaddress {
        type inet:ipv6-address;
        description
        "MC address belonging to a MPL domain.";
      }

      leaf-list interfaces {
        type string;
        description
        "List of names of interfaces enabled for this Multicast address
        . Interface name is defined in [RFC6206].";
      }
    } // addresses list
  } // container mpl-domain
  container mpl-single {
    description

```



```
        "For small devices list of MC addresses for single
        interface and domain.";
    leaf-list MCaddresses{
        type inet:ipv6-address;
        description
            "list of MC addresses belonging to one single domain and int
erface.";
    }
} // container mpl-simple
} // choice simple
} //module ietf-yang-mpl-domain
```

<CODE ENDS>

3.2. yang-mpl-ops module

This module models the operational aspects of MPL. Per domain MPL specifies four parameters I_MAX, I_MIN, K, and TIMER_EXPIRATIONS for data and control messages. The value of the MPL intervals are expressed in TUNIT. The entry SE_LIFETIME taken over from [RFC7774] fixes TUNIT to milliseconds. For very constrained devices with only one domain there can be only one instance of mpl-parameter list.

<CODE BEGINS>

```
module ietf-yang-mpl-ops {

    yang-version 1;

    namespace
        "urn:ietf:params:xml:ns:yang:ietf-yang-mpl-ops";

    prefix mpl;

    organization
        "IETF ROLL (Routing over Low power and lossy networks) Working Group";

    contact
        "WG Web:  http://tools.ietf.org/wg/roll/
        WG List:  mailto:roll@ietf.org

        WG Chair: Peter van der Stok
                  mailto:consultancy@vanderstok.org

        WG Chair: Ines Robles
                  mailto:maria.ines.robles@ericsson.com
```

Editor: Peter van der Stok
mailto:consultancy@vanderstok.org";

description

"This module contains information about the operation of the MPL protocol.
1.

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```
revision "2016-05-18" {  
  description "Initial revision.";  
  reference  
    "I-D:draft-vanderstok-roll-mpl-yang: A YANG model for Multicast Protocol for Low power and lossy Networks (MPL)";  
}
```

```
container mpl-ops {  
  description  
    "Parameter settings for each MPL server and for each individual domain of the server.";
```

```
  leaf SE_LIFETIME {  
    type uint16;  
    description  
      "lifetime in milliseconds/(mpl timer units),  
      equivalent to SEED_SET_ENTRY_LIFETIME/TUNIT as  
      specified in RFC7774.";
```

```
  leaf PROACTIVE_FORWARDING {  
    type boolean;  
    description  
      "The boolean value indicates whether the MPL forwarder  
      schedules MPL data message transmission after  
      receiving them for the first time.";
```

```
  leaf SEED_SET_ENTRY_LIFETIME {
```



```
    type uint64;
    description
      "The value indicates the minimum lifetime for an entry
       in the Seed set expressed in seconds. Default value
       is 30 minutes.";
  }

  list mpl-parameter{
    key domainID;
    description
      "Each domain has a set of MPL forwarding parameters
       which regulate the forwarding operation.";

    leaf domainID{
      type uint16;
      description
        "Each domainID must be present in  mpl-parameter list.";
    }

    leaf DATA_MESSAGE_IMIN{
      type uint16;
      description
        "The minimum Trickle timer interval, as defined in
         [RFC6206], for MPL Data Message transmissions.";
    }

    leaf DATA_MESSAGE_IMAX{
      type uint16;
      description
        "The maximum Trickle timer interval, as defined in
         [RFC6206], for MPL Data Message transmissions.";
    }

    leaf DATA_MESSAGE_K{
      type uint16;
      default 1;
      description
        "The redundancy constant, as defined in [RFC6206], for
         MPL Data Message transmissions.";
    }

    leaf DATA_MESSAGE_TIMER_EXPIRATIONS{
      type uint16;
      default 3;
      description
        "The number of Trickle timer expirations that occur
         before terminating the Trickle algorithm's
         retransmission of a given MPL Data Message.";
    }
  }
}
```

```
    }

    leaf CONTROL_MESSAGE_IMIN{
    type uint16;
    description
        "The minimum Trickle timer interval, as defined
        in [RFC6206], for MPL Control Message
        transmissions.";
    }

    leaf CONTROL_MESSAGE_IMAX{
    type uint16;
    description
        "The maximum Trickle timer interval, as defined
        in [RFC6206], for MPL Control Message
        transmissions.";
    }

    leaf CONTROL_MESSAGE_K{
    type uint16;
    default 1;
    description
        "The redundancy constant, as defined in [RFC6206],
        for MPL Control Message transmissions.";
    }

    leaf CONTROL_MESSAGE_TIMER_EXPIRATIONS{
    type uint16;
    default 10;
    description
        "The number of Trickle time expirations that occur
        before terminating the Trickle algorithm
        for MPL Control Message transmissions.";
    }

    } // list MPL-parameter
} // container MPL-ops
} // module ietf-yang-mpl-ops

<CODE ENDS>
```

3.3. yang-mpl-seeds module

This module specifies the current values of the operation of the MPL forwarder. The values are acquired by the client and set by the server. The module specifies a set of message buffers, with a buffer

per seed and domain. In constrained devices there will be only one domain, but probably multiple seeds.

The message buffer contains a set of messages where each message is uniquely identified by its sequence number and seed. The associated I, c, e, and t values indicate the progress of MPL with respect to this message, as specified in [RFC7731]. A forwarder sends and receives multiple copies of a message. When a forwarder has sent (received) a copy of a message, the forwarder has sent (received) that message.

For forwarders which are seeds, local has value true and seqno is the sequence number of the next message to send.

<CODE BEGINS>

```
module ietf-yang-mpl-seeds {  
  
  yang-version 1;  
  
  namespace  
    "urn:ietf:params:xml:ns:yang:ietf-yang-mpl-seeds";  
  
  prefix mpl;  
  
  organization  
    "IETF ROLL (Routing over Low power and lossy networks) Working Group";  
  
  contact  
    "WG Web:  http://tools.ietf.org/wg/roll/  
    WG List:  mailto:roll@ietf.org  
  
    WG Chair: Peter van der Stok  
              mailto:consultancy@vanderstok.org  
  
    WG Chair: Ines Robles  
              mailto:maria.ines.robles@ericsson.com  
  
    Editor:   Peter van der Stok  
              mailto:consultancy@vanderstok.org";  
  
  description  
    "This module contains information about the operation of the MPL protocol.  
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```
revision "2016-05-18" {
  description "Initial revision.";
  reference
    "I-D:draft-vanderstok-roll-mpl-yang: A YANG model for Multicast Protocol for Low power and lossy Networks (MPL)";
}

list mpl-seeds{
  key "seedID domainID";
  config false;
  description
    "List describes all seeds that are active in the server. Seed information contains the message buffer contents and the operational values of I, c, sequence number and the life-times per message.";

  leaf seedID{
    type uint64;
    description
      "value uniquely identifies the MPL Seed within a MPL domain.";
  }

  leaf domainID{
    type uint16;
    description
      "together with seedID uniquely identifies buffer set.";
  }

  leaf local {
    type boolean;
    description
      "When local == TRUE, seed is located in this forwarder. WHEN local == false, seed is located in different forwarder.";
  }

  leaf generate-seqno {
    type uint8;
    description
      "Sequence number of next message to be generated by this local seed.";
  }
}
```



```
leaf life-time {
  type uint64;
  description
    " Minimum remaining lifetime of the seed entry in
      SE_LIFETIME units.";
}

leaf min-seqno{
  type uint8;
  description
    "Lower bound sequence number in the buffer of the seed.";
}

leaf data-number{
  type uint8;
  description
    "Number of currently buffered data messages.";
}

leaf control-number{
  type uint8;
  description
    "Number of currently buffered control messages.";
}

list buffered-messages{
  key seqno;
  description
    " status of trickle intervals of the buffered message identified b
y seqno. and seed/domain";

  leaf seqno{
    type uint8;
    description
      "Sequence number of message.";
  }

  leaf I{
    type uint8;
    description
      "Current Trickle timer interval size in SE-LIFETIME units.";
  }

  leaf c{
    type uint8;
    description
      "number of times that copy of this message has been
        received in this interval.";
  }
}
```

```
leaf e{
  type uint8;
  description
    "number of Trickle time expirations since last
     Trickle timer reset.";
}

leaf t{
  type uint8;
  description
    " Time expressed in SE-LIFETIME units
     that message will be (is) forwarded";
}
} // list seed-timers
} // list MPL-seeds
} // module ietf-yang-mpl-seeds
```

<CODE ENDS>

3.4. yang-mpl-statistics module

This module specifies the operation of the MPL forwarder expressed in number of messages and copies. The values are acquired by the client and set by the server. Statistics are specified per seed and domain. In constrained devices there will be only one domain, but probably multiple seeds.

The parameter *k* determines how many copies of a message can be forwarded. The counters *c-too-high*, *nr-forwarded*, and *nr-not-forwarded* give insight in the consequences of the current value of *k*.

The other counters give insight in the loss of messages caused by the medium or forwarding delays. The *inconsistent/consistent* counters indicate when consistent or inconsistent messages were received according to the definition of consistent in [RFC7731].

<CODE BEGINS>

```
module ietf-yang-mpl-statistics {

  yang-version 1;

  namespace
    "urn:ietf:params:xml:ns:yang:ietf-yang-mpl-statistics";
```

```
prefix mpl;

organization
  "IETF ROLL (Routing over Low power and lossy networks) Working Group";

contact
  "WG Web:  http://tools.ietf.org/wg/roll/
  WG List:  mailto:roll@ietf.org

  WG Chair: Peter van der Stok
             mailto:consultancy@vanderstok.org

  WG Chair: Ines Robles
             mailto:maria.ines.robles@ericsson.com

  Editor:   Peter van der Stok
             mailto:consultancy@vanderstok.org";

description
  "This module contains information about the operation of the MPL proto
  col.

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  the RFC itself for full legal notices.";

revision "2016-05-18" {
  description "Initial revision.";
  reference
    "I-D:draft-vanderstok-roll-mpl-yang: A YANG model for Multicast Prot
    ocol for Low power and lossy Networks (MPL)";
}

list mpl-statistics{
  key "seedID domainID";

  config false;
```


description

"List describes performance statistics integrated over the messages identified by seed and domain identifiers. A forwarder can receive and forward multiple copies of a message uniquely identified by seqno, domain, and seed.";

```
leaf seedID{
  type uint64;
  description
    "value uniquely identifies the MPL Seed within a MPL
    domain.";
}
```

```
leaf domainID{
  type uint16;
  description
    "together with seed-ID uniquely identifies buffer set.";
}
```

```
leaf c-too-high {
  type uint64;
  description
    "Number of times that a copy was not forwarded
    because c > k.";
}
```

```
leaf nr-forwarded {
  type uint64;
  description
    "number of times copies are forwarded, while c <= k.";
}
```

```
leaf nr-of-messages-received{
  type uint64;
  description
    "number of messages (one or more copies) received, must be smaller
    than or equal to seqno.";
}
```

```
leaf nr-of-copies-received{
  type uint64;
  description
    "total number of message copies received.";
}
```

```
leaf nr-of-messages-forwarded{
  type uint64;
  description
    "number of forwarded messages, must be smaller than or equal to nr
    -of-messages-received.";
}
```

```
leaf nr-of-copies-forwarded{
```



```
    type uint64;
    description
        "number of forwarded copies, can be larger than number-of-copies-r
eceived.";
}

leaf nr-of-refused{
type uint64;
description
    "number of refused copies because seqno too small.";
}

leaf nr-of-missed{
type uint64;
description
    "number of messages that were not received (derived from gaps in
received seqno's.)";
}

leaf nr-of-notreceived{
type uint64;
description
    "number of messages that were not received
    according to control message.";
}

leaf nr-of-inconsistent-data{
type uint64;
description
    "number of inconsistent data messages.";
}

leaf nr-of-consistent-data{
type uint64;
description
    "number of consistent data messages.";
}

leaf nr-of-consistent-control{
type uint64;
description
    "number of consistent control messages.";
}

leaf nr-of-inconsistent-control{
type uint64;
description
    "number of inconsistent control messages.";
}
} // list mpl statistics
```



```
} // module ietf-yang-mpl-statistics
```

<CODE ENDS>

4. IANA Considerations

This specification has no consequences for IANA.

5. Acknowledgements

Andy Bierman has commented on the use of YANG for mpl. YANG doctors pointed out a wrong use of config.

6. Changelog

Changes from version 00 to version 01

- o config false in "statistics" and "seeds" modules
- o separated into 4 modules
- o inserted choice in domain modules
- o renamed some parameters
- o Introduced section per module

7. References

7.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<http://www.rfc-editor.org/info/rfc2119>>.
- [RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <<http://www.rfc-editor.org/info/rfc6020>>.
- [RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <<http://www.rfc-editor.org/info/rfc6241>>.

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